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Innovation Policy for Inclusive Sustainable Development in the Arab Region

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Innovation Policy for Inclusive Sustainable Development in the Arab Region

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Executive summary

Research has demonstrated the effects of innovation, particularly in technology, on economic growth, industrial optimization, improved social welfare and environmental protection. Innovation is linked to all three pillars of sustainable development: economy, society and environment. The 2030 Agenda for Sustainable Development, launched by the United Nations in 2015, gives high significance to innovation vertically and horizontally. Horizontally, innovation is mentioned in several Sustainable Development Goals (SDGs) and targets explicitly and implicitly.[1] Vertically, innovation is important for implementation modalities, creative solutions and new financing schemes for development. Innovation and technology have also been the subject of think pieces and analytical studies by the United Nations in connection with the SDGs.[2]

In its modern understanding, innovation is defined in the Oslo Manual as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations".[3] The Manual then broadens this definition, considering innovation: as the result of advanced research and development (R&D) leading to new industrial products and services, as well as the result of new marketing or work organization methods in business practices. In such a context, innovativeness lies in original ways of using technology, not necessarily owning or inventing it. Innovation is thus new within its own context, a specific market or country or organization. This is specifically important for the Arab region, as innovation does not necessarily result from cutting-edge or original development of scientific knowledge. Rather, its transformative potential can be realized in addressing local issues or improving the livelihoods of communities.

The Economic and Social Commission for Western Asia (ESCWA) has shown interest in innovation since the beginning of the millennium, through studies and events on innovation in specific sectors and on measuring science, technology and innovation (STI). Innovation also has been embedded in the work of ESCWA since 2003 on developing an information society. Since 2015, ESCWA has given high priority to innovation in terms of its importance for sustainable social and economic development in the Arab region, and it became an integral part of its work programme. The expert group meeting on "Innovation and technology for advancing the knowledge-based economy in the Arab region", for example, resulted in recommendations that emphasized the importance of innovation policy for the Arab region (Amman, 3 and 4 June 2015). This study dovetails with the need for a guide to develop national innovation policies that cater to the concept of inclusive sustainable development in the region.

A. International and regional perspectives on innovation

During the first half of the twentieth century, public policies in developed countries emerged specifically to improve the situation of STI. The concept of an innovation system is closely linked with the formulation of such public policies. At its heart, a national innovation system (NIS) has a core engine comprising interacting actors: public sector, private sector, academia, research and civil society. The NIS concept was the subject of studies and research, with two models emerging as reference: the model of the United Nations Conference on Trade and Development (UNCTAD) and the model of the Organisation for Economic Co-operation and Development (OECD). This study examines both models, explaining the main differences between them. It proposes a framework for the Arab region that considers its specific challenges and priorities in achieving the 2030 Agenda.

A policy specific for innovation is determined largely by the nature of the NIS it aims to realize and the national challenges it wishes to address. There is no single definition of a modern innovation policy, because every country has its own specific situation and priorities. There are notable differences between developed and developing countries. Developed countries spend far more than developing countries on R&D, for example. Another difference is that the private sector in developed countries plays a more significant role in R&D activities and spending, especially in terms of technological breakthroughs that occur mainly in private companies. That is why some countries, especially in Asia, have introduced catch-up strategies through technological learning and innovation, where firms address their commercial objectives by applying knowledge that is new to them, even if that knowledge is not new globally or nationally.

Five Arab countries were selected as case studies in order to discuss the innovation policies developed. The study provides a summary on each innovation-related policy or strategy in Egypt, Jordan, Morocco, Saudi Arabia and the United Arab Emirates. While some countries have formulated policies specifically for innovation, others have incorporated innovation into STI policies or information and communications technology (ICT) strategies. Some national development plans refer to innovation, although in a limited way.

At a regional level, challenges associated with building a comprehensive NIS at the service of socioeconomic development are complex and costly. Arab countries should seek closer cooperation and integration while building and consolidating their respective NISs. The adoption of the Arab Strategy for Scientific and Technical Research and Innovation is a small step towards greater collaboration and a broader common approach to innovation.

B. The proposed innovation framework for Arab countries

The proposed framework, shown in the figure below, is a guideline for formulating innovation policies based on best practices drawn from the experience of advanced, developed and emerging countries, which managed to implement successful catch-up strategies and reach high technological and social development levels. The framework is customized to the needs and priorities of the Arab region while paying attention to inclusive sustainable development, which cuts across the framework's components. Different

stakeholders are involved in various components of the NIS, which constitutes the core of the innovation policy. ESCWA focused on the need to develop a robust NIS, which is a high priority for Arab countries.

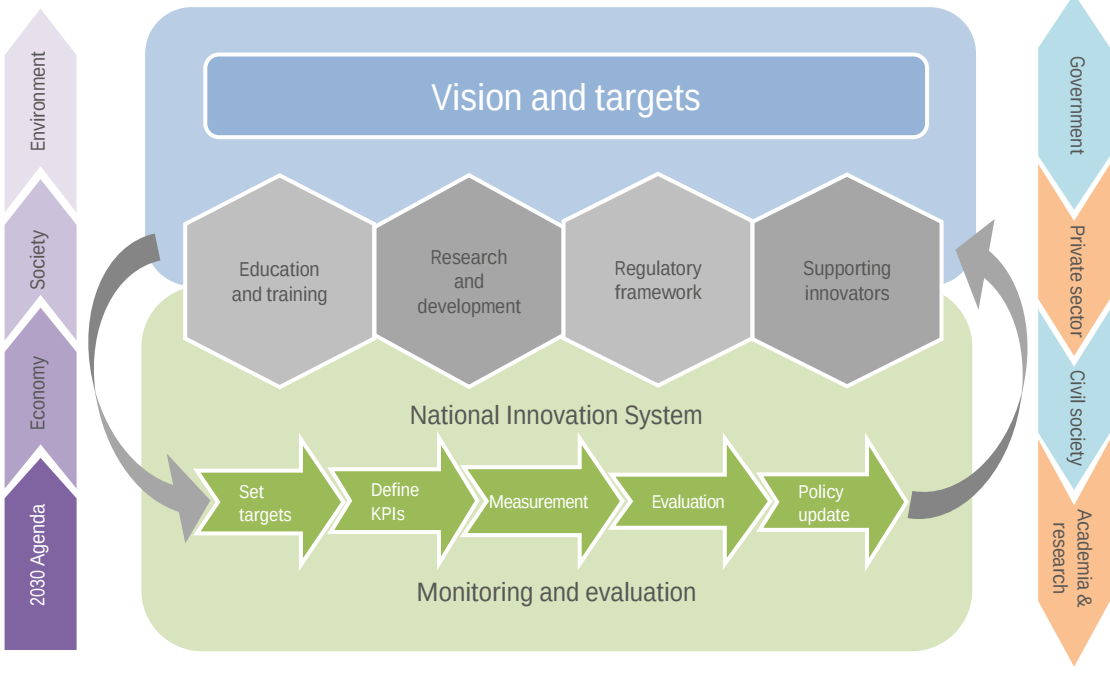
The true value of this framework lies in its details, along with the case studies that provide precedents for Arab Governments to emulate. The framework provides concrete approaches for devising innovation policies while considering social and environmental issues, in line with the SDGs. Such a framework requires a paradigm shift in the Arab region.

1. Innovation policy vision

The innovation policy should begin with a clear vision reflecting political will and commitment, while fulfilling broader socioeconomic objectives that address national challenges. The vision should be linked to the national developmental agenda. Absence of such linkage would create inconsistency in the policy's vision and/or show that policymakers do not view innovation as a contributing factor to socioeconomic development.

The innovation policy vision should provide answers to three questions: What for? By what means? By whom? The first question should be addressed through a set of strategic objectives or initiatives. The second question should be addressed by focusing on shortcomings and gaps of the NIS in order to propose projects and programmes. The third question should be addressed in terms of the needs and qualifications of stakeholders. The present study provides suggestions for an innovation policy vision in Arab countries.

Innovation policy framework for inclusive sustainable development



Endorsement of the vision at a high level emphasizes the vision's strategic importance and increases the likelihood that administrations and stakeholders will work together to achieve it. In practical terms, that is likely to require the formation of a high-level steering committee to oversee innovation policy formulation, implementation, evaluation and update. It is recommended that details of implementation be delegated to another agency with proper authority over other actors involved. The systemic nature of any innovation policy will lead to its implementation through policy measures under the responsibility of distinct ministries and government agencies dealing, for example, with education, industry, public research centres, trade, competition authorities and patent offices.

2. Components of the National Innovation System

ESCWA identified four main components of the NIS that require special attention in innovation policy for Arab countries. These components are organized under four clusters of issues related to education and training, strengthening the research and development base, elaborating a proper regulatory framework for innovation, and supporting innovators.

(a) Improving education and training

Developing quality education requires a new approach that differs from rote learning and memorization currently prevailing in Arab countries. That would require serious reform of the educational system and integration of new teaching methods focusing on critical thinking and active learning while paying attention to student well-being. At the level of secondary and tertiary education, policies should focus on the development of strong generic skills, so that specific skills can be acquired more easily during lifelong learning.

Vocational education training at higher secondary and post-secondary levels also should be central in a national educational reform policy, so as to increase the scope of skills and to address the scarcity of mid-level or craft competencies, such scarcity hindering industrialization efforts. Developing vocational education training is best carried out with active involvement of private companies.

Tapping on the skills of diasporas will contribute to building national skills. That is achievable through temporary recruitment of expatriate experts for developmental projects, offering expatriates the possibility to launch businesses in their home countries, and offering returning expatriates appropriate conditions to connect with global knowledge networks in their respective specialties.

(b) Strengthening research and development base

Arab countries should carefully consider legislation that addresses the main R&D challenges, which are: low overall spending on R&D, limited contribution of private companies to R&D, and the disconnection between R&D programmes and socioeconomic needs.

Policy measures should favour Bayh-Dole-type patent legislation and the establishment of technology transfer offices (TTOs). The open science movement, which Arab countries can join as contributors and/or beneficiaries, should be investigated. Innovation policies should give high priority to scientific collaboration among researchers in Arab and other countries, so as to strengthen national R&D programmes and participate in international research programmes. Arab Governments also should consider developing a grant mechanism to support R&D in the private sector. Whereas developed countries often opt for tax incentives,

that would not be the optimal choice for Arab countries because of weak tax systems.

(c) Consolidating the regulatory framework for innovation

Proper regulatory and legislative frameworks supporting the NIS are essential for Arab countries to ensure suitable technology transfer and development through trade, foreign direct investment (FDI) and public procurement. They are also essential to nurture and protect innovative start-ups through intellectual property protection and fair competition.

To enhance FDI, Arab countries should consider measures to establish predictable, non-discriminatory and transparent regulatory and legal frameworks plus simpler business-related procedures; reinforce and deepen regional economic integration along the principles outlined in the 2013 amendment of the Arab League Investment Agreement; and improve data collection of FDI statistics. Arab countries should also strengthen public procurement for creation of innovative solutions as well as catalytic procurement, where the public sector acts on behalf of end users.

Arab countries should strengthen their intellectual property frameworks and legislation, including patenting procedures. Fair and transparent competition is still absent in the vast majority of Arab countries and is a reflection of the rentier economic model, which is fundamentally harmful for innovators, particularly young entrepreneurs whose main assets are their energy and inventiveness. Fair competition laws are an essential complement to intellectual property frameworks because they contribute to the establishment of fair market behaviour.

(d) Supporting innovators

Young entrepreneurs need support and nurturing for their innovations to thrive. Arab countries should support innovators through business support schemes such as incubation and information services, financing (particularly early stage), and development of networks and clusters. Public-private partnerships are one way to offer such business services. Public policy should also seek to develop venture capital funds and provide public-guarantee instruments in cooperation with the banking sector, so as to meet the borrowing requirements of young firms.

Science and technology parks as well as business clusters are important mechanisms that help shape an innovation ecosystem. Networks are more formal types of relationships built around specific projects. Arab countries and firms should seek to improve networking with developed and emerging countries (in Europe, for example), as well as establish intra-Arab networks and/or reinforce existing ones.

3. Monitoring and evaluation

Monitoring and evaluation (M&E) should be an integral part of any innovation policy/strategy. Indicators that measure innovation policies generally address spending on R&D, innovation carried out by firms, exports of high-tech products and patenting, plus quality and quantity of graduates in technical and scientific disciplines. Choosing the most appropriate metrics for M&E depends on the specific targets and means set for the innovation policy. There is no one-size-fits-all recommendation, particularly in relation to impact and outcome indicators. It is appropriate to choose metrics that are relevant, measurable and feasible for targets and priorities set by the policy.

In all cases, Arab countries should improve their statistical data collection efforts for innovation-related indicators. In the monitoring system, a distinction should be made between indicators that measure the progress of implementing the adopted innovation policy/strategy based on the policy's proposed targets, contrasted with indicators measuring innovation at national level.

Composite innovation indices allow countries to be compared at the international level. The resulting rankings should, however, be handled with some caution as they most often reflect issues relevant for the most advanced countries. The best-known index for measuring innovation is the Global Innovation Index (GII). The GII, however, might not be the best index for developing countries, including Arab countries, for various reasons. Many regional and international organizations have worked since 2013 on the definition and implementation of an innovation scoreboard for the Middle East and North Africa (MENA) region. Nine Arab countries have joined that initiative. Other Arab countries are invited to join the project and to collect periodically the data related to the index.

C. Adaptation to the Sustainable Development Goals

As stated in the 2030 Agenda for Sustainable Development,[4] STI is an important issue that can provide countries with new opportunities to enhance economic, social and environmental development. In order to benefit from STI, it is necessary to optimize STI capacities and initiatives across national and thematic development platforms. This resolution includes the 17 SDGs with their 169 targets that countries and stakeholders will work to achieve during the next 15 years as part of the new Agenda.[5] Innovation was included in Goals 9 and 17.

When inspecting the targets of other goals, it becomes clear that STI activities should and/or could be used to help achieve many other targets.

The main challenge brought by the SDGs lies in their holistic nature, encompassing economic, social and environmental goals. An innovation policy adapted to address the SDGs need not include new additional components within the elements of its framework, but rather a broadening of focus from exclusively economic goals to goals that are social and environmental as well. The adapted innovation policy takes into account a more diverse range of actors; considers the regional and global situations; and integrates the concepts of openness and inclusiveness.[6] For Arab countries, such integration is feasible when Governments undertake the following: provide visionary leadership for STI as an integral component of SDG strategies; address social economy when building an enabling environment for STI; provide financing for social and environmentally relevant projects; provide incentives for talent to address social and environmental issues; and foster inclusive innovation, which allows the development of innovation driven by and made for the needs of poor and marginalized populations, particularly in low-income developing countries.

For the purpose of demonstrating how innovation policy could be customized to serve specific SDGs, the following three themes were selected:

- Youth employment. Policies and initiatives that target youth education, training and employment are necessary in all Arab countries, given that the region has the highest unemployment rate worldwide. Examples include macroeconomic policy coherence and active labour market

programmes comprising employment services, career guidance, job counselling, labour market information, and support for micro and small enterprises;

- Climate change. The Arab region stands as an example of potential adverse impacts of climate change at social, economic and environmental levels. Policies and innovations are needed to support mitigation measures, develop knowledge and capacity, and improve R&D programmes and expenditure;
- Social innovation. The Arab region needs to find innovative approaches, solutions and products to address social issues that public policies often fail to foresee or tackle. For social enterprises to succeed, they need a proper environment where social innovators can be mentored, financed and supported by public policy.

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Introduction

The science, technology and innovation (STI) landscape of the early twenty-first century is characterized by economic globalization and the emergence of information and communications technology (ICT) that facilitates information and knowledge sharing, allowing for new paradigms in research and innovation. It also affords a greater role in STI played by China and other emerging countries. The ever-rising costs of modern science and the widening gulf between STI champions and the rest of the world are a big concern for developing countries.

The Organization for Economic and Co-operation and Development (OECD) has noted that "the convergence of information technology, bio, nano and cognitive sciences has the potential to lead to 'the next industrial revolution', and already, the increase in the service component of innovation, as part of this evolution, is influencing countries' competitiveness".[7]

Arab countries should establish effective innovation policies. Such policies are necessary for developing socioeconomically and for reducing technological dependency, which could lead to a loss of effective independence. Also, such global issues as climate change, strained resources, environmental and social concerns are problems that could be addressed through specific innovation policies.

Those global issues are already high on the international agenda, following the adoption of the 2030 Agenda. STI plays a key role in implementing the Agenda at both country level and within a context of international collaboration.

Cooperation among Arab countries when implementing their respective innovation policies is essential, because of their deep cultural ties and the complementarities of their natural and human resources. Because of increasing complexities and costs, as well as globalization and interdependency of modern STI, even developed countries increasingly seek cooperation in order to raise or maintain their positions in ever-growing global value chains, so as to extract maximum value and to maximize job creation.

This study aims to provide Arab countries with a comprehensive framework that they can apply during the formulation, implementation and update of their innovation policies and/or strategies. Policies focus on high-level visions, substantiated by objectives and targets, while strategies focus on means and operational measures to achieve policy visions. It is noteworthy that some countries, including some Arab countries, have created mixed policy and strategy documents, formulated separate policy and strategy documents, or developed only strategy documents, sometimes simply called plans. Whichever terminology or approach is used, the proposed framework addresses both aspects of high-level policy vision and more operational issues that might be useful for strategy. This study uses the term "innovation policy" throughout to avoid unnecessary confusion.

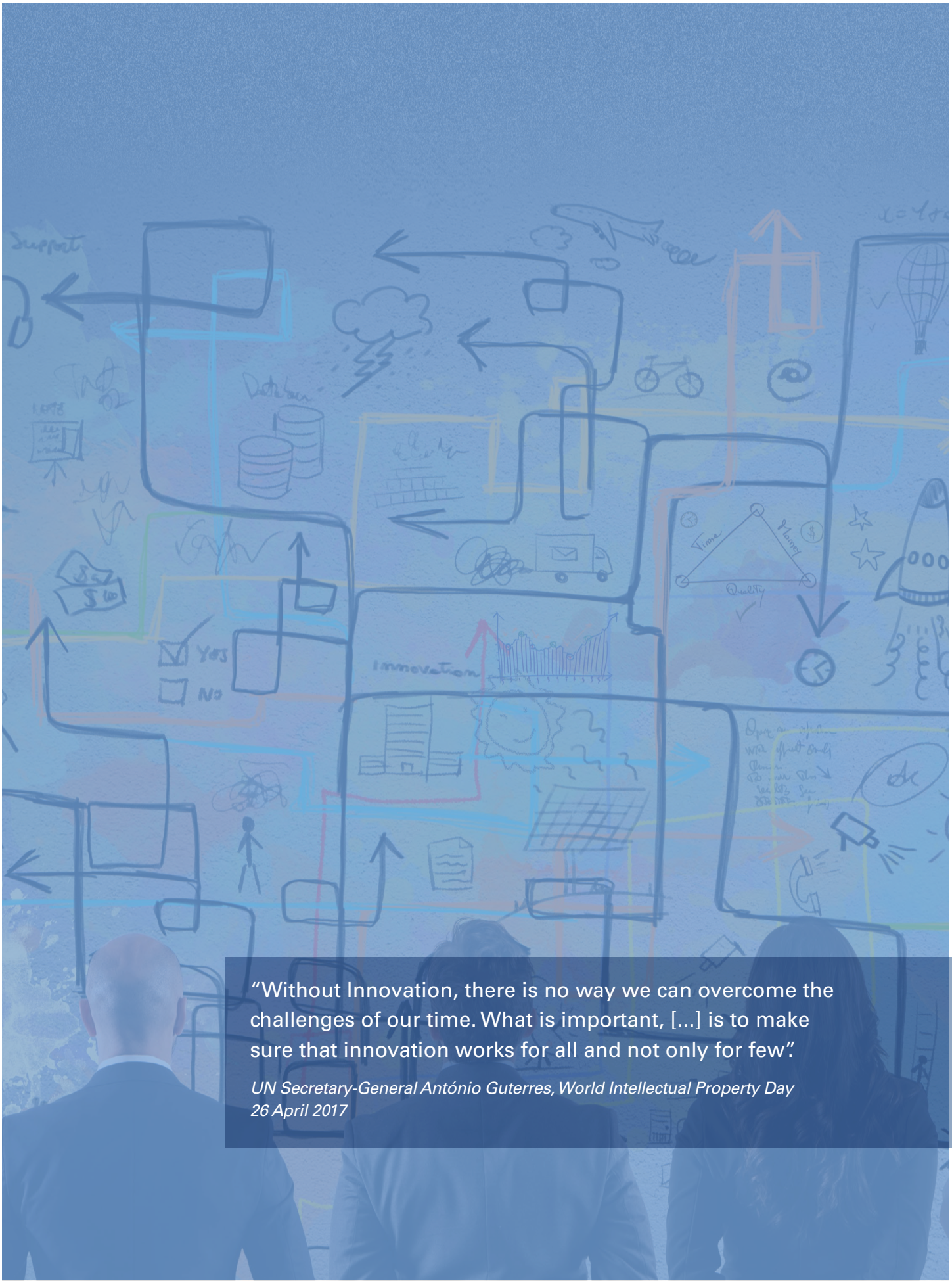
The study offers practical guidance for Arab policymakers and information for a larger readership of Arab stakeholders (including companies, universities and research centres) involved with aspects of innovation policy.

Part A of chapter 1 sets the scene by introducing essential concepts in innovation, then highlights the general approach and methodology adopted in the document. Parts B and C of chapter 1 discuss Asian and Arab country strategies respectively. Lessons drawn from Asian countries are of particular interest because of some of the unorthodox approaches (as gauged by mainstream recommendations currently provided to developing countries) used to rise to industrial and innovation levels comparable to those of advanced industrial economies.

Part A of chapter 2 focuses on the implementation of the innovation policy vision. It offers methodological guidance and suggests focus areas that the vision might address. The focus areas are drawn from an analysis of the situation in Arab countries. Although Arab countries differ in their situations and challenges, they share many common issues. Such issues include education systems, plus socioeconomic and/or sociopolitical models. They also include cultural values lying at the root of the gap between human and wealth potential and the current situation of production and the use of STI in the service of development. Part B of chapter 2 addresses four major policy areas that constitute intervention domains for innovation policies. Part C deals with monitoring and evaluation, plus issues related to indicators. It is addressed to national statistical institutes and all stakeholders within specific sectors (for example, education, research, industry and trade) in charge of collecting data. The intention is to raise awareness about essential indicators that can provide the data needed to support the implementation of an effective innovation policy. Chapter 2 also contains a boxed summary of the main policy messages.

Part A of chapter 3 addresses the impact of SDGs on innovation policies and the manner in which the latter can be adapted to address the global development agenda. The focus falls on the fact that innovation policies should be geared in such a manner that they contribute to development and the attainment of sustainable and socially equitable economic growth. Innovation policies should address environmental and social issues as well as economic growth, in what can be called the “triple bottom line”. Part B of chapter 3 selects three SDG-related sectors that are examples of high-priority issues that Arab countries face: youth employment, climate change and social innovation.

1. Innovation Policy and Innovation System: Global and Regional Perspectives



"Without Innovation, there is no way we can overcome the challenges of our time. What is important, [...] is to make sure that innovation works for all and not only for few".

UN Secretary-General António Guterres, World Intellectual Property Day 26 April 2017

1. Innovation Policy and Innovation System: Global and Regional Perspectives

A. Basic definitions

1. Innovation today

In its broadest meaning, innovation is as old as mankind, pre-dating the establishment of first civilizations. Human beings have always sought to overcome their physical limitations, plus master and adapt to their environment.

The modern concept of innovation was developed during the industrial revolution of the nineteenth century. Two factors were significant. The first was a scientific revolution, the cultural foundations of which were laid in Western Europe during the late sixteenth and early seventeenth centuries.[8] The second was more socioeconomic in nature, brought about by the advent of the modern capitalist economy where innovations, introduced by entrepreneurs and industrial firms through new products and services, became the major engine of economic growth. The perception of innovation and its supporting systems continued to evolve throughout the nineteenth and twentieth centuries and into the early twenty-first century, due to ground-breaking scientific and technical discoveries and important historical events (notably two world wars), which had a profound impact on the meaning of innovation and the role it plays in the economy and society.

The last wave of technical and scientific evolution led to a renewed interest in the concept of innovation and its systems, particularly since the last decade of the twentieth century. That was mainly, although not exclusively, motivated by the ICT revolution, which provided immense computing power on a personal level and also, through the Internet, instant communication and access to information and services at a global level.[9] Concomitantly, the global sociopolitical and economic evolution witnessed the end of the Cold War, the emergence of such new powerhouses as China, and the globalization of the world economy where trade, manufacturing and economic value chains leave no country, even among the most developed, fully capable of living only on its own resources, be they material or intellectual.

The interest in innovation and NISs evolved naturally from advanced economies seeking new economic growth to preserve and enhance their living standards. It is in that context that the work of the OECD led to the current concepts of innovation, NIS and innovation policies.

In its modern usage, innovation is defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations".[10]

The Oslo Manual[11] definition of innovation is broad, considering innovation as the result of advanced R&D leading to new industrial

products and services, in addition to new marketing or work organization methods in business practices. In those contexts, innovativeness lies more in original ways of using technology than in its ownership. A second observation involves the scope of the word "new". Something is considered innovative if it is new in its own context (for example, a given market, country or organization). Both considerations are important for developing countries. Innovation does not necessarily result from cutting-edge original development of scientific knowledge. Its relevance and impact are heightened if the innovation addresses local issues and improves livelihoods of the populations concerned.

2. National Innovation System

The concept of an innovation system is closely linked with the creation of public policies seeking to improve the global situation of STI, which emerged in some developed countries during the first half of the twentieth century.

Initially, the justification of public policy intervention in STI originated from neoclassical economic theories about market failure resulting from suboptimal levels of investment in R&D and the resulting level of innovation. Public policy intervention was needed to address the following three major effects of market failure that led economic actors (mainly companies) to reduce their R&D investments:

- Externalities, creating fear that competitors might appropriate the result of R&D and the company not be able to fully monetize the value of the knowledge it generates);
- Uncertainty, resulting from information asymmetry leading economic actors (whether firms, entrepreneurs or investors willing to provide them with funding) to adopt overcautious attitudes and underinvest in R&D;
- Indivisibilities, where pooling of efforts and cooperation even among would-be competitors is required to reach the economies of scale needed in some complex R&D efforts.

The intervention scheme described above is closely associated with a linear model of innovation in which research leads to development of new products, leading, in turn, to mass production and, finally, marketing.[12]

Modern economic evolution[13] (where innovation more frequently follows a non-linear model, meaning that innovation can come from a variety of sources, as well as new so-called "evolutionary economics")[14] has led to a new understanding of the systemic nature of innovation. Authors of the late 1980s and the early 1990s started introducing the concept of a NIS.[15]

One definition of a NIS is as follows: "The system of interacting private and public firms (either large or small), universities, and government agencies aiming at the production of science and technology within national borders. Interaction among these units may be technical, commercial, legal, social, and financial, in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology."[16] Although the definition does not specifically mention innovation, innovation is implicitly a result of the effective interaction among the mentioned stakeholders. In another complementary definition taken from the same source, the NIS is defined as "the set of institutions whose interactions determine the innovative performance of national firms".[17]

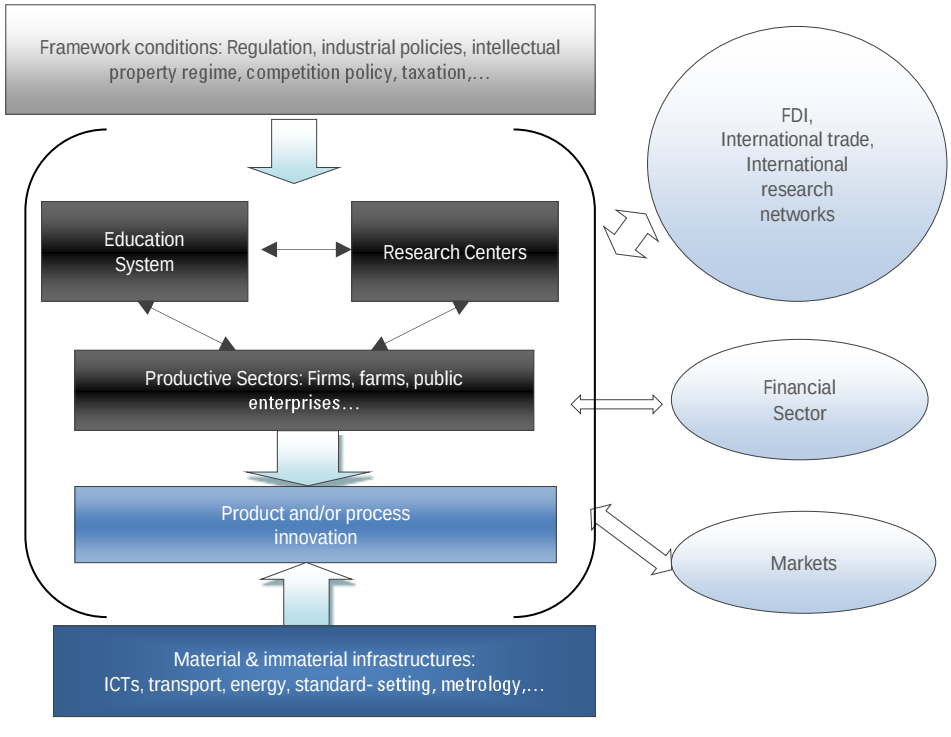
The same source elaborates: "The key insight of the systems approach is that the differences observed in the innovative performance of economies are mainly due to differences in the

system of interacting actors (firms, universities, research centres, public agencies) involved in the production, diffusion and use of science and technology as well as the environment in which those actors operate. Since the interactions within the innovation system can take place through market and non-market mechanisms, the justification for policy action is not merely to respond to market failures but also to systemic failures (in infrastructure, institutions, networks, regulations, coordination, path-dependency and lock-in effects, for example) that impede innovation."[18]

A NIS can be viewed as having at its heart a core engine comprising three categories of interacting innovation actors. The efficiency of the engine is influenced by framework conditions, plus material and immaterial infrastructure. The core engine of innovation impacts, and equally is impacted by, markets, the financial sector and other factors that influence the innovation process, including foreign direct investment (FDI), international trade and globalized research networks. A schematic diagram of a NIS is shown in figure 1.

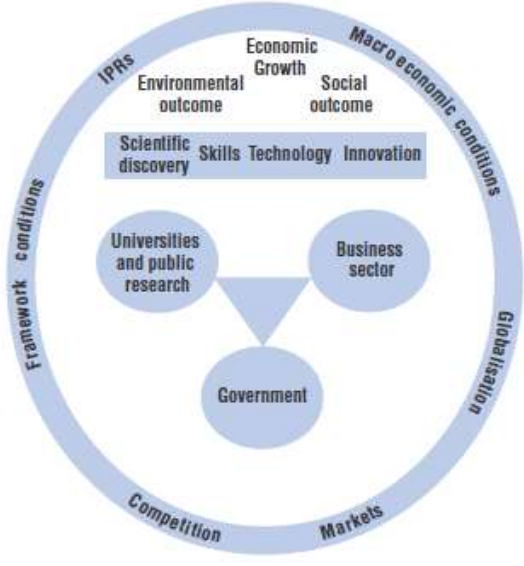
OECD, in its biannual Science, Technology and Industry Outlook,[19] uses, for the purpose of its own review of innovation systems in surveyed countries, a similar model for an innovation system (figure 2).

Figure 1. A schematic diagram of a national system of innovation



Source: UNCTAD, 2011.

Figure 2. OECD model of an innovation system



Source: OECD, 2014b.

Some nuances exist between the two models that shed light on differences in priorities between developed and developing countries. To start with, and irrespective of differences in the NIS model, developed countries generally have at least a basically functioning NIS, while in the majority of developing countries, a NIS is yet to be built.

The first striking difference between the two models is that universities and public research are present (as a single core actor) in the OECD model but government is explicitly added as a third actor. That, in turn, is due to the following three factors: the government's role as an innovation actor to improve delivery of its own service (for example, e-government); the government's ability to provide fiscal and other incentives for individuals and firms to embark on innovation activities; and the government's role in defining public research agendas and budgets that shape the national research landscape.[20]

The addition of government as an actor is important even if it does not play the same role in the majority of developing countries as it does in developed ones. However, the resources of many Governments in Arab countries, particularly, although not exclusively, among the highly resourced Gulf Cooperation Council (GCC) countries, are fully able to play the role outlined above, especially with reference to the first and third categories.

The second major difference lies in the production of the innovation process. While the UNCTAD model focuses on the generation of product and/or process innovation, the OECD model considers the generation of, and access to, skills, technology and scientific discovery, in addition to innovation. Innovation is considered as producing economic growth and creating concomitant environmental and social outcomes.

While the somewhat narrow scope of product and/or process innovation in the UNCTAD model might be suitable for many developing countries, the consideration of innovation's impact on economic growth plus environmental and social outcomes is important even for developing countries. In many developing and emerging countries, a balance between economic growth and social and environmental outcomes is still missing. China, for example, faces major environmental challenges as an unwanted by-product of rapid economic growth. In the light of the 2030 Agenda, which will be discussed in chapter 3, the role of innovation in ensuring economic growth and consideration (even improvement) of environmental and social outcomes is all the more important. No Arab country is an exception in that respect.

The third major difference lies in the consideration of the macroeconomic framework and global conditions surrounding and

supporting innovation. While conditions are more or less similar in both models, the UNCTAD model is more directive with regard to the role of framework condition and material and immaterial infrastructure (not specifically emphasized in the OECD model) in influencing the core innovation system. That is likely to be more suitable for developing countries and for Arab countries.

3. Innovation policy

Innovation policy is determined largely by the nature of the innovation system it aims to realize and the challenges it should address in order to fulfil that goal. For example, early innovation policies that addressed mainly market failure were narrow in their scope (sometimes limited to specific industrial sectors) and were aimed at supporting firms to enhance their R&D expenditure and/or to pool resources and efforts with peers, even if they were competitors, for overall sector advancement and the country's global competitiveness.

While such intervention mechanisms are still applicable and valid, the innovation system models discussed above imply that any innovation policy is necessarily broader in its scope, "complex and demanding in its design, implementation and monitoring", according to the OECD.[21]

There is no universal definition of modern innovation policy, because each country has its own specific situation and priorities. However, quite a large consensus exists regarding the main issues that innovation policy should address and the challenges it should deal with, particularly in the context of developing countries. The best definition of innovation policy can be found through observation and study of the best practices and lessons learned from the experiences of developed and developing countries. Some key issues that any innovation policy should address, particularly in the context of developing countries, are as follows:

- Scope. As already implied, any innovation policy is necessarily broad in scope. It is concerned with strengthening the 'supply side' of knowledge and technology and management of the 'demand side', as well as the interactions between the two sides and the development of enabling conditions. In a complementary view emphasizing specific challenges faced by developing countries, an innovation policy should provide four main functions: support innovators by appropriate incentives and mechanisms; remove obstacles to innovative initiatives; establish responsive research structures; and foster a creative and receptive population through an appropriate education system;[22]
- Science and technology transfer. Developing countries are characterized by the large size of the informal sector in their economies, dominated by micro-, small- and medium-sized firms. In such a context, innovation "is more incremental than radical and takes place in an informal setting more often than it does in formal R&D laboratories" and, most importantly, "innovations are primarily driven by investments in and mastery of new machinery and equipment that embody more advanced technologies".[23] Even when, in addition to the above, larger-scale investments are carried out in a more formal setting by large national firms (whether private or state-owned) or by subsidiaries of foreign firms through FDI, "innovation policy for development is fundamentally concerned not with the generation of new knowledge but with jump-starting, fuelling and managing a process of learning, and developing the [national] competencies and capabilities

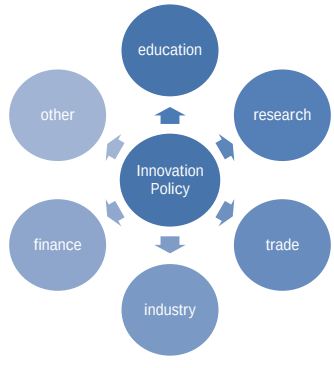
that are required for such technological learning and catch-up to succeed";[24]

- Socioeconomic impact. Any innovation policy should build on the political leadership's vision of a global society and have socioeconomic impact. That is valid even for developed countries and all the more for developing ones. A key principle that developing countries should adopt when devising their innovation policies is to maximize innovation in all industries. That might seem basic common sense, yet there is evidence that "developing nations that emphasize across-the–board productivity and innovation perform best".[25] In more practical terms, innovation policy should put "much greater importance of accelerating innovation in agriculture" and "the importance of understanding and addressing innovation processes in the informal sector".[26] In addition: "The role and significance of innovation goes beyond the objective of economic success. Rather, it should be seen through the lens of inclusive development for both men and women [and related inclusive innovation] because it can address poverty and health issues, and through the lens of environmental sustainable development because it can address problems of pollution and energy provision";[27]
- Types and phases of innovation. Innovation can occur at different points of the value chain from initial conception, R&D, transfer to production, and deployment to markets. The Oslo Manual prescribes surveys not only of innovation in terms of products (goods or services) and processes, but also in terms of marketing and organizational practices. In OECD countries, most innovative firms combine several modes of innovation, while services innovation has become a driver of competitiveness in global value chains.[28] Strategies of sophisticated countries recognize this broader scope and "their innovation strategies constitute a coherent approach that seeks to coordinate disparate policies towards scientific research, technology commercialization, ICT investments, education and skills development, tax, trade, intellectual property (IP), government procurement, and regulation in an integrated fashion that drives economic growth by fostering innovation";[29]
- Governance of innovation policies. The issues discussed above regarding the nature and scope of innovation policy lead to the conclusion that a 'whole-of-government' approach is needed for governance through a powerful coordinating body, placed at the centre and highest level of government, in order to allow for innovation policy to have pervasive influence as shown in figure 3. A similarly central role can be replicated at subnational level (regional or even local), where "innovation takes place primarily in a local milieu with a concentration of knowledge, talents and entrepreneurs".[30] Such a governance model, although necessary as being a direct consequence of the system approach adopted for a NIS, is highly challenging for Governments of developing countries in terms of material resources and competencies. Often, in such countries, innovation policy is entrusted to ministries of science and technology which, in addition to their narrow focus, "tend to lack the political weight that would be needed" and where "budgets for STI policymaking are extremely low, when they exist at all".[31] Consequently, innovation policy, particularly in the context of developing countries, should be viewed as central to government action and placed at the highest level of a pyramid of policies and measures related to the establishment

of key framework conditions, effective tax, trade and investment environments, and key factor inputs as shown in figure 4. The four layers mentioned here are "not sequential in the temporal sense but rather reflect the fact that even the most sophisticated innovation policies will not produce the desired results if they are not based on a strong foundation".[32] Sadly, it is quite common, that "nations often focus on the top of the pyramid because these are often the easiest to implement politically… while some of the policies at the base of the pyramid are much more difficult to achieve politically because change challenges entrenched interests in government or the private sector";[33]

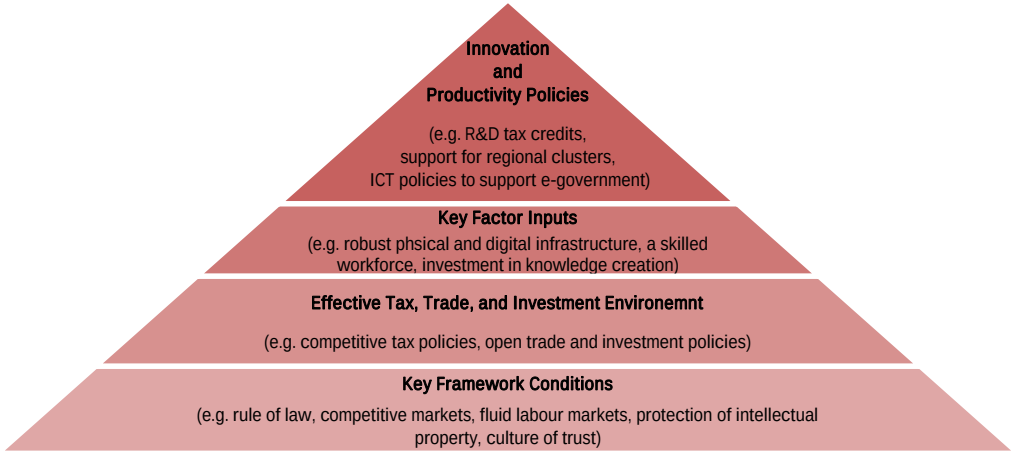
- Measurement issues. Measurement through reliable indicators is essential for the proper monitoring and evaluation of any policy. STI is no exception. The difficulty of STI measurement stems from the broad scope of the systemic approach of a NIS. That means that data on important framework conditions must be collected, as well as data relating to trade, investment, core innovation, patenting and R&D activities. An issue of concern in many developing (and Arab countries) lies in the correlation between low innovation levels and bad data. Although a detailed discussion of STI measurement frameworks is beyond the scope of the current document,[34] developing countries should at the very least start conducting systematic company surveys in accordance with the Oslo Manual methodology and address innovation in the formal as well as in the informal sector because of the importance of the latter sector in their economies.[35]

Figure 3. Model for a strong innovation policy



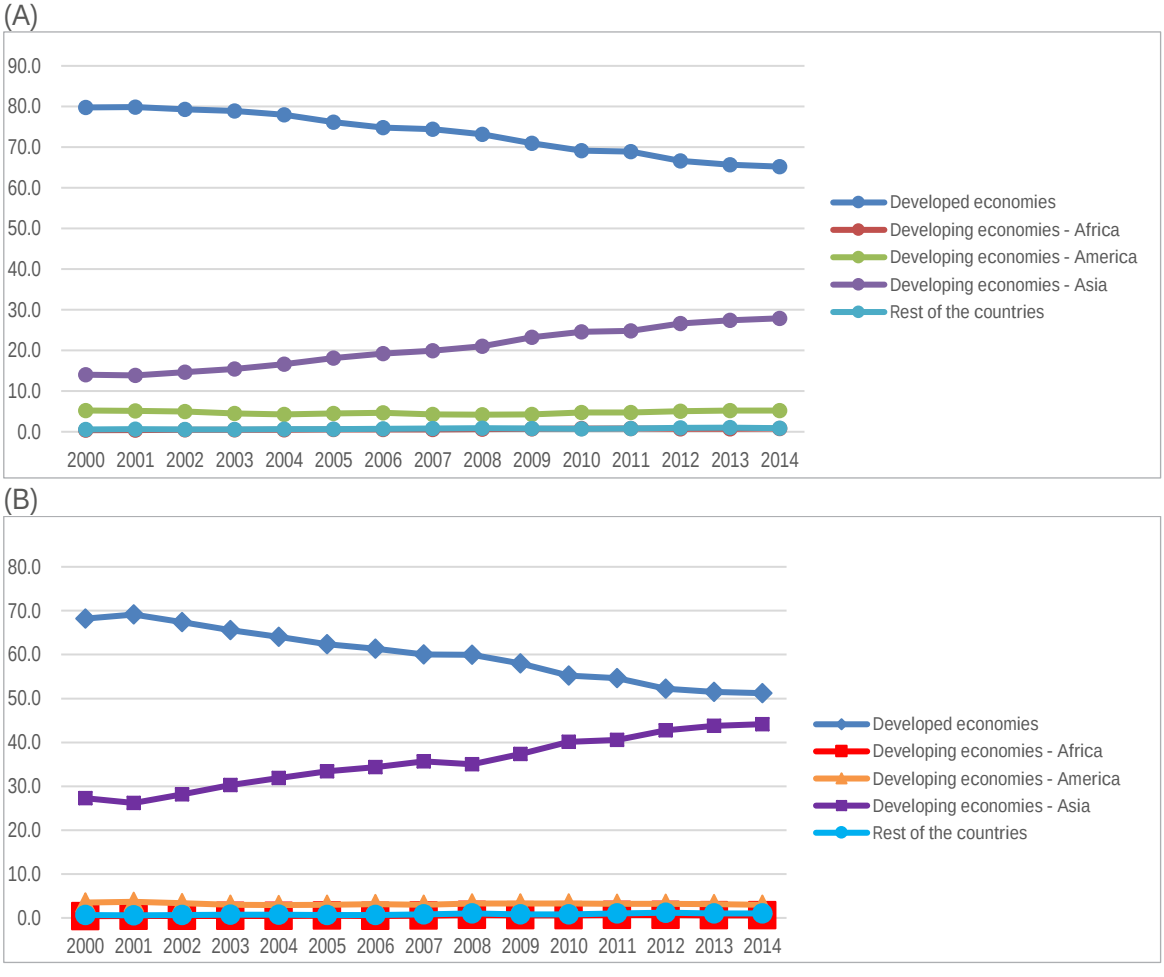
Source: World Bank, 2010.

Figure 4. The economic growth policy pyramid



Source: Atkinson, Ezell and Information Technology and Innovation Foundation, ITIF, 2015.

Figure 5. Distribution of medium-technology (A) and high-technology (B) manufacturing exports by different country groups, 2000-2014 (percentage)



Source: UNCTAD, 2015.

Based on the discussion above, the following working definition of innovation policy is suggested:

> Innovation policy comprises the broad set of policy measures that address both the demand and supply side of knowledge and technology for the purpose of ensuring sustainable economic growth and addressing social and environmental concerns. Innovation policy should be elaborated at the highest political level with a whole-of-government approach and ensure proper monitoring and evaluation of its actions through adequate and measurable indicators.

B. Current landscape of innovation policies and establishment of NIS

"The success of a number of developing countries in technological and economic catching-up, mainly in East Asia, has renewed interest in technology and innovation among

policymakers in many developing countries."[36] Judging by their share in high- and medium-technology manufacturing exports, it is most revealing that, among developing countries, only those of the Asian continent have managed to secure a sizeable share of it and keep improving since the beginning of this century, as shown in figure 5.

Innovation policies are equally high on the agenda of advanced developed countries. That is due to new technologies that are shaping tomorrow's industries and services, affecting work conditions and ways of living, while contributing to globalization in which even advanced economies are struggling to ensure economic growth and defend positions in increasingly globalized value chains.[37]

1. Innovation policies 'hot issues' in advanced countries

The OECD STI outlook questionnaire provides a good overview of the situation of innovation policies in advanced OECD and other emerging and associate countries.[38] Some of the main innovation policy priorities or 'hot issues'[39] identified by surveyed countries will be discussed below. These hot issues shed a light on how new scientific and technological developments as well as globalization shape the innovation policies of countries, including developing and Arab ones.

(a) Public research infrastructure

Although public research represents less than 30 per cent of total R&D in OECD countries, it plays a key role in basic research and, subsequently, in the innovation system by "providing new knowledge and pushing the knowledge frontier". It represents more than three quarters of basic research carried out in OECD countries.[40]

Beyond being a key provider of basic science, public research must address important issues, including how to attract and keep local and international talent. It is expected (particularly in times of low public budgets) that basic research will contribute to the economy through knowledge transfer to industry and adapt its "governance arrangements, incentive frameworks and academic culture to this new context transfer". A third substantive area consists in technology convergence, which requires the development of interdisciplinary research structures away from silo-type research.[41]

These issues can have impact on public research infrastructure (PRI) policies and can potentially result in the following policy trends:

- Increased attention to multidisciplinary sciences. "Some countries have reinforced an interdisciplinary approach to public research governance, evaluation and funding arrangements to address 'grand challenges' such as climate change, ageing societies and development";[42]
- Emphasis on efficiency, prioritization and concentration of resources. "This has led to a restructuring of research activities: an increase in mergers and in the size of institutes, better co-ordination across research units, and the introduction of new public management approaches in universities and PRIs to reinforce autonomy, accountability and business-like operational models";[43]
- Development and strengthening of PRIs. "[With many countries] engaged in long-term planning through roadmaps and master plans, better co-ordination of research units and increased investment in research capacity and platforms";[44]
- Internationalization of public research. Policy trends address a variety of measures

from "performance-based funding for institutions or grant funding for research projects to include criteria that favour or stimulate international co-operation", mechanisms such as grants or simplified visas to attract inward mobility of high-performing scientists, support of outward mobility of own students to gain experience abroad, and encourage researchers based abroad to return to their home country[45] (box 1).

(b) Human resources and skills for innovation

An OECD survey[46] of adult population problem-solving proficiency in a technology-rich environment (requiring computer literacy and cognitive skills) found that nearly two thirds of the population lacks the necessary skills.
A major policy priority lies in improving the percentage of entrants to tertiary education in science, technology, engineering and mathematics (STEM) fields. In 2012, that level stood at an average of 38 per cent in OECD countries. For example, "as part of the Five-Year Strategic Plan for Federal STEM Education (2013), the United States aims to increase the number of graduates in STEM fields by one third, or one million, over the next decade". One key element to boost participation and interest in STEM fields lies in raising skills of teachers or reforming school curriculums. "Initiatives to attract top STEM graduates into teaching, particularly in low-performing schools, are another policy option."[47]

The availability of STEM specialists is important, because skills associated with innovation necessarily include specialized knowledge. However, problem solving, creative thinking and behavioural skills are equally important. Consequently, policy initiatives in many countries address such entrepreneurial 'soft skills', starting at school level. For example, "Denmark's national innovation strategy (2012) aims to integrate innovation and entrepreneurship training into mainstream education at all levels through initiatives such as more practice-based instruction"; and "entrepreneurship is now a mandatory component in primary and secondary schools curricula in Sweden and Finland".[48]

Although employment rates of university graduates were close to 90 per cent (OECD average) in 2012, two observations are worth highlighting: a gender gap issue, the proportion of employed women generally being lower; and issues concerning suboptimal skills allocation and global averages. For example, according to one OECD study, "between 10 per cent and 40 per cent of doctoral degree holders do not work in research and many are in jobs unrelated to their doctoral degree, especially after a few years of their working life".[49]

Box 1. Bringing scientists back home

Measures taken by some OECD members and leading emerging countries to bring their scientists back home indicate the phenomenon of brain drain, which, due to globalization and internationalization of science, could affect any country.

In Argentina, the Scientists and Researchers Overseas Network establishes links with Argentinian researchers located abroad and encourages their return to the country through job opportunities. China's Thousand Talents Programme offers relocation stipends to world-renowned Chinese researchers working abroad. Belgium, Finland, France, Germany, Slovenia, Sweden and Switzerland provide financing or assistance for expatriate researchers to return to their home countries. The Momentum Programme in Hungary provides funds and domestic career opportunities to reduce emigration of young researchers. Israel aims to compensate for a recent brain drain by recruiting Israeli researchers working abroad for 30 new centres of excellence in universities.

Source: OECD, 2014b, p. 134.

Policy measures primarily aim to improve employability and career patterns of university graduates (with particular attention to doctoral degree holders) and to address skills mismatch and gender gap issues. Policies deal with three main features, as follows:

- Demand-pull. To improve demand for highly skilled labour, whether in companies (for example, through tax incentives for hiring PhD holders) or in academia and public administration (job creation and centres of excellence);
- Supply-pull. To improve training and lifelong learning opportunities (for example, by developing a national qualification framework), encouraging the mobility of the highly skilled (through legal measures related to immigration, universities and public employment), targeting researchers (through financial incentives and scholarships) and targeting inactive/underrepresented populations (measures to reduce gender/minority gaps);
- Matching demand and supply. To monitor and forecast gaps (data collection on market needs), information systems and skills frameworks (development of information platforms to better connect labour markets and skills formation systems) and skills policy governance (joint participation by business and academia in the design of a skills policy agenda).[50]

(c) Innovation in firms and entrepreneurship

Although firms in OECD countries support the majority of R&D efforts, government funding of business R&D (as a percentage of GDP) is not negligible. It could represent more than (or nearly) 0.4 per cent in such countries as France, the Republic of Korea, Russia and Slovenia, 0.27 per cent in the United States and 0.1 per cent in China[51] and Japan. The government's support of a firm's R&D takes the form of either direct funding (grants loans, procurement) or indirect funding (R&D tax incentives).[52] It is, therefore, important that policy deals with issues related to adjusting and improving the efficiency of support measures for firms.

In contrast, evidence from some major OECD countries, such as Brazil, shows that "young firms less than five years old represented about 20 per cent of non-financial sector employment over the last decade [the first decade of the twenty-first century] but have generated nearly half of the new jobs". Although "most start-ups exit within five years, those that survive grow very fast on average and contribute more than proportionally to employment and productive growth".[53] Policies should, therefore, support innovative entrepreneurship in a context of falling venture capital (VC) and business angel investments, both important financing sources for innovative start-ups.

Major policy issues relate to the implementation of a proper policy mix to support a firm's R&D, create instruments to promote entrepreneurial financing, and support innovative start-ups. They include the following:

- Policy mix. An important issue for Governments of advanced countries is the policy mix for measures aimed at supporting a firm's R&D. The intervention instruments comprise the following:
  - Population-targeted versus generic instruments. The former are "those targeted towards specific types of firms, especially SMEs [small and medium enterprises] or new-technology based firms". During the past decade, the policies in many countries have moved towards targeted instruments;
  - Sector- and technology-targeted versus generic instruments. The former "support specific fields of R&D and

innovation or specific industry sectors". Although half of surveyed countries indicated that they are moving towards sector/technology-specific instruments, some notable exceptions (China and Germany) are moving towards more generic support;[54]

- Financial versus non-financial instruments. The former include both direct and indirect financing and the latter "include a variety of tools, including business innovation services, organization of events, and information campaigns that promote business innovation". Although there is a movement towards non-financial instruments, the balance remains in favour of financial instruments in 75 per cent of countries;
- Competitive versus non-competitive instruments. The former "selectively allocate funding on the basis of criteria such as expected performance and relevance", while the latter "may be granted universally or after a short selection process based on eligibility criteria". There is a strong tendency towards competitive instruments. As usual, there are always exceptions;
- Supply-side versus demand-side instruments: The first option aims to "boost knowledge production and supply" while the latter aims to "focus on boosting market opportunities and demand for innovation as well as encouraging suppliers to meet expressed user needs". Although there is a long-standing and continuing focus and dominance of supply-side instruments, many countries nonetheless indicated that they expected to see an increased emphasis on demand-side instruments;[55]

- Promote entrepreneurial financing. Access to financing is a major difficulty faced by innovative entrepreneurs even in advanced countries. Public financing has acquired a more important role since the decrease of VC and business angel financing;
  - Direct financing plays an essential role and could take different forms, including grants and subsidies (primarily small seed amounts to finance feasibility studies or proof of concepts in SMEs), public VC particularly at the seed and early stage, and loan guarantees (one of the most common tools) for entrepreneurial companies during the entire technology life cycle through loans at reduced interest rates (soft loans) or paid back in the event of project success;
  - Tax incentives are the major form of indirect mechanism financing and are often combined with direct financing in most countries. In 2013, for example, 27 OECD countries provided tax incentives for R&D;
  - Third-party financing through crowdfunding enabled by the Internet and social networks is growing rapidly (more than 700 platforms globally in 2013). Although not a government-financed mechanism, third-party financing should be properly regulated by governments, to ensure scientific integrity and reduce cyberfraud risk;[56]
- Innovative start-ups and entrepreneurship. Supporting innovative start-ups does not stop with financing issues. Other important measures related to the provision of a supporting environment include the following:
  - Business incubators. Although they have a long-standing tradition in OECD countries, some countries "have decided to include incubators in their

NIS to improve the quality of publicly sponsored advice and training";
- Simplified business regulations are aimed to ease market entry for new businesses. Italy, for example, "has reduced registration fees, taxation and social contributions for R&D-based start-ups";
- Business accelerators help fast-growing entrepreneurs through skills development and mentoring services. Most "involve public-private partnership in which programme activities are delivered by private sector organizations such as business consultancies and business advisors";
- Government investment funds could bolster innovative start-ups. For example, the Republic of Korea "has set up a public-private Future Creation Fund worth $471 million, two fifths of which is reserved for start-ups and firms less than three years old";
- Entrepreneurship support programmes target specific populations (youth, seniors, women, and people with disabilities) through a combination of financial assistance and business advice.[57]

2. Lessons learned from successful catch-up strategies of Asian countries

Apart from the essential difference between developed and developing countries, where the former spend much higher amounts in R&D as a percentage of their gross domestic product (GDP), another salient difference lies in the fact that in developed countries R&D is essentially taking place in firms pushing the frontier of knowledge in their own laboratories. Consequently, "STI policy in LDCs [least developed countries], as in all developing countries, should be geared to technological catch-up with more technologically advanced countries through technological learning and innovation. Innovation in this context occurs when firms commercially apply knowledge that is new to them, even if it is not new to the world or to the country".[58]

Japan, the New Industrial Economies (NIE) of the Republic of Korea, Singapore, Hong Kong and Taiwan, and more recently China, offer examples of the implementation of successful catch-up strategies.

The high rates of the gross capital formation (GCF)[59] as a percentage of GDP are characteristic of Asian economies. In 2010, that figure was 45 per cent in East Asia (including China and the Republic of Korea), 35 per cent in South Asia, and 28 per cent in South-East Asia.[60] In contrast, the average of the MENA region (including the GCC) is 25 per cent, and has declined slightly since 1969. Egypt, the major non-GCC Arab country, has seen a decrease in GCF from 30 per cent in 1982 to nearly 20 per cent in 2010, essentially due to the fall in the public sector's contribution from 20 per cent to 10 per cent, with no compensatory increase from the private sector.[61]

In addition to capital formation, a second element of growth is skilled labour. At the global level, "most countries with a low level of GDP per capita in 1981 appear to have increased the average years of tertiary schooling faster than those with high standards of living at the beginning of the period".[62] That is a logical catch-up ingredient, because the ability to absorb new technologies and innovate is dependent largely on advanced skills, particularly in STEM specialties.

However, growth theory acknowledges the high importance of total factor productivity (TFP), which combines the ingredients of capital and

labour to produce higher growth.[63] The growth of TFP reflects the impact of technological progress and innovation, playing a key role in the growth trajectory of any given country.

Consequently, favouring the accumulation of labour and capital, even though necessary, is not enough. Innovation policies should support innovative capabilities in order to make good use of existing technology and gradually contribute to technological progress plus successful non-technological innovation.[64] In that respect, the experience of Asian countries offers useful lessons about successful catch-up strategies in terms of learning and innovation, the role of government and industrial leapfrogging.

(a) Learning and innovation trajectories

A three-phase sequence was observed to apply in a range of industries in East Asia, including garments, machine tools and motorcycles. Successful assimilation of foreign technologies within a country involves the following three phases: initiating production by importing foreign technology and implementing production by pioneers; following in the wake of pioneer success, the emergence of followers and the expansion of production quantity, leading to a decline in profits; triggering upgrading through incremental technological improvements to process and product design, resulting in quality upgrades and a possible shift from producing for local markets to producing for export markets.

The first step of assimilation and appropriation of imported technology involves costs and risks, depending on technological efforts of various kinds and the development of various technological capabilities at the level of the firm and the farm (if the imported technology concerns agriculture). Technical mastery of imported techniques involves acquisition of tacit knowledge through training, experience and watching. That is essential for necessary adaptations in establishing and operating new facilities.

A consequence of that gradual learning process is that firms begin with simple assembly operation and graduate towards more complex tasks, such as process adaptation and R&D. As the firm moves closer towards the technology frontier of leading firms, the relationship with foreign buyers evolves from original equipment manufacturer (OEM), to given production specification, to own-design manufacture (ODM) and, finally, own-brand manufacture (OBM).

Accompanying policies should be adapted as the country or given industrial sector evolves over time in technological maturity. The experience of Asian countries shows that the role of government was essential in accompanying and nurturing emerging industries, particularly in the fragile early steps of knowledge acquisition and mastery of imported technology.

For example, during the early stage of catch-up in the Republic of Korea, "the most important policies for technology acquisition were implicit policies: both trade policy and financial policy stimulated demand for technology. Trade policy involved a combination of tariff protection to stimulate domestic business start-ups and export promotion to push firms to become internationally competitive, as well as some protection for the domestic machinery industry to enable capital goods to be imported at international prices". In that early step, the role of R&D was minimal: "Public research institutes were set up but played a minimal role in technology development: rather, they helped local firms strengthen their bargaining power in relation to foreign technology suppliers."

However, "during the later stages of catch-up, from the 1980s onwards, when firms from the Republic of Korea were importing more complex technologies in medium- and high-tech industries... this situation changed. Policies affecting the domestic supply of technology, and in particular the Republic of Korea's own research and development programme, assumed more importance, and policies to stimulate demand, increase supply and link the two all worked effectively together".[65] Table 1 summarizes the role played by R&D activities in business, universities and government research institutes in the Republic of Korea during the different maturity phases of its industrialization.

(b) Role of government

An abundant literature[66] analyses the impressive industrial and economic take-off of Japan and NIE. One salient feature that characterizes the catch-up of those countries' firms with the most advanced technologies lies in the role played by government to support and orchestrate an effective mix of industrial and innovation policy.

"Unlike many other Governments that intervened extensively, those in East Asia did so not to constrain the business sector as a whole in the interests of other classes ('populism'), and still less to replace private enterprise ('real socialism'); nor did they seek simply to extend favours to certain individual interests ('crony capitalism'). [Rather,] it was to promote the interests of the business sector as a whole, and... to do so by creating new wealth through capital accumulation and productivity improvement [and] ensure that the behaviour of individual businesses accorded with the long-term interest of the business class as a whole in generating a rapidly growing volume of profits and capital."[67]

Table 1. Evolution of R&D activities in the Republic of Korea

	Initial stage	Intermediate stage	Knowledge-intensive stage
Business R&D	• Little R&D investment; • Imitative reverse engineering; • Limited engineering.	• Formative stage; • Advanced reverse engineering; • Development and engineering.	• Dominant role in the nation's R&D; • Globalization of R&D; • Research, development and engineering.
University R&D	• Minimal role; • Undergraduate teaching oriented.	• Formative stage; • Informal links with industry.	• Basic research being strengthened; • Stronger formal links with industry.
Government R&D	• Strengthening industry's bargaining power in technology transfer; • Training experienced researchers; • Reverse engineering of advanced technologies; • Leading role in the nation's R&D.	• Expansion of government-supported research institutes network; • Incubating experienced researchers; • Leading role in national R&D policies.	• Leading role in national R&D projects; • Technical support for SMEs.

Source: UNCTAD, 2007, p. 67.

The role played by government in building firm-level capabilities, productivity and international competitiveness spanned a multitude of interventions related to trade policy, technology policy, financial and fiscal support measures, plus competition policy. Three salient features of those government interventions are outlined below, particularly those related to innovation policy and technology acquisition by firms.

- Export orientation was closely associated with technology acquisition. In the early phases of industrialization: "Governments of Japan, the Republic of Korea and Taiwan province of China sought to protect domestic technological learning by screening FDI and controlling licensing agreements. Singapore, while maintaining an open door to FDI, has increasingly sought to attract investor interest in activities involving more advanced technology";
- Technology screening in association with sequential entry into the market were used as competition policy measures aimed at inducing firms to compete vigorously to be early entrants. In Japan, for example, "to be qualified as an early entrant, a firm had to demonstrate its technological and financial capabilities to assimilate new technologies. Therefore the industrial groups competed in searching for promising new technologies, conducting preparatory research, finding an appropriate foreign licenser, and securing the necessary investment funds";
- Rent distribution to firms through a mixture of incentives (selective protection, competition and subsidies) had a central objective to "induce firms to increase production capacity and productivity and to compete aggressively for increased market share". The "realization of rents (and also other subsidies) was related to performance standards, including a requirement to export". One key objective of the system was "to close off other non-productive channels of wealth accumulation, such as agricultural landlordism, urban real estate speculation and the exploitation of military and bureaucratic office for private gain".[68]

(c) Industrial leapfrog

Technology catch-up by new entrants, particularly when they come from emerging and developing countries, is often associated with imitation. Although imitation is an essential condition to learn by doing and to close the technological gap with established industry leaders, it can be insufficient to catch up in the long term.

Firms in the process of catching up with leaders might obtain dated technologies as those in advance stages of development are not necessarily willing to provide their newest technologies to those lagging behind. It is therefore imperative that latecomers practice active innovation through R&D to catch up.[69] In addition, latecomers to a given industry are not aiming at a static target but at a moving one, as technological leaders introduce further innovation.

Lessons learned from a comparative study of the shipbuilding industry in three Asian countries (China, the Republic of Korea and Taiwan) conclude that a moderate amount of knowledge transfer, in conjunction with self-learning and research, is most advantageous for successful technological catch-up.[70]

In the study, Taiwan and China demonstrated opposite approaches. In Taiwan, an over-reliance on Japanese technology led to fewer exploratory efforts to diversify product portfolios and develop new technology. China's reluctance to adopt foreign technologies in the 1980s led to a search for development without the influence of advanced technologies from

leaders as well as a lack of ability to absorb external knowledge, which caused the eventual failure of technological catching-up.[71]

The Republic of Korea's success lay in the ability to maintain a balance between the use of external knowledge and the exploration of new and unknown knowledge. That allowed Korean shipbuilders to leapfrog established incumbents by adopting new technological paths. That is a well-known pattern in industry where incumbents are less prone to adopt new technologies, being burdened by the weight of their legacy.

"When British shipbuilders were sticking to the old riveting method, Japan took a challenge to adopt the welding method from the U.S. and saw a dramatic increase in productivity. Likewise, Korean shipbuilders' choice to select membrane technology led to overcoming Japanese dominance in the liquefied natural gas vessel market. These cases are good examples of how exploration of a new technological trajectory can effectively incapacitate incumbent firms. Unless these latecomer firms possessed independent innovative capability built on the basis of sufficient absorptive capacity and combinative capability, they would not have been able to explore new technological paths ahead of other competitors."[72]

The transfer of explicit knowledge, through technology transfer and licensing, might foster only imitation, but the transfer of tacit knowledge in combination with self-learning and research could provide organizations with more successful results.[73]

C. Innovation policies in selected Arab countries

Analysis of innovation at the national level requires an examination of what Governments are doing to foster innovation. At the macro level, Governments focus on developing policies and strategies that consider the local requirements, opportunities, needs and resources. The situation is not uniform among Arab countries. The sections below provide a brief overview of policies and/or strategies that are formulated specifically for innovation or that are formulated for broader purposes but with relevance to innovation, such as STI and ICT policies/strategies. Five Arab countries at differing levels of development and innovation advancement and geographic distribution were selected, namely Egypt and Morocco from North Africa, Jordan from the Mashreq region and Saudi Arabia and the United Arab Emirates from GCC countries.

1. Egypt

The Egyptian Ministry of Scientific Research put in place a national strategy for scientific research and innovation in 2005. Consequently, the period 2007-2016 was declared at the presidential level the "decade for science and technology".[74] The strategy was complemented with the Developing Scientific Research Plan 2007-2016, which was developed to restructure science and technology (S&T) governance, improve national S&T capabilities (investments and human resources), develop a complete value chain from research to commercialization, and build an S&T culture. The plan's approach was sectoral and technology-oriented.

When this strategy concluded, Egypt set about implementing its new National Strategy for Science, Technology and Innovation covering the period 2015-2030, which falls within the framework of Egypt's Vision 2030. In addition, Egypt has two other strategies relevant to innovation: the Technology Innovation and Entrepreneurship Strategy and the National ICT Strategy. These four strategies are summarized in the following sections.

(a) Sustainable Development Strategy: Egypt's Vision 2030

In line with the 2030 Agenda adopted by the United Nations in 2015, the Government of Egypt formulated its new Sustainable Development Strategy: Egypt Vision 2030.[75] Knowledge, innovation and scientific research form a pillar under the economic dimension of the strategy in which the Government pledges to build a knowledge society based on creativity and innovation that foster state growth and human welfare. This requires a comprehensive ecosystem for scientific research, technology and innovation, infrastructure, legislation and human resources.

The pillar has the following three overall goals:

- Build a conducive environment for producing and localizing knowledge;
- Activate and develop an integrated national system of innovation;
- Link knowledge applications and innovation outputs to national priorities.

Vision 2030 also describes the challenges for knowledge, innovation and scientific research, and it proposes programmes for the period 2016-2030. It also includes a list of relevant indicators and subindicators, the value of each and target values for the years 2020 and 2030. The goals envisioned by the Government are having Egypt in the top 40 countries for innovation, quality of scientific research intuitions, and retaining innovative talents and capacities, and in the top 20 countries for the number of patents and IP.

(b) National Strategy for Science, Technology and Innovation 2015-2030

The strategy[76] was prepared in two phases and was multi-stakeholder in nature. It involved the Ministry of Scientific Research, research centres, funds and universities. It also capitalized on the knowledge of local experts and expatriate professionals, and the advice of United Nations Educational, Scientific and Cultural Organization (UNESCO). A comprehensive survey was conducted to identify national priorities.

The strategy includes a detailed description of the status of scientific research in Egypt and includes qualitative and quantitative evaluation of higher education indicators, R&D inputs (number of researchers), R&D outputs (publishing and patents) and performance of scientific research institutions. The strategy also notes that more than 70 per cent of innovation support activities and technology transfer are ICT-related. The value of gross domestic expenditure on R&D (GERD) was 0.43 per cent of GDP between 2009 and 2010 and increased to 0.68 per cent in 2013.[77] One of the notable expected outcomes of this strategy is to increase GERD to 1 per cent, and is even stipulated in Egypt's 2014 Constitution.[78]

A detailed SWOT (strengths, weaknesses, opportunities and threats) analysis was developed, covering human resources, enabling environment for research, development and innovation (RDI), the international positioning of Egypt, IP and scientific publishing. The strategy defines in detail the challenges of the RDI ecosystem in Egypt, including the weak links between academic scientific research and industry, limitations in funding, lack of comprehensive laws, and absence of research targeted at social needs. Based on the list of challenges, the strategy defines two broad tracks (table 2), each with focus areas. Each focus area has its own goals, proposed initiatives and key performance indicators (KPIs).

Table 2. Main tracks and focus areas of Egypt's STI strategy

Track I Creating a stimulating and supportive environment for innovation and excellence in scientific research to foster inclusive community development and production of new knowledge to achieve international leadership	Track II Knowledge production, transfer and localization of technology to contribute to socioeconomic development
• Scientific research policies and legislation; • Scientific research ecosystem indicating the detailed role and responsibilities of each component; • Support and development of human resources and infrastructure; • Achieving international leadership in science and technology; • Investing in scientific research and partnerships; • Scientific research, educational industry and scientific culture; • International cooperation.	• Energy; • Water; • Health; • Food and agriculture; • Natural resources and environmental protection; • Technology applications and future sciences; • Strategic industries; • ICT; • Education; • Media and social values; • Investment and trade; • Tourism industry.

Source: مصر، وزارة التعليم العالي والبحث العلمي، 2015.

The executive plan within the strategy lists detailed projects to achieve the goals, as well as the responsible institutions, sources of funding, timelines and budget required. Implementing the executive plan will capitalize on risk management, partnership management and transparency, and change management. STI policy governance in Egypt has undergone major changes since 2007 and figure 6 shows the proposed new STI ecosystem structure.

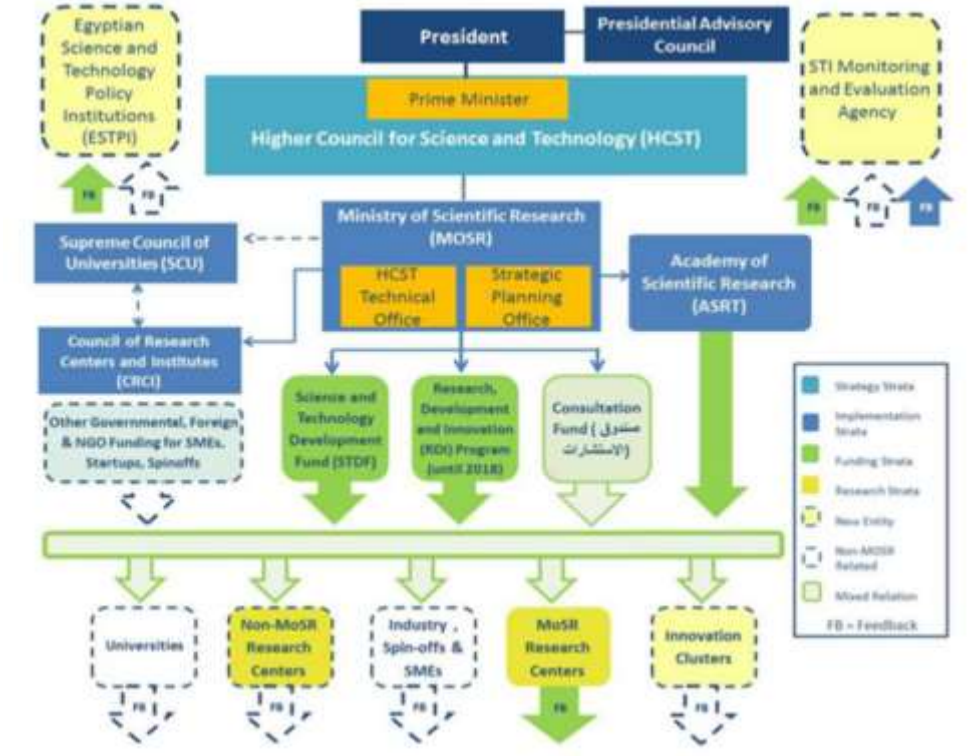
(c) Technology, Innovation and Entrepreneurship Strategy

This strategy was developed by the Technology Innovation and Entrepreneurship Centre (TIEC)[79] for the period 2011-2014. It was built upon the outcomes of ICT policies implemented by the Ministry of Communication and Information Technology in 2010. ICT exports, at that time, reached $1.1 billion and Egypt became recognized as a global hub in offshoring and outsourcing. This innovation strategy was, therefore, oriented towards technology and entrepreneurship.

The vision of this strategy is to make Egypt the main regional innovation hub by 2020. The following four goals were aligned with this vision: to enable ICT companies to be established, operate and be innovative; to entice foreign and local ICT companies to generate, enrich and expand innovative ideas; to build Egypt's brand as a regional hub for innovation; and engage stakeholders in the task of generating, financing, supporting and deploying ICT-related innovation.

The strategy's implementation is structured around six pillars that aim to achieve the following: stimulate the innovation culture; brand Egypt as a regional innovation hub; facilitate IP management; establish innovation clusters; create an enabling business environment to facilitate innovation and entrepreneurship; and build human resources. Thirteen initiatives clustered under three hierarchical groups support one or more strategy pillar as illustrated in figure 7.

Figure 6. New structure of the STI ecosystem in Egypt



Source: Academy of Scientific Research and Technology, 2016.

(d) National ICT strategies

Egypt's most recent National ICT Strategy (MCIT, 2012) covers the period 2012-2017 and falls within the framework of a wider strategy until 2020.[80] Each new strategy builds on the results of the previous one. For example, the National ICT Strategy of 2007 resulted in sectoral growth due largely to the private sector. Between 2003 and 2010, the ICT sector provided the treasury with about 71 billion Egyptian pounds (LE) from licenses, sales, tariffs and dividends.[81]

The 2012-2017 strategy identifies seven pillars and six targeted initiatives. ICT innovation and entrepreneurship is one of the strategic pillars, and has the following objectives:

- Position Egypt as a regional innovation hub;
- Accelerate development and economic growth in Egypt by developing the ICT sector, with emphasis on creativity;
- Support industry to create high-level job opportunities for professionals and graduates in various specialized fields of ICT;
- Attract foreign investment to boost innovation and entrepreneurship in the ICT sector;
- Establish companies able to innovate in the field of ICT;
- Develop the ICT sector by engaging stakeholders in the introduction, funding and support of innovative ideas;
- Create an environment that encourages creativity and entrepreneurism;
- Promote creativity and innovation in ICT to address development challenges.

Figure 7. Egypt's technology and innovation strategy initiatives

Source: Egypt, Technology, Innovation and Entrepreneurship Center, 2011.
Note: Bubbled numbers refer to supported strategy pillars.

This pillar has three main programmes for centres of excellence, entrepreneurship support and e-learning. The strategy also aims to establish an environment conducive to technology innovation and entrepreneurship by promoting the use of innovative technologies to solve development challenges, attract more foreign investment in innovation and entrepreneurship, and support the establishment of innovative start-ups. The strategy aims to facilitate 10,000 job opportunities in the field of innovation. Two of the six targeted strategic initiatives—creativity and innovation in Arabic digital content, and RDI in ICTs for people with disabilities—are highly relevant to innovation.

2. Jordan

The Government of Jordan has been building its NIS for several years and put in place the following strategies/policies that support innovation: the National Policy and Strategy for Science, Technology and Innovation; the National Innovation Strategy; and the National Information and Communications Technology Strategy. The most recent editions of these strategies/policies are summarized in the

following sections. It is also worth noting that the Government has developed a national vision and strategy for Jordan 2025,[82] which addresses innovation from both an entrepreneurial and a scientific research perspective.

(a) The National Policy and Strategy for Science, Technology and Innovation 2013-2017

In Jordan, the Higher Council for Science and Technology (HCST) is the institution responsible for formulating and implementing a national STI policy. As such, HCST developed an STI policy for the period 2006-2010, an evaluation of which showed that 60 per cent of planned projects have been implemented. In January 2013, HCST developed a new policy/strategy document for the period 2013-2017.[83] The process for developing this document was multi-stakeholder in nature and involved a steering committee, a technical committee and sectoral committees. The document includes two main parts: the national policy for STI, and the strategy to implement this national policy during the period 2013-2017.

The policy/strategy highlights the status of STI in Jordan and includes statistics, including the percentage of GERD from GDP, which was 0.34 per cent for 2003, less than the targeted 1 per cent, and noting that the most recent percentage available was 0.43 per cent. The 2013-2017 strategy embeds lessons learned from the experience of several countries, including Egypt, Finland, Lebanon and Turkey, and is based on consultations with experts from those countries. It also pays special attention to the actors, policies and legislative framework, STI infrastructure, human resources and STI ecosystem.

Based on a SWOT analysis, the document identifies five strategic goals and the KPIs of each. The strategic goals have been translated into five main programmes (or action plans) to be implemented within the policy time frame. The main vision that drives those goals emphasizes the importance of R&D and the participation of the private sector in such activities, nurturing an innovation and entrepreneurship culture, creating a technology transfer infrastructure and strengthening the links between the main stakeholders of the NIS in Jordan.

The programmes that will be implemented to reach the strategy's goals, with their estimated budget in Jordanian dinars (JOD),[84] are summarized in table 3 with a total budget for the 2013-2017 period of JOD 9.7 million.

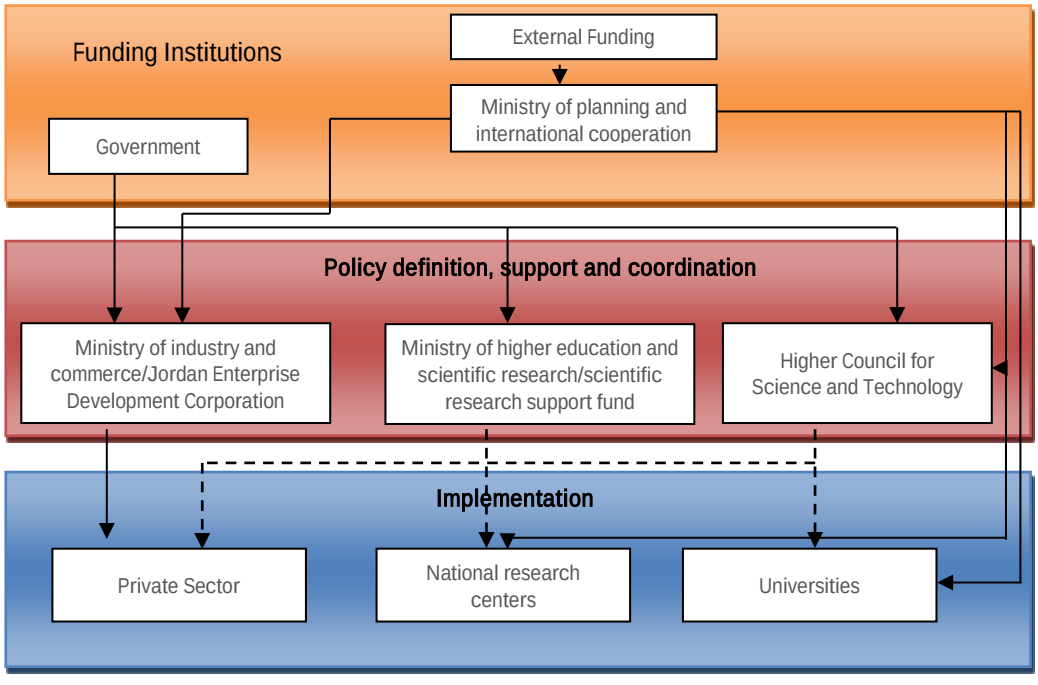
From a sectoral perspective, the strategy focuses on water, energy, food and human health. It also addresses inclusive development as a target for graduate research and theses. Figure 8 summarizes the structure of the STI ecosystem in Jordan with all actors involved in funding, policy definition, support and coordination, and implementation.

Table 3. Programmes of the Jordanian STI strategy with the associated budget (2013-2017)

Programme	Budget
Organizational, policy and legislation framework	JOD 1.4 million
Infrastructure and human resources	JOD 1.8 million
Governmental fund for higher education and scientific centres	JOD 0.4 million
Increasing the productivity and competitiveness of the national economy and supporting the private sector in tackling R&D activities	JOD 4.3 million
National innovation	JOD 1.8 million

Source: Jordan, Higher Council for Science and Technology, 2013, pp. 37-77.

Figure 8. Structure of the STI ecosystem in Jordan



Source: Jordan, Higher Council for Science and Technology, 2013, p. 10.

(b) The National Innovation Strategy 2013-2017

The HCST prepared a strategy focused primarily on innovation, namely the National Innovation Strategy 2013-2017.[85] The strategy was prepared further to directives from the National Council of Competitiveness and Creativity, in collaboration with the Ministry of Planning and International Cooperation and with the support of the World Bank and the Korean Development Institute. The main aim of this strategy is to build a Jordanian economy based on innovation and creativity.

It seeks to provide a favourable environment for innovation to thrive while addressing the need for an enhanced culture of innovation, strengthened research and development, specialized human resources and a favourable business environment.

The following six clusters were identified as national priorities to enhance innovation and competitiveness: education; ICT; architecture and engineering services; banking and financial services; medical services and the pharmaceutical industry; and clean technologies. The strategy includes an executive plan that proposes several projects for each cluster, briefly describing what each project is and its budget estimate. These projects cover the following strategic cross-cutting concerns: institutional framework; policies and legislation; infrastructure and human resources; government financing for higher education and scientific research institutions; productivity and competitiveness of the national economy and partnership of the private sector; and the national innovation programme. Table 4 summarizes the scope of each cluster's projects and its budget.

Table 4. Summary of the executive plan of Jordan's National Innovation Strategy (2013-2017)

Education and career guidance services (JOD 3 million)
This cluster consists of 12 projects covering many subjects, including accreditation and classification of private schools, a study/plan to match specializations with market requirements, mainstreaming innovation and entrepreneurship spirit among higher education students, building the capacity of newly appointed university instructors, rehabilitation workshops and laboratories of the Vocational Training Corporation.
ICT cluster (JOD 0.61 million)
This cluster includes six projects on Jordanian innovation IP laws, namely: an assessment study of ICT cluster opportunities, an assessment study of the ICT sector IP, developing pilot projects for innovation practices and scientific research, a fund for supporting innovative services and products in the ICT sector, organizing programmes and promotional and marketing campaigns for the innovation and IP services in the ICT cluster.
Architecture and engineering services cluster (JOD 1.91 million)
This cluster consists of six projects covering the strategic plan for small engineering offices, a comprehensive study on best practices in merging engineering offices, an annual engineering conference, establishing an Academic-Professional Experience-Exchange Council, branding and positioning strategy, and improving the regional and global position of this cluster through training programmes and certificates.
Banking and financial services cluster (JOD 1.02 million)
This cluster includes six projects to achieve the following: establish an umbrella for all entities involved in micro finance and financial leasing; establish a fund for loans to innovators; dedicate an award for innovation finance; enhance the relationship between financial institutions and academia; provide future career paths; and enhance entrepreneurship in this field.
Medical services and pharmaceutical industries cluster (JOD 6.67 million)
The cluster includes 14 projects that focus on many areas, including: establishing a Jordan medical biotechnology consortium; developing programmes for teaching medical sciences regulations; specialized skill programmes for the biomedical workforce; physician research awards; and partnerships with international universities to jump-start physician researcher training programmes.
Clean technology cluster (JOD 1.277 million)
The cluster includes eight projects addressing such matters as the following: the impact of nano-clay on the germination of barley; producing nano-materials from medicinal plants; the production/effect of organic liquid fertilizers; the effect of using nano-water on the productivity and behaviour of chickens; and producing two sheep breeds by crossbreeding three breeds.

Source: Jordan, Higher Council for Science and Technology, n.d.

One of the notable outcomes of the strategy is the National Centre for Innovation (NCI), which is being set up under the umbrella of HCST with funding from the World Bank. The NCI will be a one-stop information and referral hub for all activities related to innovation and private-sector development. It will provide legal/regulatory advocacy and advisory services to SMEs and coordinate resource referrals, and monitor and evaluate innovation activities and other key performance indicators that reflect economic shifts towards innovation. The NCI is scheduled to start its activities in 2017.

(c) National Information and Communications Technology Strategy 2013-2017

The development of Jordan's most recent National ICT Policy 2013-2017[86] was led by the Ministry of Information and Communications Technology (MoICT). The strategy largely accounts for the ICT sector as a booster and medium for innovation. According to its mission statement, the MoICT aims to create a competitive environment in collaboration with the private sector and encourage investment in ICT. Such investment shall be translated into innovative services and products that fit citizen needs.

The objectives of the strategy are the following:

- Improve the business and investment environment by enhancing the legislative framework and creating new markets opportunities;
- Increase FDI;
- Boost exports of national ICT products, services and capabilities;
- Maintain and develop a competitive telecommunication infrastructure to support continuous IT sector innovation and to serve local and regional ICT markets;
- Develop agile national professional training and certification capabilities to meet local and regional ICT sectors' needs;
- Stimulate the creation and development of suitable Arabic language digital content that is accessible online throughout the Arab region.

Each of the strategic objectives has several initiatives. Innovation-related initiatives focus on the following: supporting ICT innovation centres (business centres, incubators and technology transfer offices (TTOs)); a competitive telecommunication infrastructure to support private ICT sector innovation; and an award for digital Arabic content creativity and innovation. Innovation is also identified as one of four pillars that foster ICT diffusion, the others being ICT network infrastructure, education and the business environment.

The strategy covers the ICT sector horizontally and vertically; development will happen in the ICT sector per se, but also in other sectors such as health care, tourism and logistics, using ICTs.

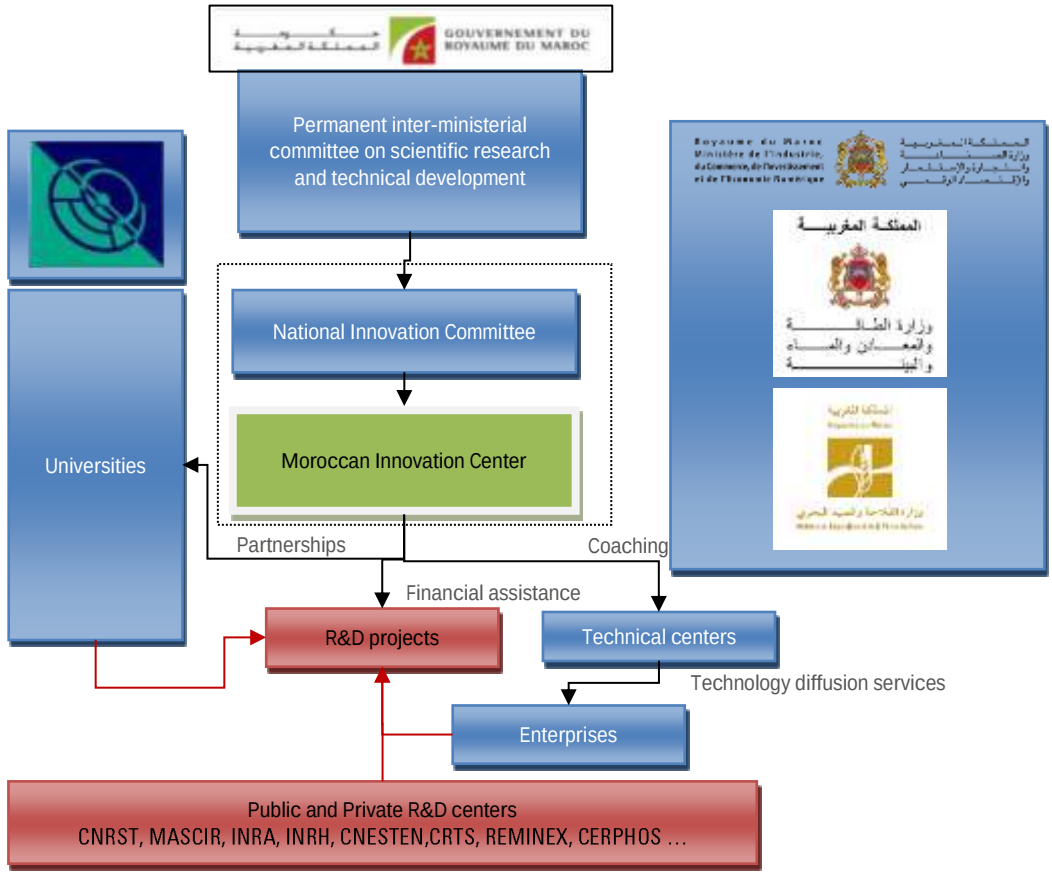
The outcomes of the overall strategy will be evaluated by comparing the indicators measured in 2017 with those from 2011. For example, investment in the ICT sector is expected to increase from $205 million to $450 million, revenues are expected to increase from $2 billion to $3.15 billion, Internet penetration would also increase from 65 per cent to 85 per cent, and the sought-after employment creation in the ICT sector would be 20,000 compared with 15,835 in 2011.

The success of the strategy relies on the motivation of the private ICT sector to invest in and realize the strategic objectives. In other words, success is correlated with the strength of the public and private partnership. Government responsibility will be to provide the enabling business environment to encourage the private sector and give it attractive reasons to invest.

3. Morocco

Unlike many other Arab countries, Morocco has been implementing an initiative dedicated specifically to innovation (figure 9). The following sections describe three items that contribute to innovation in the country: the innovation initiative, which is directly linked to innovation; the National Strategy for the Development of Scientific Research (Horizon 2025), which has some implications for innovation; and Digital Morocco, which is also linked to innovation.

Figure 9. Innovation ecosystem in Morocco



Source: Morocco Innovation Initiative, 2009.

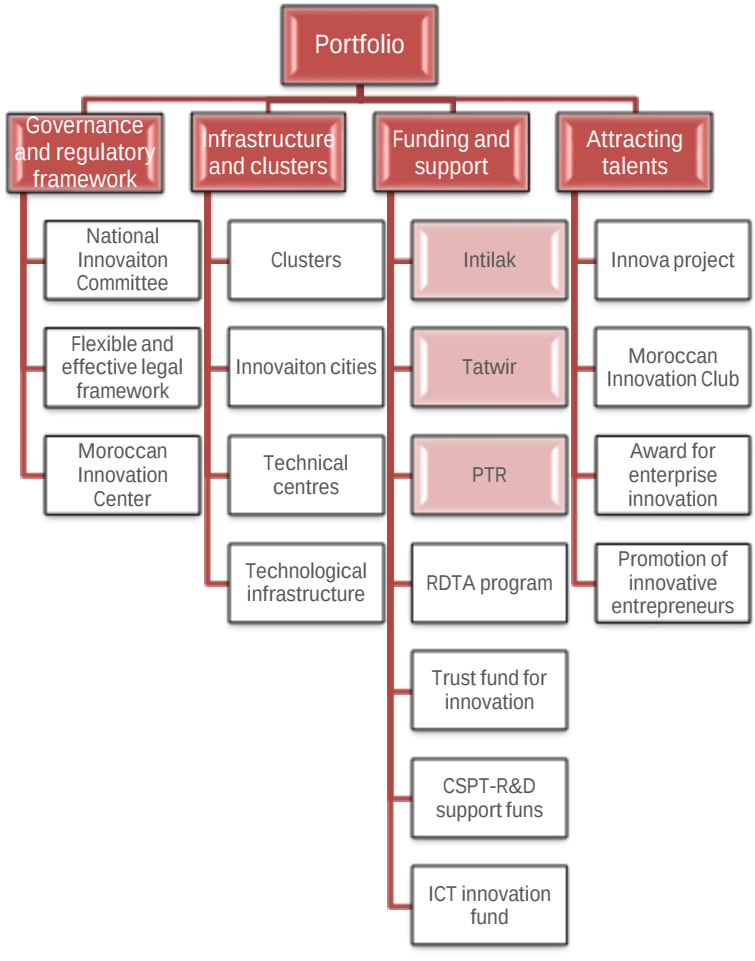
(a) Morocco Innovation Initiative

The Morocco Innovation Initiative[87] is the responsibility of the Ministry of Industry, Trade and New Technologies. The main objectives of this initiative are the following:

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

At the time the initiative was developed in 2009, GERD in Morocco reached a value of 0.71 per cent.[88] The initiative aimed to have 1,000 Moroccan patents per year, starting in 2014, and 200 innovative start-ups per year, starting in 2014. The funding proposed was 50 million Moroccan dirham (MAD)[89] to support the technological R&D programme and MAD 400 million for the innovation support funds.[90] Figure 10 summarizes the components of the initiative.

Figure 10. Portfolio of Moroccan Innovation Initiative



Source: Zemmita, 2014.

(b) National Strategy for the Development of Scientific Research (Horizon 2025)

Although this strategy focuses on scientific research, it has considerable implications for innovation. The strategy[91] states that in 2003, R&D expenditure was 0.79 per cent of GDP; the target for 2025 is set at 3 per cent. The strategy included an ambitious action plan for the years 2015-2016, with a list of activities and indicators of achievement for each objective. Table 5 summarizes the types of sectors and focus areas identified in the strategy.

In this strategy, innovation programmes, technology transfer and valorization are important components, with implications for financing. The strategy includes activities/indicators to ensure inventions and intellectual discoveries in scientific R&D are linked to an innovation process, including incubators, rapid prototyping and technology transfer, to ensure socioeconomic impact. In order to encourage excellence in innovation, the strategy proposes re-establishing the national award for innovation and research in S&T.

Table 5. Sectors and focus areas of the Moroccan scientific research strategy

Competitive sectors	Sectors with good potential	Fragile sectors
• Tourism; • Construction and public works; • Commerce and services.	• Agricultural activities; • Agro-industries; • Artisanal production; • Mining.	• Textiles.

Source: Morocco, Direction de la Recherche scientifique et de l'innovation, 2014.

(c) Digital Morocco

The Ministry of Industry, Trade and New Technologies, in collaboration with the National Telecommunications Regulatory Agency (ANRT), launched in 2009 the National Strategy for Information Society and Digital Economy, Digital Morocco 2013.

This strategy was designed around the following four priorities: social change; implementation of user-oriented public services, computerization of SMEs, and the promotion of the ICT industry. It had two supporting measures, namely developing human capital and building trust and confidence in the cyberspace, and two implementation modalities, namely managing the strategy and allocating financial resources.

The strategy was subject to an evaluation exercise in 2013 by the Cour des Comptes.[92] The evaluation reported that activities to promote RDI in ICT were still in progress, including the RDI fund, the legal framework for the RDI centre, and building an entrepreneurial culture. Only 22 per cent of the strategy had been implemented, with 25 per cent delayed, 32 per cent in progress, 18 per cent yet to start and 3 per cent cancelled.

4. Saudi Arabia

Saudi Arabia realized that innovation, and STI in general, are at the heart of national economic development. As such, Saudi Arabia's Vision 2030 includes innovation in the private sector and advanced technologies as one of its focus areas. The sections below summarize some recent and ongoing STI-related policies and plans.

(a) National Policy for Science and Technology

In 2012 the Saudi Ministry of Economy and Planning, in collaboration with King Abdul-Aziz City of Science and Technology (KACST), developed a Science and Technology National Policy. This policy is structured around the following 10 strategic principles serving as an umbrella for more detailed measures:

- Adopting a comprehensive vision for a STI system;
- Improving quality of education and training;
- Promoting, developing and coordinating national capabilities for scientific research and technology development;
- Keeping up with trends in scientific research and technological development;
- Developing and diversifying financial support sources allocated for the activities of the national STI system;
- Enhancing technology transfer and development;
- Fostering individuals' creativity and innovation capabilities;
- Developing regulations for the national STI system and improving the efficiency of scientific and technical institutions;

- Furthering scientific and technological cooperation at the Gulf, Arab, Islamic and international levels;
- Making scientific and technological information available and easily accessible.[93]

(b) STI in Saudi Arabia's national development plans

National development plans (NDPs)[94] in Saudi Arabia have included a dedicated track for STI development as a means to achieve social, economic and environmental goals. Since the eighth NDP (2005-2009), tangible STI results have been seen with the formulation and implementation of the first National STI Plan.

In the ninth NDP (2009-2015), the STI component aimed to localize and develop advanced strategic technologies in all production and service sectors and elements of the STI system to raise productivity and competitiveness. The NDP explains that the STI system in Saudi Arabic consists of KACST and about 200 scientific research units that are part of universities or public institutions. In 2008, GERD was estimated at 0.4 per cent of total GDP.

In 2016, the tenth NDP was launched for the period 2015-2019. This NDP aims to increase GERD to 1.3 per cent of total GDP by 2019 and to 2 per cent by 2025. The plan strongly encourages activities that support innovation and the transformation to a knowledge-based society. It also focuses on improved cooperation between the private sector, universities and research centres.

(c) National STI plans

The First National STI Plan (Maarifah)[95] ran from 2005 to 2009, and was followed by the Extended First National STI Plan from 2010 to 2014. The plan's programmes comprised the following: strategic technologies; RDI capacity-building; innovation and technology transfer and localization; science, technology and knowledge society; developing human resources; developing and enhancing funding; STI systems development; and STI organizational structures development.

The strategic technological areas identified as targets by this plan were the following: water (treatment and management); oil and gas; petrochemicals technology; nanotechnology; biotechnology; information technology; electronics, communication and photonics; space and aeronautics; energy (such as renewable energy, energy storage and management); environmental technology; advanced materials; mathematics and physics; medical and health; agriculture technology; and building and construction.

The plan was evaluated in 2013 in collaboration with AERES[96] and resulted in a report that detailed all activities and outcomes. STI indicators revealed an obvious impact on research outcomes, patents and other KPIs. A dashboard was developed by KACST and Thomson Reuters to monitor scientific research outcomes. The evaluation of the plan detailed budget support given to universities for R&D projects that had a total of 642.3 million Saudi riyal (SAR).[97] The largest budget was allocated to medical research (SAR 145.17 million) followed by biotechnologies (SAR 124.14 million) and environmental research (SAR 53.45 million). The Second National STI Plan, focusing on the same technological areas, will run in parallel to the tenth NDP (2015-2019).

(d) National ICT Plan

The Ministry of Communications and Information Technology in Saudi Arabia

has put in place a long-term vision for building the information society. Under the umbrella of that vision, two five-year ICT plans have been developed; the first covered the period 2008-2012, the second covering 2015-2019.[98]

An evaluation exercise determined that the first plan had an implementation rate of 76 per cent, with achievements related to innovation mainly in the digital Arabic content initiative and Bader incubator.

The National ICT Plan has obvious links to R&D, creativity and innovation. Building the ICT industry and competitiveness rests upon the following four main goals:

- Establish and support SMEs and start-ups;
- Create an attractive investment environment, that is a leader regionally and globally;
- Support establishing large IT companies;
- Stimulate research, creativity, innovation and development.

The last goal highlights that an RDI ecosystem is the backbone for a flourishing ICT industry, which should be sought by Saudi Arabia as a priority. The plan proposes several projects to fulfil this goal, including a national award, IP management, transforming inventions into innovations, the social impact of ICT, and establishing a centre for open-source software.

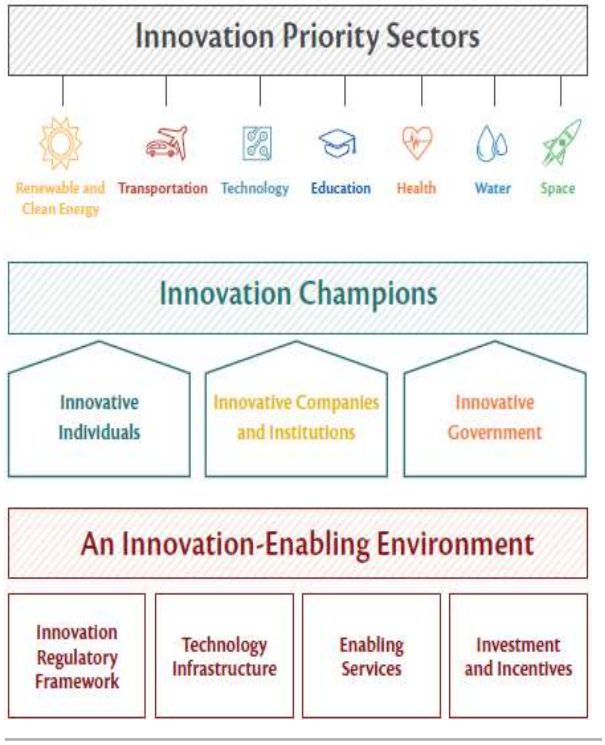
5. United Arab Emirates

The Government of the United Arab Emirates has implemented several initiatives and policies to become a world leader in innovation. Such initiatives include the year of innovation, innovation week and establishing a chief executive officer (CEO) for Innovation post. The National Innovation Strategy; the Science, Technology and Innovation Policy; and the Government Innovation Framework are summarized below.

(a) National Innovation Strategy

The United Arab Emirates National Innovation Strategy (NIS)[99] aims to "take innovation... to new heights, where a culture of innovation is embedded amongst individuals, companies and governments. It primarily focuses on identified priority sectors that will drive future innovation". The NIS framework is structured around three key pillars: an innovation-enabling environment; innovation champions; and innovation priority sectors. Figure 11 shows the three pillars and their corresponding components.

Figure 11. Pillars and components of the United Arab Emirates NIS



Source: United Arab Emirates, Ministry of Cabinet Affairs, 2015, p. 7.

Table 6. Enablers and goals of the United Arab Emirates STI Policy

Talent
• Focus on strong STEM skills development in all school years and achieve excellent education outcomes; • Establish a strong local STEM workforce; • Employ and retain nationals in R&D work fields; • Develop strong local R&D management skills; • Attract and retain the best STEM minds and talents from all over the world; • Ensure knowledge transfer between global and local talents.
Investment and incentives
• Provide adequate government funding of basic scientific research; • Increase industry funding of R&D activities; • Ensure availability of risk capital to support entrepreneurial activity; • Encourage the growth of SMEs in the fields of science and technology.
Universities and supporting institutions
• Strengthen higher education and basic and applied research in the fields of science and technology in universities; • Equip universities with world-class laboratories and computing; • Expand specialized R&D facilities to support key innovation sectors; • Ensure the availability of supporting institutions for technology transfer and incubating innovation.
Regulation and IP protection
• Develop flexible regulations that encourage the growth of innovative projects and businesses in the country; • Provide best protection of intellectual property; • Facilitate the import of technology, equipment and materials critical to research; • Encourage the inflow of scientists, researchers and innovators; • Develop mechanisms and incentives to strengthen individual and corporate innovation; • Encourage innovation, entrepreneurship and reward risk-taking.
Partnerships and networks
• Enhance cooperation between universities and the private sector in STI; • Make government R&D accessible to the private sector; • Encourage international partnerships with universities and big research institutions; • Establish distinguished expertise in certain unique areas through partnerships.

Source: United Arab Emirates, 2015.

In November 2014, the National Science, Technology and Innovation Committee was established to monitor the implementation of NIS. The Committee also has other responsibilities, including coordination, exchange of expertise between federal and local entities, following up progress of innovation initiatives and engaging the private sector. The STI Policy described below is one of the Committee's outcomes.

(b) Science, Technology and Innovation Policy

The year 2015 was announced as the year of innovation in the United Arab Emirates.[100] The goal of the policy is to achieve robust science and technology-based innovation.

Focus areas were identified according to the following criteria:

Table 7. United Arab Emirates selected STI indicators and 2021 targets

Indicator	Source	2012 results	2021 targets	Key sponsor
Average TIMSS score	International Association for the Evaluation of Educational Achievement	Rank 23 of 42 (2011 report)	Among the top 15 countries	Ministry of Education
Average PISA score	Organization for Economic Co-operation and Development	Rank 46 of 65 (2012 Report)	Among the top 20 countries	Ministry of Education
Global Entrepreneurship and Development Index	Global Entrepreneurship and Development Institute	Rank 19 (2016 Report)	Among the top 10 countries	Ministry of Economy
Global Innovation Index	INSEAD	Rank 47 (2015 Report)	Among the top 10 countries	Ministry of Economy
Share of 'knowledge workers' in the labour force	Ministry of Labour	22.76 per cent (2014)	40 per cent	Ministry of Labour
GERD as percentage of GDP	Federal Competitiveness and Statistics Authority	0.5 per cent (2012)	1.5 per cent	Ministry of Higher Education and Scientific Research

Abbreviations: TIMSS, Trends in International Mathematics and Science Study; PISA, Programme for International Student Assessment.
Source: United Arab Emirates, 2016.

- Meet present and future national needs to help tackle challenges faced nationally and regionally;
- Align with present and future international trends to benefit from opportunities and developments emerging worldwide;
- Align with the country's capabilities and unique assets so that the United Arab Emirates can become a world leader and simultaneously achieve high returns.

In total, 24 focus areas for STI were determined. These areas represented a mix of opportunities (for example, semiconductor process development) and challenges (water management and economics).

Five key enablers were identified for the success of the STI Policy: talent, investment and incentives, universities and supporting institutions, regulation and IP protection, and partnerships and networks. A set of specific goals is associated to each of these enablers as summarized in table 6.

Finally, the country's National Vision 2021 identifies a number of STI-related indicators and sets ambitious targets for each.[101] Table 7 shows some of these indicators and their targets for 2021.

(c) The Government Innovation Framework

The Government Innovation Framework[102] developed in 2015 is a practical tool that aims to transform the Government of the United Arab Emirates into one of the most innovative worldwide. The Framework explains seven phases of innovation in public-sector institutions: research, new proposals, development and testing, proof of concept, execution, dissemination and change.

It also provides guidelines on how to process these seven phases. Innovation in the public sector requires an enabling environment that nurtures talents, provides networks and knowledge sharing, emphasizes transparency and provides space for innovation. Budget and impact measurement are also featured as key components in this framework.

6. Links between innovation, productivity and economic growth in the Arab countries

It is acknowledged that innovation has shock effects on economic growth via two paths, as shown in figure 12. The first path would employ productivity growth as a mediating variable, where innovation affects firstly productivity [link A], which in turn would affect economic growth [link B]. The second path is the more direct effect, where innovation changes economic growth [link C].

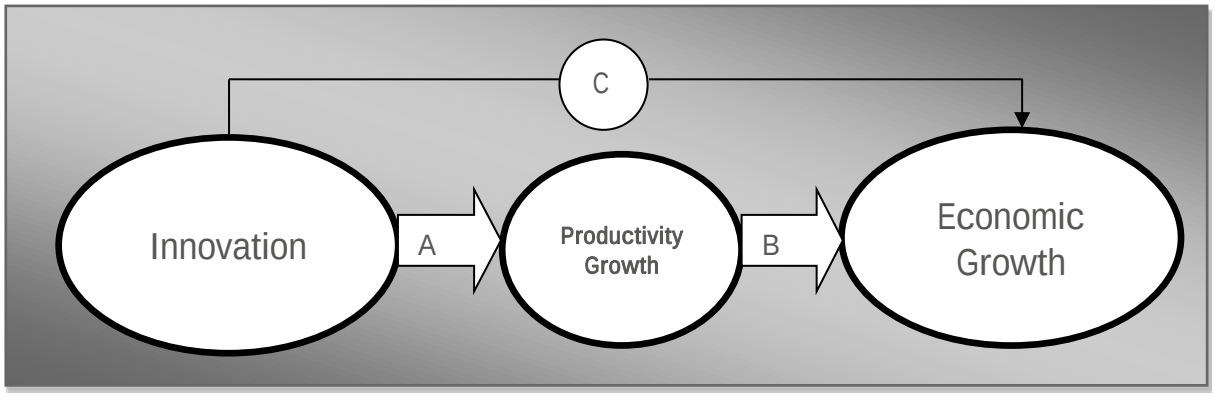
There are many studies that examine the effects of innovation on productivity (link A), and fewer examining the link between productivity and economic growth (link B). As for the relationship between innovation and economic growth (link C), many approaches focus on the company level (micro data) rather than national level (macro data).

(a) Links between innovation and productivity

Based on the popular definitions of productivity, earlier research showed that capital (K) and labour (L) explained less than half the variability in productivity growth.[103] The remaining sources of variability were attributed to innovation in boarder terms: technological advancement in capital, labour quality, efficiency, R&D activities, ICT and others.

The neoclassical theory[104] proposed a growth model where innovation enhances productivity over time. There are many empirical studies that examine the relationship between innovation and productivity.[105] Studies have also tended to find a significant link between innovation (in terms of R&D) and productivity growth.[106] Also, innovation impacts positively on productivity, and internationally, its effects vary between 0.035 to 0.290 per cent in elasticity, which means that each 10 per cent increase in innovation will produce an increase in productivity by 0.35 to 2.9 per cent.[107]

Figure 12. Links between innovation, productivity and economic growth



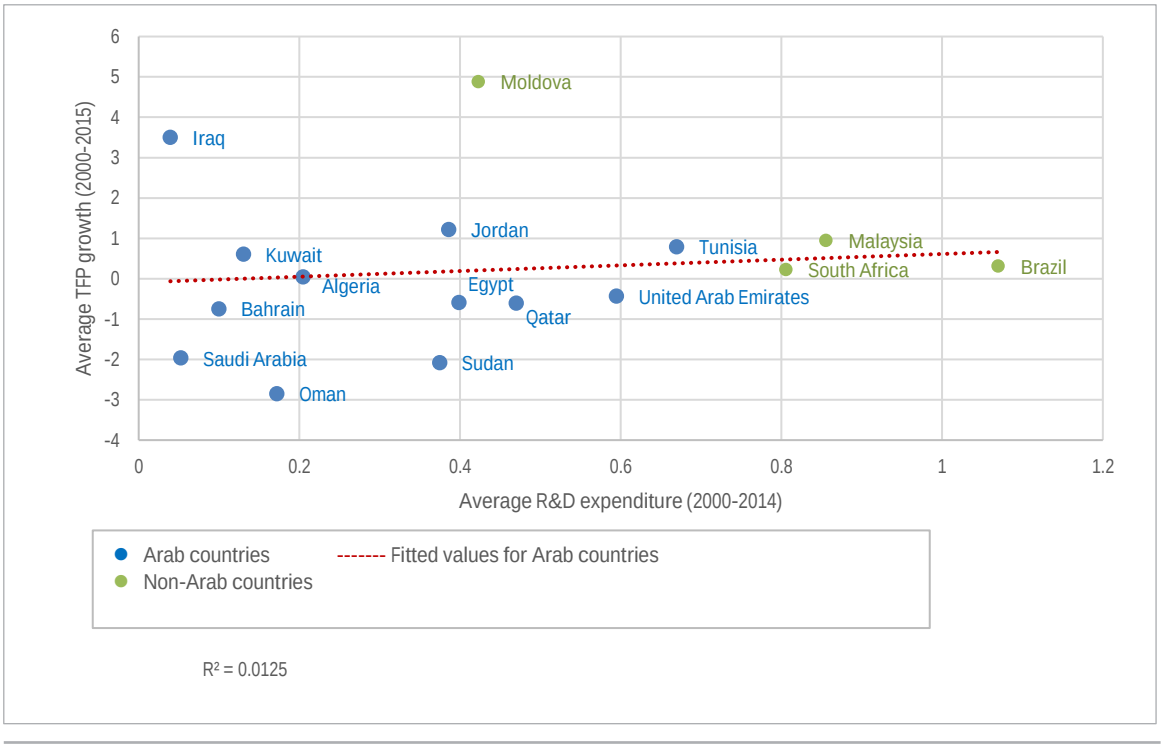
Source: Hall, 2011; Mohnen and Hall, 2013.
Note: The following elements are considered as part of innovation: R&D expenditure, ICT expenditure, count of patents, technological progress, or simply to encompass all aspects, expenditure on innovation as a percentage of GDP.

In the Arab region, R&D, which is strongly linked to innovation, seems to have no effect on productivity, measured in term of total factor productivity (TFP) growth. The linear association, as shown in figure 13, is almost horizontal, showing there is no association between the two variables. It should be noted that these results contradict the international trend. For comparison purposes, this figure also shows the association between R&D and the TFP in selected developing countries: Brazil from Latin America, Malaysia from Asia, Moldova from Eastern Europe and South Africa from Africa. Brazil, Malaysia and South Africa have higher spending on R&D than all the Arab countries.

(b) Links between productivity and economic growth

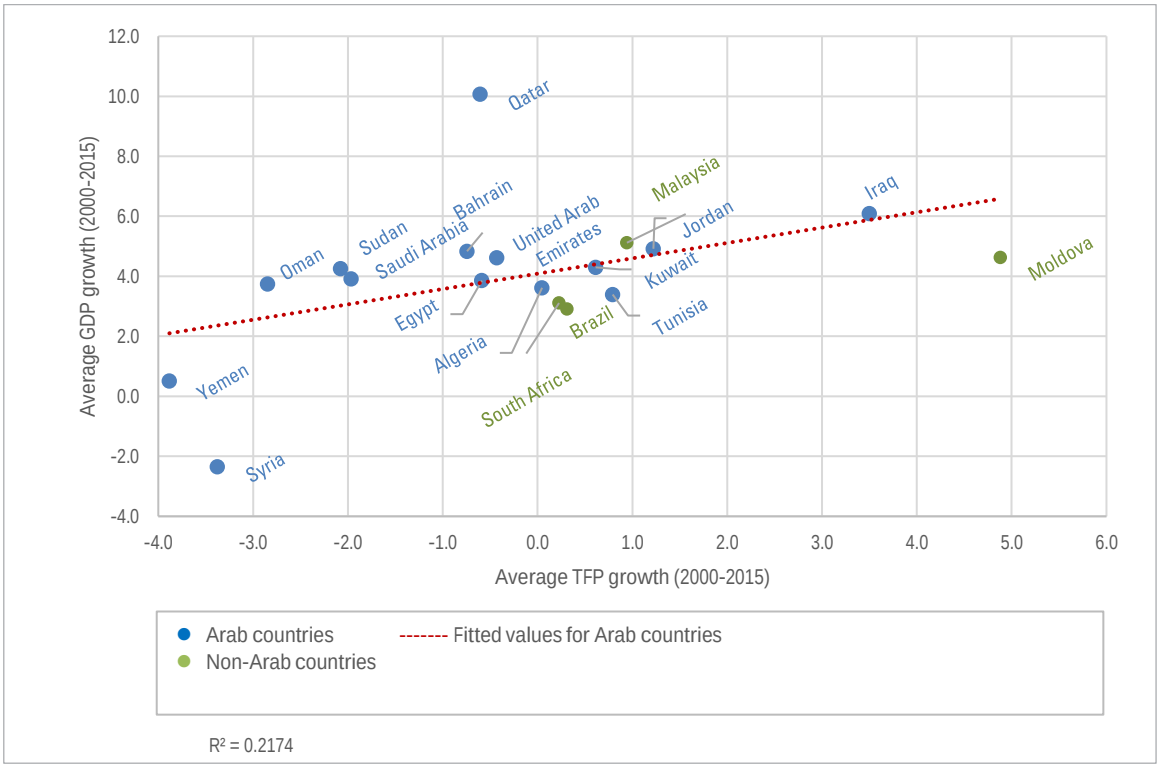
In typical neoclassical economic models and using growth-accounting, TFP is considered one of the sources of economic growth. Usually, TFP is obtained as a residual after subtracting the actual growth of GDP from the growth of inputs corrected by their relevant productivities. However, a more sophisticated neoclassical growth model introduced by Fernald[108] used TFP as an exogenous variable to define GDP. In the Arab region, a clear positive association exists between TFP and GDP growth as described in figure 14.This figure also shows the association between productivity and economic growth in selected developing countries, Brazil, Malaysia, Moldova and South Africa, for comparison purposes.

Figure 13. Association between R&D and productivity



Source: Based on data from the World Bank, World Development Indicators database (available from http://data.worldbank.org/data-catalog/world-development-indicators, accessed 15 November 2016), and The Conference Board, Total Economy database (available from https://www.conference-board.org/data/economydatabase/, accessed 15 November 2016).

Figure 14. Association between productivity and economic growth



Source: Based on data from the World Bank, World Development Indicators database and The Conference Board, Total Economy database (figure 13).

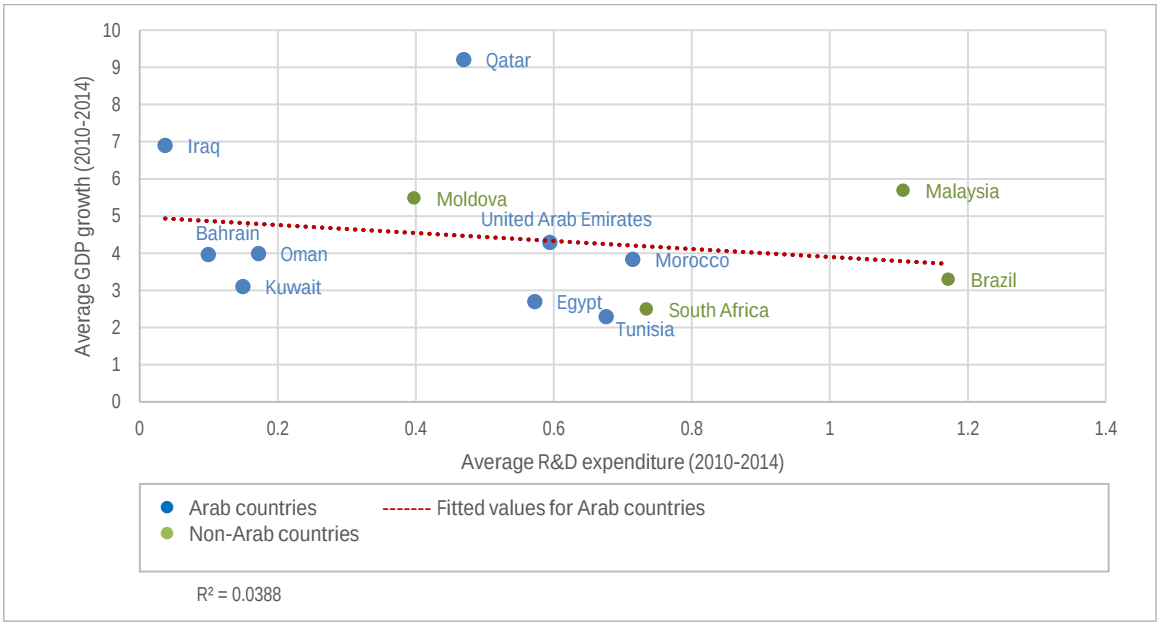
(c) Links between innovation and economic growth

This relationship has been discussed thoroughly in the literature[109] at the company level but not at the macro level. It has been argued that innovation helps companies achieve a competitive advantage, leading to economic growth on the country level. Another study[110] shows that knowledge and innovation are both important drivers of economic growth but have heterogeneous spatial impacts.

Empirically, at the macro level, innovation makes a significant contribution to growth. The majority of the surveyed studies found a strong and enduring link between R&D capital and growth.[111] Typically, a 1 per cent increase in the R&D capital stock is estimated to lead to a rise in output of between 0.05 and 0.1 per cent.

Figure 15 shows a descriptive association in the Arab region not quite in concordance with theoretical and empirical evidence in the rest of the world. According to the simple fitted relation, on average for Arab countries, R&D expenditure and economic growth are almost independent. A possible reason for this anomalous finding is that most R&D expenditure in the Arab region originates from government, the majority of it in the form of current expenditure, particularly wages and salaries. Nonetheless, further careful research is required to unearth the lack of association between R&D expenditure and economic growth in the Arab region.

Figure 15. Association between innovation and economic growth



Source: Based on data from the World Bank, World Development Indicators database and The Conference Board, Total Economy database (figure 13).

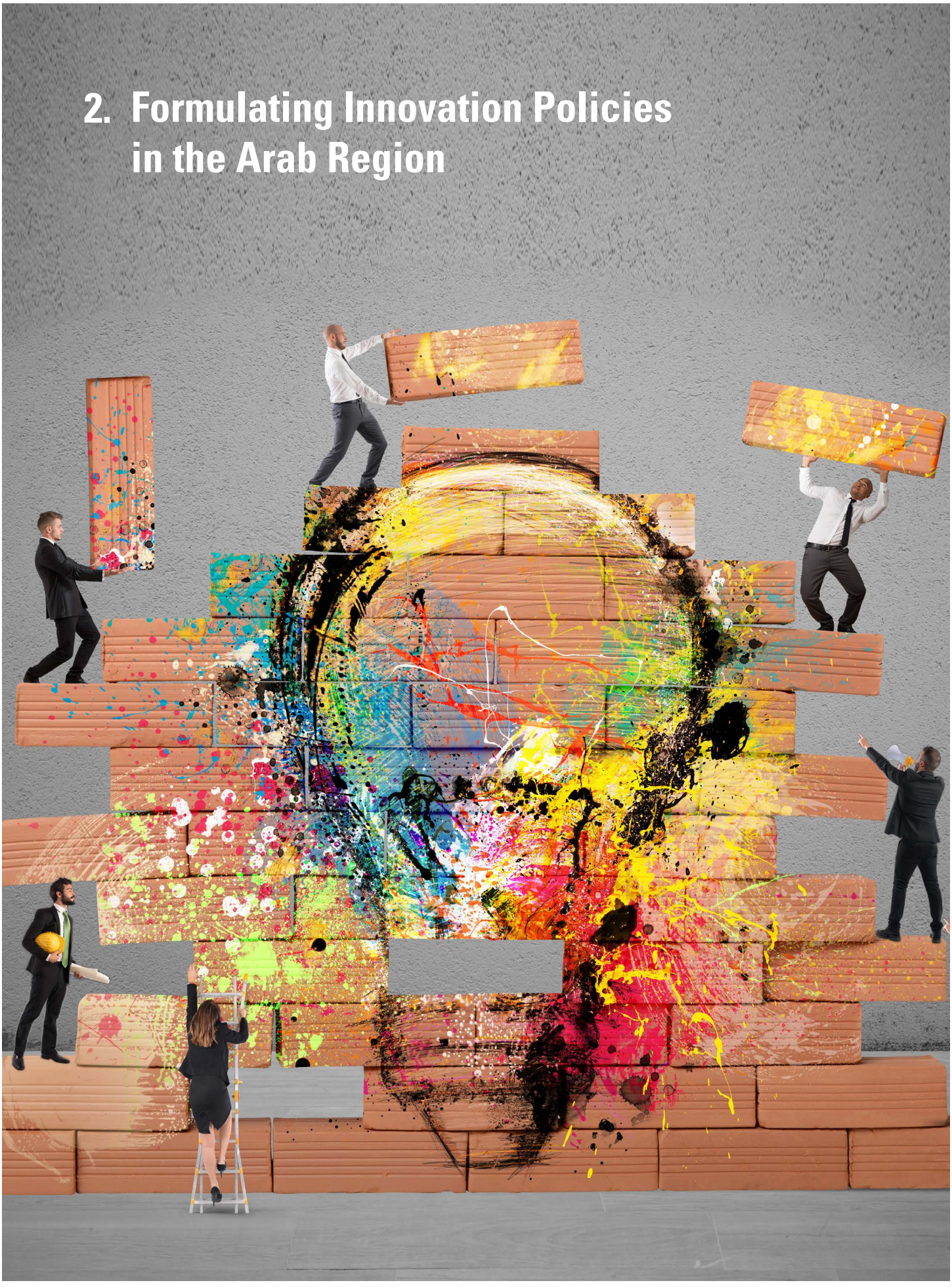
7. Beyond national strategies: regional innovation strategies

Challenges associated with building a comprehensive NIS at the service of socioeconomic development are complex and costly: Arab countries should seek closer cooperation and integration while building and consolidating their respective NIS. The recent adoption of the Arab Strategy for Scientific and Technical Research and Innovation[112] is a small step towards greater collaboration and a broader common approach to innovation.

The strategy addresses the core issue of building an NIS by suggesting a common approach to coordinating its core triad of higher education, research institutions and the production and services sector. It also deals extensively with the definition of specific research areas, but the relevance of some are quite removed from regional capabilities and priorities. Although the strategy identifies essential mechanisms to improve efficiency, relevance and financing of research and innovation, it fails to identify how and by whom this will be ensured. Of greater concern is that the strategy is narrow in its scientific and technical focus away from the broader inclusive and sustainable socioeconomic development priorities of the Arab region.

Integration and coordination of Arab national innovation policies require a deeper level of economic and regulatory integration than countries have achieved to date. However, with the deep cultural and historical ties, essential resource complementarities (human versus financial) and common developmental and environmental challenges, such an integrated effort for Arab innovation policies is recommended and necessary. In order for this to happen, a broader regional development compact, similar to the Europe 2020 strategy, should be implemented, requiring a higher level of common political will absent from the current Arab context.

2. Formulating Innovation Policies in the Arab Region



The ESCWA framework is a guideline for formulating innovation policies, customized to the needs and priorities of the Arab region and pays special attention to inclusive sustainable development.

2. Formulating Innovation Policies in the Arab Region

This chapter aims to provide a comprehensive framework to support elaboration of innovation policies by Arab countries. While they differ in development levels, available resources and the status of their NIS, Arab countries share many common challenges and have strong cultural, political and historical links. The latter aspect is essential, as outlined in the previous chapter. Although developing a regional innovation policy is outside the scope of this document, one objective of the proposed framework is to lead Arab countries to adopt compatible approaches with a view to closer cooperation and integration, in the manner of the European Union (box 2).

Another important objective of this framework relates to the recent adoption by the United Nations General Assembly of the 2030 Agenda for Sustainable Development and the potential contribution of innovation policies to fulfilling the 17 SDGs agreed to by the international community. The next chapter will address how innovation policies can help achieve these goals by delivering solutions in SDG-related sectors of high relevance to Arab countries.

It is not the purpose of this chapter to suggest a single 'one-size-fits-all' approach to innovation policies. Generic approaches, or approaches that can be adapted to meet the challenges faced by Arab countries with illustrative examples and success stories drawn from developed, developing and Arab countries, are brought forward instead.

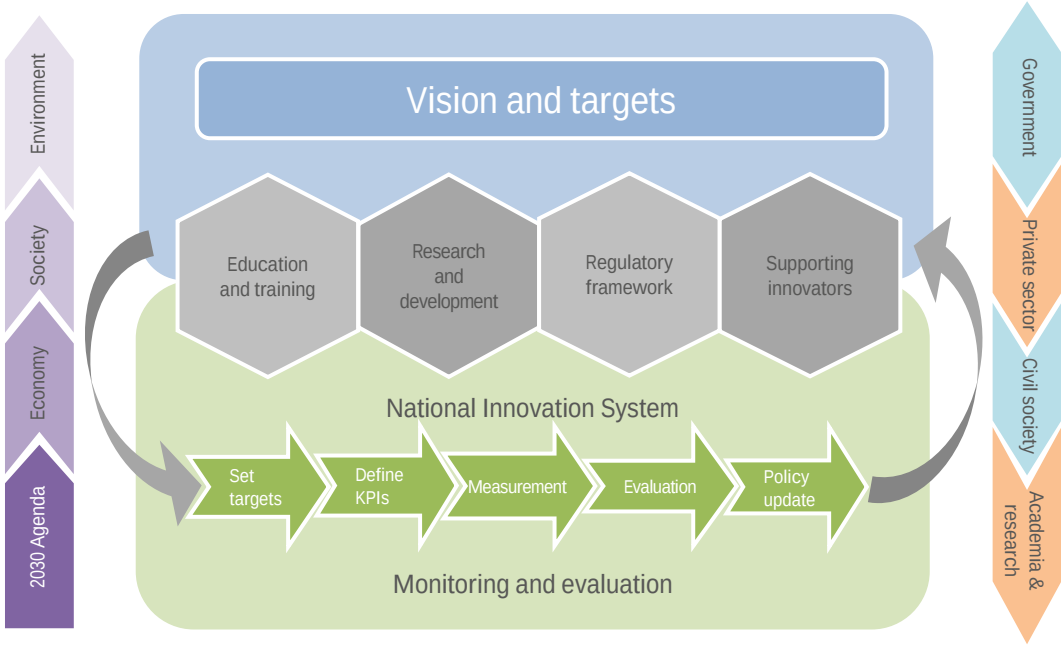
The material of the proposed framework will be divided into three sections. The first one addresses the elaboration of the innovation policy vision, highlighting its importance from strategic and practical standpoints. Based on the findings from the previous chapter, high-level objectives that could be borrowed by Arab countries' innovation policies after proper adaptation to the local context are suggested.

The second section addresses specific components or building blocks of the NIS, whose development and consolidation constitute the core purpose of any innovation policy. Focus will be placed on critical components, particularly those needing attention and development in most Arab countries.

In the third section, the importance of monitoring progress of the NIS will be highlighted, as no policy can be successfully implemented without a proper monitoring and evaluation framework with associated indicators.

Figure 16 shows the proposed framework for the formulating innovation policy for Arab countries.

Figure 16. Innovation policy framework for inclusive sustainable development



Source: Authors.

A. The innovation policy vision

No innovation policy stands a reasonable chance of becoming successful without a clear political vision outlining its contribution to broader socioeconomic objectives that address national challenges.

Many countries, some Arab, have elaborated national visions outlining general socioeconomic objectives and projected rank among nations in some global indicators (related to GDP level, health, education, infrastructure, industrial development). When such a national vision exists, an innovation policy should necessarily be consistent with it and clearly spell out how it will contribute to its stated objectives. Should such a link between the innovation and the global national policy be weak or missing, this reveals, at best, inconsistency in the policy vision or, at worst, that policymakers do not view innovation policy as a clear contributor to socioeconomic development. Generally such visions address mid-term targets (10 to 15 years), depending on the timing of their elaboration. This produces target dates between 2020 and 2030. Regional examples include the visions 2030 of Bahrain, Egypt and Saudi Arabia, and the vision 2021 of the United Arab Emirate.

Whether or not an innovation policy is backed by a higher-level national vision, it must in any case have a set of high-level objectives that form its vision. Such a vision is needed to ensure consistency and to facilitate implementation and governance. Innovation policy high-level objectives should address a country's socioeconomic priorities and shortcomings in its NIS system. Based on the NIS discussion in the previous chapter, some objectives are suggested for Arab countries as a possible source of inspiration during the elaboration of their innovation policies.

Box 2. Regional innovation strategy of the European Union

The Innovation Union initiative of the European Union (EU) was launched in 2010 as an essential component of the broader Europe 2020 strategy for smart, sustainable and inclusive growth. The latter had been launched in the aftermath of the global financial crisis of 2007 to help the EU overcome the crisis and become a smart, sustainable and inclusive economy with high levels of employment, productivity and social cohesion. Innovation, within a regional integration framework, is thus considered a key component to support a strategy primarily aimed at putting the EU back on a sustainable growth path at a time when it faces growing competition from emerging countries.

Innovation Union adopts the broader vision of innovation as outlined by the Oslo Manual in that it impacts not only on products and services but also equally on processes and organizations, and on people's daily lives. The initiative is aimed at creating an environment that enhances innovation by improving access to finance for research. It is structured around more than 30 action items clustered under the following priority areas:

- Strengthening the knowledge base and reducing fragmentation: the main achievement lies in the launch of Horizon 2020, the biggest RI funding programme in the world, featuring simplified access rules and specific tools encouraging business and SMEs participation. Extrapolating current trends to the end of 2020, about €3 billion will have been invested into thousands of Europe's most innovative SMEs;
- Getting good ideas to market: key achievements are the easing of access to finance, with €2.8 billion to be implemented through InnovFin – EU finance for innovators, the European Unitary patent, which will allow for patent protection in 26 States on a one-stop-shop basis, several tools to increase demand for innovation through procurement, and non-technological innovation through initiatives that aim to harness the potential of creative industries and design-driven innovation;
- Maximizing social and territorial cohesion: key achievements include the deployment of strategies and tools that promote convergence across European regions in innovation performance. The European Structural Investment Funds will contribute €118 billion to smart growth on the basis of the submission of a smart specialization strategy;
- Pooling forces to achieve breakthroughs: five European Innovation Partnerships (EIPs) were launched in the key areas of active and healthy ageing, water, agricultural productivity, raw materials and smart cities;
- Leveraging policies externally: a strategic planning of priorities for future cooperation has been developed through road maps for international cooperation, a key achievements being the Scientific Visa;
- Making it happen: key achievements include measures to support national reforms in research and innovation, such as the self-assessment tools. In order to monitor and benchmark innovation performance across Europe and between Europe and its main international partners, monitoring tools such as the Innovation Union Scoreboard, the Regional Innovation Scoreboard and the Innovation Output Indicator were put in place and published regularly.

Source: European Commission, 2010, 2013 and 2015; Hollanders and others, 2016.

1. Formulating the innovation policy vision

There is a generally accepted wisdom that science, technology and innovation are highly beneficial to economic productivity, social inclusion and in addressing environmental challenges, among other things. It is clear, however, that modern science is increasingly costly, financial and human resources for STI are limited even in advanced countries, and priorities set for STI are, first and foremost, political,[113] and influence not only potential outcomes but also their eventual application. In the context of heightened competition among

nations to 'grow up' in the globalized value chain, there will be no easy transfer of technological know-how towards emerging developing countries. As the experience of Asian countries discussed in the previous chapter has shown, developing countries aspiring to go up this ladder should acquire technological know-how primarily as a result of hard work and establishing a favourable balance of power (mainly through trade and FDI) with more advanced countries to enforce better technology transfer terms. Such challenges should be uppermost in the minds of Arab policymakers when developing the vision of their innovation policies.

The emergence of innovation policies as a tool to manage an effective NIS is a recent concept. It primarily results from a mixture of growth and globalization constraints as well as new technological revolutions (such as ICT) where policy choices defining priorities and resources allocation needs good coordination and consistency. This is not to imply that state dirigisme is back. The state acts more like a global coordinator—closer to an orchestra conductor than an army general—to ensure that all actors (public or private) effectively contribute to the realization of a vision and its related priorities.[114]

The innovation policy vision should primarily spell out the 'what for' question, which might be articulated through a limited set of strategic objectives/initiatives (box 3) in clear, non-technical language, even if the contribution of STI to their fulfilment must eventually be clarified in the strategy details. The choice of such objectives, although par excellence political, should however be based on a candid and transparent SWOT analysis of the country's STI system (or, in many developing countries, the existing parts of it) and its socioeconomic priorities.

No country, however much its NIS lags, should avoid addressing this 'what for' question; this is not a question only for advanced developed countries, even if they can afford to set more ambitious and sophisticated objectives. Addressing the 'what for' is essential also for developing countries to optimize the use of their meagre resources at the service of their most urgent and pressing priorities and to influence the build-up to their NIS towards that purpose.

The next logical item of the innovation policy vision is to address the 'by which means' question. This boils down to addressing shortcomings in the country's NIS that hinder global strategic objectives through specific programmes, activities or initiatives. This might concern any component of the NIS (see the NIS framework discussion of previous chapter) that needs consolidation. One might argue that in some developing countries this list might be long and entail the full elaboration of a properly functioning NIS. While this is true to some extent, it is valid to assume that the elaboration of the strategic vision should be weighed in the light of each country's specific NIS and the objectives it has set out in its innovation policy.

Since resources are limited, it is essential to prioritize NIS components that will become the focus of the innovation policy after cost-benefit analysis. More concretely, it would be advisable to prioritize those components that rely on—and contribute to the development of—the country's endogenous capabilities, are relevant to immediate socioeconomic needs (with a focus on inclusiveness, including gender), and have a chance of becoming sustainable and not continuously dependable on additional budgetary efforts. Similar to the 'what for' global objectives, the 'by which means' objectives should spell out specific NIS components to be improved, with associated quantitative and timely indicators.[115]

Finally, the innovation policy vision must also address the actors; the 'by whom' question. Empowering actors of the NIS, improving their skills and enlarging the basis of potential innovators are among the most difficult challenges when devising an innovation policy for developing and developed countries alike. It is important to ensure coordination among those actors. Different ministries or public bodies, the private sector and academia to name but a few may be responsible for implementing specific programmes of an IP. The role of an implementing agency to coordinate such actors is discussed below.

Developing skills for innovation and quality of education are central to the 'by whom' question; they are, however, insufficient on their own, particularly in developing countries where many other factors can limit the availability, efficiency and coordination among actors within the NIS. Such factors include the following: brain drain; inappropriate soft skills even among the educated; cultural barriers to innovation (weak valorization of risk-taking) in society and within administration (leading to the improper application of top-level directives on the ground); weak or broken links[116] between the so-called knowledge production system (universities and research centres) and the concerns and priorities of society and the economy; and a political economy model[117] where established rents discourage risk-taking and innovation by enterprises or innovators.

In summary, the 'by whom' provision is dependent on having a requisite number of skilled innovators and an environment that enables them to stay in the country and thrive. The former might be central in developed countries, where the environment might need only adjustment or adaptation, while in most developing and Arab countries ensuring the proper environment will be of equal or even greater importance than having sufficient skilled personnel.

The full set of 'what for', 'by which means' and 'by whom' objectives that define the innovation policy vision should fit into a consistent whole. The 'by which means' objectives logically precede the 'by whom'; in practice they could be pursued concurrently. Ultimately, all the vision's objectives should feed the top-most 'what for' strategic objectives as shown in the example of box 3.

Other examples of innovation policy visions from selected developed and emerging countries are summarized in box 4.

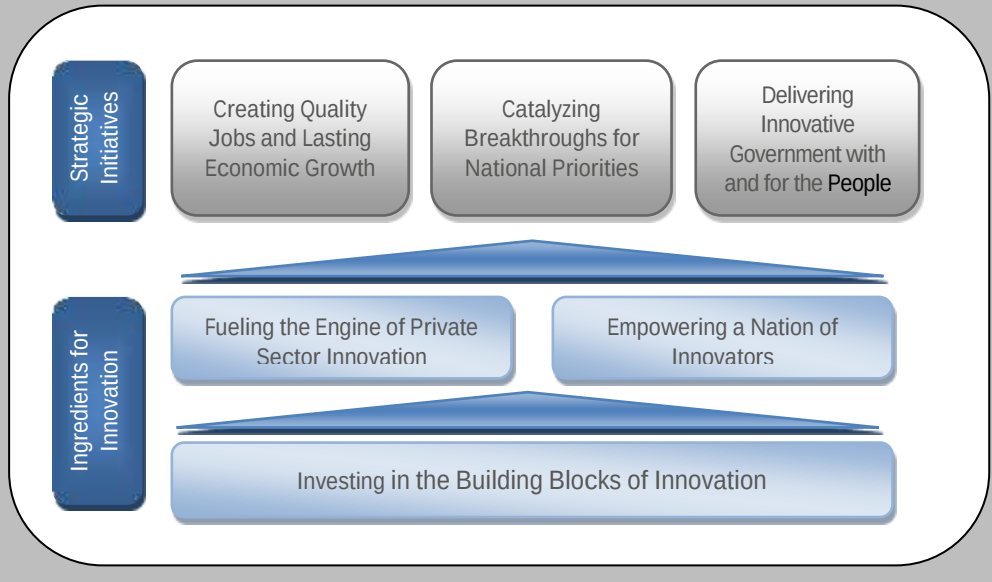
No policy, strategy or plan should be complete without a set of well-defined targets. Based on a summary of innovation policy/strategy visions provided by OECD,[118] increased share of GERD as a percentage of GDP, sometimes associated with the share of private sector and/or government expenditure on R&D, would appear the dominant target of many developed and emerging countries.

2. Practical benefits of innovation policy vision

We outlined in the previous chapter how innovation policy should necessarily be broad in scope. Collaboration and coordination are crucial, not only among officials from different government administrations, but stakeholders from different backgrounds and cultures (public sector, scientific and technical community, private sector, informal sector and civil society/non-governmental organizations (NGOs)).

Box 3. The United States innovation strategy

This strategy was initially elaborated in 2009 by the Obama administration and updated twice, in 2011 and 2015. The vision is articulated around three strategic initiatives supported by three clusters, as shown in the figure below.



This strategy is for the world's first economy; nevertheless, it advocates that innovation is "a wellspring for growth", and "a powerful tool for addressing our most pressing challenges as a nation". The detailed objectives of the three supporting clusters address matters that, even within an advanced economy, need particular attention and improvement to enable its innovation ecosystem to continue thriving. They aim, for instance, to make world-leading investments in fundamental research, supporting innovative entrepreneurs and commercializing federally funded research.

The first strategic initiative is aimed at creating quality jobs and lasting economic growth. It entails sharpening the United States' edge in advanced manufacturing, investing in industries of the future and building an inclusive innovation economy. An assessment of the potential comparative advantage of United States industries over less technologically advanced countries is needed. The role of innovation in providing job opportunities for all, even to those who might have lost their jobs due to international competition, should be enhanced.

The second strategic initiative is aimed at catalysing breakthroughs for national priorities and leveraging specific technologies where focused investment can achieve transformative results. Examples of these breakthroughs are targeting disease with precision medicine, accelerating the development of new neurotechnologies through the BRAIN Initiative, and promoting clean energy technologies and advancing energy efficiency.

The third strategic initiative is aimed at delivering innovative government with and for the people. Optimized government services can be delivered at lower cost by fostering a culture of innovation through innovation labs and providing better government through more effective digital service delivery.

Source: United States of America, National Economic Council and Office of Science and Technology Policy, 2015.

Box 4. Innovation policy visions from selected developed and emerging countries

Finland's Action Plan for Research and Innovation Policy (since 2012) aims to do the following: encourage constant renewal through experimenting and taking risks; make faster, more efficient use of research outcomes and strengthen the social impact of STI policy by broadening the scope of innovation activities; ensure long-term basic funding for universities and public research institutions; and use competitive research funding more strategically to boost the exploitation and social impact of research.

France's National Research Strategy (2013-2018) identifies 10 societal challenges and defines a research strategy for each challenge, a strategy for large equipment, a limited number of major scientific and technological priorities and some steering rules. The 10 challenges are: sustainable resource management and adaptation to climate change; safe, effective and clean energy; industrial revival; health and wellness; food security and demographic challenge; sustainable mobility and urban systems; information society and communications; innovative, integrative and adaptive societies; spatial ambition for Europe; and freedom and security for Europe, its citizens and its residents.

China's Medium and Long-term National Plan for Science and Technology Development (2006-2020) aims to do the following: enhance China's STI capabilities; use innovation as a tool to restructure Chinese industry and shift growth from investment-driven to innovation-driven; build a conservation-minded and environmentally friendly society; and enhance independent innovation capabilities as a national priority.

Malaysia's National Science, Technology and Innovation Policy (2013-2020) aims to do the following: advance scientific and social R&D and commercialization; develop, harness and intensify talent; energize industries; transform STI governance; promote and sensitize to STI; and enhance strategic international alliances.

Source: OECD, 2014b, pp. 110-123.

Table 8. Innovation policy targets in some selected countries

China: Twelfth five-year plan for S&T development (2011-2015)
• Raise R&D expenditures to 2.2 per cent of GDP; • Raise investment of large and medium-sized industrial enterprises in R&D to an average of 1.5 per cent of their revenue; • Increase proprietary core technologies, increase the role of large-scale enterprises in driving technological innovation, foster world-leading innovative SMEs; • Raise the number of researchers to 43 out of every 10 000 employees; • Raise the share of citizens with basic scientific proficiency to more than 5 per cent.
Colombia: National Innovation Strategy (since 2011)
• Raise R&D expenditures to 0.5 per cent of GDP; • Raise doctoral grants to 3 000 in 2014; • Raise the share of technologically innovative companies to 25 per cent of firms in 2014.
Denmark: Research 2020 (since 2012)
• Raise R&D expenditures to 3 per cent of GDP; • 95 per cent of a youth cohort to complete an upper secondary education programme; • 60 per cent of a youth cohort to complete a higher education programme; • 25 per cent of a youth cohort to complete a long-cycle higher education programme.
Korea: Third S&T Basic Plan (2013-2017)
• Contribution rate of R&D to economic growth: 40 per cent; • S&T-related job creation: 640 000; • STI capacity: world top seventh.

Source: OECD, 2014b, pp. 110-123.

The innovation policy vision provides a set of global objectives towards which all stakeholders should work. These objectives establish common goals that facilitate communication, mutual understanding and collaboration among diverse actors.

It is crucial that innovation policy vision and its associated objectives are adopted on high. A high-level endorsement increases the likelihood of different administrations and stakeholders collaborating to realize the vision; adoption at head of state/government level emphasizes the strategic importance of the vision for the country's future (in the example given in box 3 the vision is adopted at the top-most presidential level).

A high-level endorsement has a logical corollary: the establishment of a steering committee to implement the innovation policy. It is recommended that the steering committee delegate the day-to-day implementation to an agency with authority over all involved actors (particularly within government agencies or ministries) in this task. The high-level steering committee, though not responsible for its day-to-day management, can ensure innovation policy is implemented consistently, monitored and enforced in case of deviation.

The steering committee also has the authority to arbitrate in cases of conflict or differences of interpretation among stakeholders or administrations. Such conflicts might well be common, due to the complexity of innovation policy where long-term benefits sometimes need to be weighed against possible short-term losses. Only a top-level authority with a clear vision of national priorities can deliver such arbitration to remove roadblocks to the strategy.

3. Suggested high-level innovation policy objectives for Arab countries

Despite differences in wealth, economic development, science and technology levels, and the quality/availability of human capital, Arab countries share common challenges as they seek to establish a comprehensive NIS. Many of these challenges were discussed in the previous chapter and in recent ESCWA publications;[119] they concern the core fabric of the NIS as well as the surrounding framework and economic and cultural conditions.

The following set of high-level objectives address these challenges and are offered for consideration by Arab countries as they elaborate their innovation policy vision. These are generic proposals; each country should formulate and adapt its own objectives according to its specific situation, constraints and national priorities.

The proposed objectives fall under five main headings and address the core fabric of the innovation system, the economic system, human capital, sustainable development and social challenges, and cultural values. They focus mainly on structural issues encountered in many Arab countries.

Each of these high-level objectives should be supported by a multitude of lower-level 'by which means' and 'by whom' objectives, depending on the specific situation of each country.

(a) The core fabric of the innovation system

This fabric is dysfunctional in most Arab countries as acknowledged by the Arab Strategy for Scientific and Technical Research and Innovation[120] and a recent ESCWA study;[121] linkages among the central triad of universities, research centres and industry are weak at best.

In addition, R&D is primarily conducted by universities and public research centres with only minor contributions from the private sector.

Consequently, the following two objectives can be assigned to an innovation policy:

- Improve linkages between universities, research system and industry, and focus research priorities on productive sector needs;
- Increase the private sector contribution to R&D and innovation initiatives, including by the informal sector.

(b) Economic system

A central plight of Arab economies is the rentier economy model based on rent distribution (drawn from natural resources but equally attributable to monopolies) by an omnipotent State: "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."[122] Fixed capital formation in Arab countries is significantly below levels observed in emerging Asian regions, and despite "recent 'investments' (by Arabs) of $5-6 trillions"[123] no significant technology transfer was witnessed, maintaining "Arab addiction to technological dependence".[124]

This is a major hindrance to developing an effective NIS in Arab countries. An STI policy could thus seek the following among its high-level objectives:

- Improve investment levels (fixed capital formation) of the private sector in association with measures to encourage technology transfer;
- Pending a significant take-off in private sector investment, the public sector should take the lead, particularly in high-risk long-term infrastructure investments;
- Develop public-private partnerships in domains where the private sector could be more effective than State administration and engage in innovative and cost-effective approaches;
- Link FDI with stringent technology transfer clauses and prioritize investments with potential absorptive capacity;
- Increase the formalization rate of the informal sector in association with financial incentives to support productive investments and entrepreneurship;
- Encourage and promote entrepreneurship and start-up enterprises, particularly among youth and women.

(c) Human capital

Many Arab countries, including oil rich countries, spend 4 to 5 per cent of their GDP on education, which is comparable with many developed countries. In 2014 this effort materialized, on average, in a 99 per cent gross enrolment rate at primary education level, 87 per cent at lower secondary, 58 per cent at upper secondary, and 29 per cent at tertiary level. Although the pre-primary level of 27 per cent is still low, it is an increase from 15 per cent since the start of the century.[125] Despite important investments in education, improvement in women's enrolments and development of tertiary education (with nearly 1,000 universities), Arab countries still need to raise the quality of their systems. In 2015, for example, the King Saud and King Abdulaziz universities in Saudi Arabia were the only Arab institutions to be included in the Shanghai Ranking of World Universities list of top 500 world universities.[126] The annual Arab Knowledge Report[127] addresses the shortcomings of the Arab education system at school level, which could be considered a root factor in the limited technology transfer and low innovation levels in Arab countries.

All Arab countries need to improve the quality of their education systems, from early childhood to postgraduate university level for both men and women. Key challenges include the following: education methods must be revisited, with a focus on teacher quality and development of students' critical thinking; development of technical and vocational training, and curricula adapted to market needs; a general focus on quality rather than quantity of graduates in all disciplines; and inclusiveness of education, taking into account gender issues and the availability of schools and universities in rural versus urban areas.

Key initiatives related to human capital might involve the following:

- Carry out a comprehensive reform of the education system aimed at developing students' creativity and independent thinking from an early age and attracting the best talents to become teachers;
- Increase student recruitment in STEM specialties and in quality vocational training, and involve private sector representatives in curricula definition;
- Improve the integration of schools and universities into society and economic life through practical training as an integral part of a student's development, and also improve the contribution of socioeconomic actors to education curricula through practical means and specific expertise.

(d) Sustainable development and social challenges

The Arab population has nearly quadrupled over the past 50 years, from 106.1 million in 1965 to 388.1 million in 2015.[128] This population bulge has led to high urbanization rates (many Arab countries are at above 80 per cent), many congested cities, often growing without adequately controlled planning, strained public infrastructure (water, sanitation, roads, public health and education services), and, most dramatic of all, strained water and food resources in an already dry region with extensive desert surfaces.

Climate change is not making the situation any easier; frequent seasons of drought in the region has exacerbated the flow of pauperized rural dwellers into cities, leading to social and political unrest[129] and abandoned agricultural lands prone to desertification. Conflict in some Arab countries, with the resulting refugee crisis (inside affected countries and in neighbouring countries) raised additional social challenges.

In such a context, an innovation policy should have among its objectives the following:

- Short-term solutions to populations facing social difficulties, with a focus on innovations that bring public services at lower cost and entrepreneurship development that brings some economic relief;
- Methodologies to address the SDGs through the mobilization of STI in order to develop renewable energies, rehabilitate agricultural lands and combat desertification, manage water resources efficiently, reduce pollution by industries, address gender gaps and develop low-carbon urban transport alternatives.

(e) Peace and security

The Arab region is currently one of the least peaceful regions in the world. Since the Arab uprisings, open conflict is ongoing in many Arab countries.

It may be something of a paradox to say that innovation policies, primarily aimed at

contributing to inclusive and sustainable socioeconomic growth, are necessary to build peace and security in the Arab region. In some countries experiencing extreme conflict there are certainly more pressing humanitarian and social priorities, but no sustainable way out of the current crises is possible without leveraging STI for development, whether through providing job opportunities for youth, lessening economic inequalities and building more inclusive societies, or addressing acute climate change.

Chapter 3, which deals with the impact of SDGs on innovation policies, will provide concrete examples of how such policies can address the pressing challenges faced by Arab countries.

Innovation policies in the Arab region should spell out in their vision the contribution of STI to peace and stability, and how they will address socioeconomic and environmental issues at the origins of the current situation.

(f) Cultural values

In his 2012 book, Zahlan discusses why Arab countries fell into scientific stagnation from the early tenth century and the many lost opportunities to catch up with modern science and technology in neighbouring Europe since the early nineteenth century. While many insightful socioeconomic and political reasons[130] are given, they cannot fully explain why the catch-up process has not worked in the region as it has elsewhere, such as in Japan, which had similar technological levels until the mid-nineteenth century.

The lack of a culture of self-reliance was advanced by Zahlan to explain this failure. A more likely reason is the nearly 10 centuries of a 'broken link' between government and the people, with resulting economic and intellectual stagnation that has deeply imprinted cultural values and blocked effective catch-up.

This is not a theoretical matter: the Arab uprisings are consequences of this stagnation, the resolution of which is long overdue, if only to provide decent living opportunities to the more than 100 million Arab youth. Many Arab Governments have got the message and started building national visions to unlock this stagnation (box 5).

Such visions, although emanating from the top, primarily address the nation's living forces—its youth—with a clear message that effort and risk-taking can pay off; they necessitate cultural change and, whether explicitly spelled out or not, should result in a new compact between government and people, which, if successful, will be something dramatically new in this region, with STI playing a central role.

Based on the above, the main policy messages on innovation policy vision are included in box 6.

Box 5. Saudi Arabia Vision 2030

The largest Arab economy (nearly a quarter of all Arab States' combined GDP) with a population of 30 million, a large percentage of which are youth (nearly 45 per cent of the population are under 25), Saudi Arabia recently elaborated its Vision 2030. This vision addresses important socioeconomic issues and sets ambitious targets, leveraging the country's important material resources and wealth, its strategic position and the potential of its young population.

The vision articulates its objectives under the themes of vibrant society, thriving economy and ambitious nation. Many objectives are relevant for an innovation policy vision and reveal the challenges faced by the wealthiest Arab country. The following are excerpts from the vision statement:

- Developing our children's character: focus on the fundamental values of initiative, persistence and leadership, as well as social skills, cultural knowledge and self-awareness;
- Learning for working: invest particularly in developing early childhood education and redouble efforts to ensure the outcomes of the education system are in line with market needs. Also expand vocational training to drive economic development, and focus on innovation in advanced technologies and entrepreneurship;
- Enabling a bigger role for small and medium enterprises: enhance access to funding and encourage financial institutions to allocate up to 20 per cent of overall funding to SMEs by 2030. Also establish additional new business incubators, specialized training institutions and venture capital funds, and support SMEs in marketing and help export their products and services, by leveraging e-commerce and collaborating with international stakeholders;
- Improving the business environment: review regulations with the aim to improve the business environment and enforcing contracts, and enable banks and other financial institutions to adapt their financial products and services to the needs of each sector. Also create an environment attractive to local and foreign investors, and earn their confidence in the resilience and potential of the national economy;
- Developing digital infrastructure: partner with the private sector to develop the telecommunications and information technology infrastructure, especially high-speed broadband, expanding its coverage and capacity within and around cities and improving its quality. Additionally, improve regulations and establish an effective partnership with telecom operators to better develop this critical infrastructure.

Source: Saudi Arabia, 2016.

B. Building and consolidating the NIS components

As discussed in the previous section, a strategy vision is defined by the set of high-level objectives and supporting initiatives to build and consolidate the NIS components. This section discusses the latter, drawing on best practices from developed and developing countries, and the challenges and priorities for Arab countries.

Policy initiatives suggested in this section are not meant to be exhaustive given the scope and complexity of innovation policies. This section shall focus only on selected key considerations for Arab countries in developing their innovation policies. Countries are invited to consult the literature mentioned in this document and beyond, particularly country-specific STI profiles carried out by UNCTAD and OECD, which could provide inspiration on specific issues and examples of policy. Initiatives discussed under this section will be organized under the following four components: education and training; strengthening the research and development base; elaborating a proper regulatory framework for innovation; and supporting innovators.

Box 6. Main policy messages – 1

The innovation policy vision

The innovation policy vision should spell out the 'what for' question, which might be articulated through a limited set of strategic objectives/ initiatives in clear and non-technical language.

The next logical item of the innovation policy vision to address is the 'by which means' question: addressing shortcomings and gaps in a country's NIS that might hinder global strategic objectives.

The innovation policy also needs to address the 'by whom' question. Empowering actors of the NIS and improving their number and qualifications is probably one of the most difficult challenges when devising an innovation policy, for developing and developed countries.

No policy, strategy or plan can be complete without a set of well-defined targets and measurable indicators.

A clearly defined policy vision, supported by a steering committee and generally chaired by the high-level authority that endorses the vision and ensures consistent implementation and arbitration when conflict or differences in interpretation arise among stakeholders and administrations.

Strategic priorities for the innovation policies of Arab countries should address a set of interdependent objectives that improve the relationship between the main actors of the NIS, advance an economic system that fosters innovation, improve the quality of human capital, deal with sustainable development and social issues, including gender, and encourage societal values that support risk-taking and entrepreneurship.

One might query the consistency of initiatives addressing such a disparate set of challenges. The answer lies in the NIS framework for any given innovation policy, as discussed in the previous chapter, and in its concrete contribution to the global objectives of the innovation policy, as discussed in the first section of this chapter.

1. Improving education and training

This key component determines the availability of competent technicians and scientists, and potential innovators, and increases the absorptive capacity of the economy; the latter is critical for the success of developing countries' catch-up strategies and their capacity to adopt and develop new technologies.

Four objectives related to education and training can be addressed by STI policies. The first concerns developing quality education, both in absolute terms and through specific skills adopted for a knowledge-based and innovation-driven economy. The second concerns developing new skills and teaching methods that foster innovative minds and an entrepreneurial spirit for men and women, as well as a capacity for lifelong learning in a rapidly evolving technological world. The third concerns developing skills for all, which includes the important element of vocational training but also other forms of skills development not necessarily within the formal education system. In a globalized world, even scientists from developed countries, by choice or by necessity, may spend many years away from their country. Addressing the brain drain with new approaches that help soften the impact by mobilizing emigrated scientific diasporas is important. Furthermore, inclusiveness is crucial in the education system, and the gender gap in basic and higher education, as well as in vocational training, should likewise be addressed by innovation policies in the Arab region.

(a) Developing quality education

Although many developing countries still suffer from lack of access to schooling, the quality and relevance of education are crucial considerations when seeking to ensure an adequate supply of human capital for innovation. School completion rates do not reveal whether cognitive skills, platform competencies, and the higher skills needed for a knowledge-based economy have been acquired.[131] According to the World Bank, students who have completed five or even nine years of schooling in the average developing country have not necessarily mastered the basic cognitive skills. This proportion reaches more than half, compared with less than 5 per cent in leading OECD countries.[132]

Box 7. Finland: a non-competitive education for a competitive economy

Finland has long been an international leader in education. It has consistently ranked in the top tier of countries in all PISA assessments since 2000, and its performance has been notable for its remarkable consistency across schools. Finnish schools seem to serve all students well, regardless of family background or socioeconomic status. The following interrelated factors are often offered as the reasons behind successful reform and strong educational performance in Finland.

A focus on equity and well-being. Education in Finland is not just about teaching and learning; it also has a strong element of child well-being and care. Schools are expected to maintain strong support systems for all learners: healthful nutrition, health services, psychological counselling and student guidance are normal practice. Today it is widely recognized that the six-year primary schooling provides a solid basis for high educational performance. Schools are typically small, with class sizes ranging from 15 to 30 students.

Teachers who are highly valued and highly trained. By the end of the 1970s, all teacher-education programmes became university-based. At the same time, scientific content and educational research methodologies began to enrich the teacher-education curriculum. Teacher education is now research-based, meaning it must be supported by scientific knowledge and focus on thinking processes and cognitive skills used in conducting research. Teaching is consistently the most admired profession in regular opinion polls of high school graduates. Wages are not the main reason young people become teachers in Finland. More important than salaries are such factors as high social prestige, professional autonomy in schools and the ethos of teaching as a service to society and the public good.

A culture of trust. The Finnish education system was highly centralized until the early 1990s. The gradual shift towards placing trust in schools and teachers began in the late 1980s. In the early 1990s, the era of a trust-based school culture formally started in Finland. This culture means that education authorities and political leaders believe that teachers, together with principals, parents and their communities, know how to provide the best possible education for children.

Sustainable leadership and political coherence. The success of Finnish education reform is based mainly on institutions and institutional structures established in the 1970s and 1980s, rather than on changes and improvements implemented since the 1990s. Changes in Finnish education after 1990 have been more about ideas and innovation than about new structures. Education in Finland is seen as a public good that contributes to the well-being of all and, therefore, has a strong nation-building function.

Source: OECD, 2012, pp. 93-112.

Box 8. A reform to produce market-ready graduates in Egypt

In Egypt, public expenditure on higher education stands at an acceptable level of 1 per cent of GDP, compared with an average of 1.4 per cent for OECD countries. This corresponds to 26 per cent of total public spending on education, close to the OECD average of 24 per cent. Nonetheless, most of these resources cover administrative costs, particularly the salaries of academic and non-academic staff, rather than being allocated to educational programmes. This practice has created a legacy of outdated equipment, infrastructure and learning materials. The amount spent on each student averages just $902 (23 per cent of GDP per capita), just one tenth of the $9,984 (37 per cent of GDP per capita) spent on each student in OECD countries.

There tends to be a high ratio of students to staff, especially in humanities and social sciences, which attract 7 out of 10 Egyptian students. Technical colleges offer a two-year programme of study in a number of specializations, including manufacturing, agriculture, commerce and tourism. A few technical colleges provide five-year courses leading to advanced diplomas, but these technical diplomas lack the social status of university degrees. Whereas 60 per cent of secondary school pupils are channelled towards technical and vocational secondary schools, almost 95 per cent of enrolments in post-secondary technical colleges come from general secondary schools. This leaves many pupils from technical and vocational secondary schools with no prospects for further education.

The Government has announced a $5.87 billion reform plan for higher education to produce market-ready graduates able to contribute to a knowledge economy. The plan runs from 2014-2022 and will be implemented in two phases. It aims to improve access to technical education within universities, ensure quality assurance, raise the level of educational services, link the output of the higher education system with labour market requirements, and make universities more international. The Government is preparing to introduce preferential admission criteria for promising students. This should improve the flexibility of their academic pathways.

Source: UNESCO, 2015, p. 449.

The quality of an education system can be gauged by measuring the skills developed by students; this is generally carried out through nationwide standard tests evaluating the level of students in fields such as mathematics, literacy and science at a given age/school grade. Such tests should evaluate gender gaps in the education system to ensure an inclusive strategy.

Tests carried out at a multi-country scale provide useful comparisons into the methods that lead to good educational outcomes. One such test is the OECD Programme for International Student Assessment (PISA),[133] which has produced good results in Finland. The methods it employs might inspire policies to improve education quality in Arab country schools (box 7).

Allied to its quality, the relevance of education is a concern for many developing countries, which often "suffer from a shortage of labour with mid-level craft skills as well as high-level skills".[134] The mismatch of tertiary-level skills is critical in many Arab countries (box 8).

Policies must aim to produce tertiary-level graduates with competencies relevant for the economy. In many developing countries, "feedback from employers indicates the need

for more relevant tertiary education and research" and "employer surveys report that tertiary graduates have weak high-level and platform skills such as problem solving, business understanding, computer use, communication and teamwork".[135]

Policies aimed at increasing enrolments in STEM specialities, especially among girls, and improving links between the education system and industry are a step in the right direction. However, the skills mismatch is a broader concern that needs an array of complementary measures that address supply and demand. Although intended for developed countries, the OECD skills strategy suggests the following measures that could be relevant for some Arab countries, particularly those with a high percentage of tertiary students:

- Focus on developing strong generic skills so that specific skills can be more easily acquired later;
- Focus on creating a system that is flexible and thus responsive to economic change, rather than relying on skills forecasts as a guide to policy;
- Have comprehensive information systems that allow students to understand course content, associated labour market outcomes and the role of education and training providers, and that allow employers to understand the content of qualifications;
- Involve employers and other social partners in designing and delivering skills policies;
- Funding and financial incentives that avoid distortions (for example, inducing students to choose academic tertiary over vocational tertiary education because fees for the latter are too high) and barriers to participation (owing, for instance, to financial constraints for students from low-income backgrounds).[136]

(b) Developing new skills and teaching methods

One of the most critical challenges for education and training, one faced by developed and developing countries alike, is the rapid obsolescence of skills and competencies due to shorter technological cycles and the emergence of new ICT-driven business models. The nature of salary work is evolving towards increased employee autonomy and lifelong skills evolution and versatility.

There is consensus that new lifelong or learner-centred learning methods develop independent mindsets and autonomy that enable innovative talents to emerge. These are in opposition to traditional learning methods, where the teacher is the sole source of knowledge, conveying facts to learners whose main task is to learn and repeat them.[137] It is important to note that lifelong learning is important for developing new skills and accommodating women. Also, it should be understood as not only for adults after they have completed their studies. Rather, it starts from the early-school formative years. A comparison of traditional and lifelong learning is summarized in table 9.

While new learning methods may be costly, particularly for developing countries, traditional methods are prone to produce ever larger and increasingly frustrated cohorts of 'educated' unemployed. In any case, new learning methods cannot be implemented overnight and at full scale,[138] so it is advisable to start them in pilot schools to gain experience in their operation before any larger roll-out.

Some advanced OECD countries have implemented new learning methods at a larger scale, sometimes in conjunction with specific entrepreneurship curricula as illustrated in the examples of box 9.

Table 9. Traditional versus lifelong learning methods

Traditional learning	Lifelong learning
The teacher is the source of knowledge	Educators are guides to sources of knowledge
Learners receive knowledge from the teacher	People learn by doing
Learners work by themselves	People learn in groups and from each other
Tests are given to ensure students have mastered a set of skills and to ration access to further learning	Assessment is used to guide learning strategies and identify pathways for future learning
All learners do the same thing	Educators develop individualized learning plans
Teachers receive initial training plus ad hoc in-service training	Educators are lifelong learners; initial training and ongoing professional development are linked
'Good' learners are permitted to continue their education	People have access to learning opportunities over a lifetime

Source: World Bank, 2010, p 175.

Box 9. Developing skills for innovation and entrepreneurship: examples from OECD countries

Denmark's national innovation strategy (2012) aims to integrate innovation and entrepreneurship training into mainstream education at all levels through initiatives such as practice-based instruction.

As part of a five-year plan launched in 2013, Korea aims to encourage more problem-solving and practice-oriented instruction in primary and secondary education.

The Action Plan for Entrepreneurship in Education in Norway (2009-2014) aims to strengthen skills such as creativity and innovative thinking through their integration into curricula at all levels of education.

Portugal's National Strategy for Industrial Development for Growth (2014), and the 2013 Spanish Law on support to entrepreneurship and its internationalization, aim to foster entrepreneurial competencies through changes to school curricula.

Since 2012, higher education students in Poland must study an entrepreneurship component, while entrepreneurship has become a part of the training of higher education teaching staff in Estonia.

Source: OECD, 2014b, pp. 236-238.

(c) Developing skills for all

The shortage of mid-level craft skills—more commonly, of good technicians—can be more critical in developing countries than the lack of high-level skills. Mid-level skills not only influence the technological absorptive capacity of developing countries and quality of their industrial production, they contribute to the essential improvement in agricultural productivity and more traditional food and craft production.

Social values in Arab countries, whereby secondary school graduates pursue a tertiary degree regardless of the poor job opportunities it might offer, strongly contribute to the low demand for vocational education and training (VET).

As big a problem is the lack of quality VET to prepare trainees for a private sector largely dominated by the informal economy. Some NGO-led initiatives try to stir the development of VET in Arab countries, illustrating innovative approaches, such as actively involving prospective employers, but the impact of these efforts remains limited without an effective national policy.

Establishing an effective VET system is challenging for many developing and Arab countries: such a system is needed to develop a strong industrial base, which in turn, is required to develop student's skills, but "employers [in developing countries] are often not satisfied with the quality of vocational education and training. In particular, they complain of the low quality of training schemes, trainees' lack of practical skills, and inappropriate training content".[139]

It is difficult to evaluate VET in Arab countries due to scarcity of data;[140] the few data available from Arab national VET institutes indicate a small percentage of people enrolled in the system. By comparison, statistics for the European Union from Eurostat indicate that for 2013 almost half (48.3 per cent) of upper secondary students in the 28 EU member States followed a vocational training programme; the proportion reaches 90.8 per cent among those enrolled in post-secondary, non-tertiary education.[141]

There is no magic recipe to increase the quality and enrolments in a VET system. One potential strategy is to ignite a so-called virtuous circle, consisting of a series of measures that aim to gradually consolidate the VET system with the active involvement of companies. Some of these measures can be implemented immediately, others later when the industrial base reaches a certain level of maturity. Each country should elaborate its own model based on its needs and priorities, and the projected evolution of its industrial base. Some suggested measures to improve and consolidate the VET system are discussed in annex table A.3.

(d) Addressing the brain drain issue with new approaches

Although some studies claim that skilled emigration – measured as a percentage of tertiary degree holders – has fallen in the Middle East and Northern Africa regions from 12 and 10 per cent respectively in 1975 to only 6 per cent in 2000, this fall is most likely due to an inflation of the denominator. In absolute terms, the phenomenon had likely not abated. As early as 2000 it was estimated that nearly one million Arab tertiary degree expatriates lived in OECD countries.[142]

Due to the increasingly global nature of modern science and technology, and associated research and development (as will be discussed in the next section), movement and competition for highly skilled workers is affecting all countries, developed and developing alike. While it is true that the former have a greater potential to attract the best talent (even more so than peer-developed countries, as noted in chapter 1), developing countries, if they play their assets well, could benefit from this global movement of talent, transforming brain drain into brain circulation. Talent circulation could be transformed from a zero-sum game (what the country of origin loses is what the recipient country gains) into a win-win opportunity. There is evidence from OECD countries that "the research impact of scientists who change university (or research centre) across national boundaries is 20 per cent higher than those who never move abroad".[143]

What may drive new policy measures, even in developing countries, is the belief that the mobility of researchers and scientists is closely related to scientific collaboration and with student flows in the opposite direction.

As pointed out "mobility among scientists appears to occur in the context of wider and more complex networks of mobile, highly educated and skilled individuals".[144]

Leveraging skilled diasporas beyond the immediate benefits of remittances and donations (which, however welcome, cannot compensate for lost competencies) involves enabling these diasporas to carry out investments in their home country and act as knowledge and innovation intermediaries with the outside world.

Concrete initiatives aimed at leveraging skilled diasporas might involve the following measures:

- Recruiting, even on a temporary basis, expatriate experts for developmental projects in their home country;
- Offering expatriates the opportunity to exercise their entrepreneurial spirit by launching businesses in their home country;
- Offering expatriates who choose to return to their homelands work conditions that keep them 'connected' with mainstream knowledge hubs in their specialty.[145]

The success of such measures relies on the "capability of the home country economy, its dynamism, and the availability of organizations of excellence with which overseas talent can engage".[146] Box 10 summarizes measures taken by Morocco to leverage diasporas.

Box 10. Leveraging diasporas: the case of Morocco

Highly skilled Moroccans (those with a tertiary or graduate degree) make up 15 per cent of the Moroccan diaspora estimated at 4.5 million. This equates to more than 400,000 Moroccans living abroad who have a university degree.

Aware of the diaspora's role in developing innovation, since the 1990s the Government has made significant efforts to involve Moroccans living abroad (MLAs). Examples of these efforts include the following:

- Maghribcom, launched in January 2013, is a web platform for MLAs to follow the initiatives and policies of the Ministry in charge of them. It provides Moroccan professionals with information on business opportunities, ad hoc collaboration, investment and employment;
- FINCOME (Moroccan Forum of International Competences Abroad) is a programme that aims to encourage MLAs to support the economic, social and cultural development of Morocco through training, research, expertise, consultancy or investment initiatives of their own;
- The International University of Rabat (UIR) is the first public-private partnership in higher education in Morocco. The strategic orientation of the UIR, research, development and innovation (RDI), is to establish applied research with a strong, innovative market-oriented component to meet the socioeconomic needs of the country. Most UIR researchers are from the academic and scientific diaspora.

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

However, policies and initiatives targeting MLAs are still insufficient to address the needs of the Moroccan economy. The impact to date has been limited. More data are needed on highly skilled MLAs, their research and the innovations they have contributed to, and the impact of actions taken in Morocco towards mobilizing innovative migrants of the Moroccan diaspora. Such data would enable policy to be tailored towards more targeted ends.

Source: Boukharouaa and others, 2014, pp. 123-131.

Box 11. Main policy messages – 2

Improving education and training

Developing quality education requires a new approach, a move away from the rote learning and memorization prevailing in Arab countries. Particular attention should be paid to student well-being and developing their curiosity and critical thinking during the early stages of their primary education.

Higher secondary and tertiary education policies should focus on developing strong generic skills, so that specific skills can be more easily acquired later during lifelong learning. It is important to involve employers and other social partners in the design and delivery of curricula.

New teaching methods could be gradually implemented by developing them in pilot schools before more widespread deployment. There is no alternative; the current system continues to produce ever larger and increasingly frustrated cohorts of 'educated' unemployed.

Developing VET at higher secondary and post-secondary level should be high on the agenda for innovation policies, not only to ensure all youth obtain a useful qualification but also to address the scarcity of mid-level or craft competencies in the region that hinders industrialization. VET could be best developed by igniting a so-called virtuous circle through a series of measures aimed at gradual consolidation of the VET system with the active involvement of companies.

Brain drain among the educated, a significant phenomenon in the region, should be addressed through measures to leverage skilled diasporas. Such measures might include the following: temporary recruitment of expatriate experts for developmental projects; offering expatriates the opportunity to exercise their entrepreneurial spirit and launch businesses in their home country; and offering returning expatriates appropriate conditions to enable them to stay connected to global knowledge networks in their respective specialties.

Brain drain phenomena has a special status as it impacts and, in turn, is impacted upon, by innovation policies beyond the scope of specific measures that aim to attract skilled diasporas. Brain drain has its roots in poor economic conditions and in the absence of a properly functioning NIS that does not provide sufficient professional and material incentives to keep talent at home; this, in turn, slows down efforts to establish a functioning NIS due to lack of human capital. There is no magical recipe to break this cycle, in which most developing and Arab countries are trapped, other than by applying in a holistic manner the policy recommendations discussed in this chapter. Most likely, results will materialize slowly. This, however, is the only way to ensure incentives attract skilled diasporas and ignite a new virtuous circle, in which returning diasporas strengthen the NIS and attract others to return. The inability to date of incentive measures to qualitatively change the landscape of NISs in developing countries emphasizes the need to establish comprehensive innovation policies.

Based on the above, the main messages for improving education and training are highlighted in box 11.

2. Strengthening the research and development base

Like most developing countries, Arab countries' global research and development spending, measured as a percentage of their GDP, is low. No Arab country is above 1 per cent and a majority are below 0.5 per cent (chapter 3 and annex table A.4). They generally share the following features: a large share of public R&D and correspondingly meagre share of private sector R&D (opposite to developed countries); an R&D system largely disconnected from socioeconomic needs; and weak connection with global research networks and limited mobility for researchers.

This section will examine these features, highlighting policy measures that might be adopted by Arab countries. The three are interrelated and addressing each in separation would likely reduce the effectiveness of any response: better quality public R&D that addresses socioeconomic priorities will necessarily increase the private sector share in R&D eventually and improve international links and integration with global science networks.

This section will focus on measures to improve the quality and relevance of R&D, whether conducted by public institutions or private companies (the supply side), knowing that they also influence the demand side and resulting investment levels and spending on R&D. The low level of R&D spending (as a percentage of GDP) in many developing countries reflects meagre government and company financial resources; however, it is also to a significant extent due to lack of demand for R&D. This, in turn, is due to the lack of capability to leverage produces through the enhanced productivity of companies or efficiency in government and other social services.

(a) Improving universities' R&D relevance for socioeconomic needs

In the few Arab countries with available data on R&D efforts, the vast majority of full-time equivalent (FTE) researchers[147] work within Government and universities, the figure reaching more than 80 per cent in the latter (annex table A.5). The low ratios of FTE researchers per million inhabitants in Arab countries is far below those of developed or even emerging countries.

Against this backdrop and the established disconnect between Arab universities' R&D activities and socioeconomic needs,[148] efforts to improve the efficiency and relevance of R&D activities should be high on the agenda when formulating Arab innovation policies.

Two policy instruments for establishing Bayh-Dole-type legislation and TTOs are presented below. University-industry cooperation is also highlighted through an example taken from Malaysia. Finally, open science is presented as an emerging paradigm that might increase the return on public investments in scientific research, consequently improving linkages between research and socioeconomic concerns, and enable developing countries to benefit from advances in developed countries at no cost.

(i) Bayh-Dole-type legislation

Bayh-Dole-type[149] legislation encourages universities, public research laboratories or any other recipient of public research funds to exploit the proceeds of publicly funded research to its own benefit. Practically, this translates to 'spinning off' innovative companies from research laboratories. In theory, the scheme is flawless; not only does it encourage initiatives for useful research but public money used to fund it is paid back by the economic benefits drawn from these new firms. Although the scheme has contributed to the creation of many innovative firms, it has been criticized for giving incentives to universities and public research centres to move away from essential basic research.

Whether such schemes can be useful for Arab countries should be weighed in the light of the above considerations. Scarce resources should not be directed away from equally important basic research, and the impact on the quality of teaching should be taken into account if researchers are working in universities.
If adopted, such schemes should be subject to close scrutiny and their impact on the economy and consistency with larger scale industrial policy evaluated.

Box 12. Establishing national technology development and transfer systems in selected ESCWA member States

Technology transfer has been identified as essential to prosperity in many parts of the world, and many developed countries have already implemented a consistent technology transfer model that answers their needs and is of great value to their economic and social growth. Like many developing countries, however, the Arab region does not have a strategy or sustainable model for technology transfer.

The ESCWA Technology Center (ETC) launched its project to establish NTTOs in selected member States in 2015. This project is being implemented in the following seven Arab countries: Egypt, Lebanon, Mauritania, Morocco, Oman, Tunisia and the Sudan, where ESCWA is cooperating with national agencies in charge of research, development and innovation. The following is a list of national focal points in four countries were the project is more advanced:

- Egypt: Academy of Scientific Research and Technology;
- Lebanon: The National Council for Scientific Research;
- Morocco: National Centre for Scientific Research and Technology;
- Tunisia: National Agency for Scientific Research Promotion, Ministry of Higher Education and Scientific Research.

The main aim of this project is to enhance innovation system capacity by updating related policies and establishing NTTOs linked to universities and research institutions to facilitate partnerships between the research community and the economic development sector, industry and relevant government and nongovernment actors. This is crucial for developing a sustained and purposeful national technology sector.

Since its launch, the project has undertaken several studies, mainly in four above-mentioned countries. Each one provides analysis of the RDI system, describes the intellectual property and patent system, identifies the main STI stakeholders and concludes by highlighting the challenges to advancing STI. Analysis suggested that the four Arab countries need to pursue several policy reforms to establish an effective and sustainable innovation ecosystem and TTOs. This resulted in further studies on drafting appropriate laws and regulations and mechanisms for enhancing innovation systems and establishing national technology transfer bodies. In each country, the studies and their findings were discussed during a national workshop that gathered the main STI stakeholders alongside high-level government officials.

Later in this project (2015-2017), the ETC and the national focal point in each country will do the following: organize capacity-building workshops on technology transfer; develop the NTTO operational framework; and train NTTO staff in operational duties. The project will conclude its activities in 2017 by organizing a regional forum of NTTOs.

The NTTOs will help to integrate the capacity of innovators, investors, entrepreneurs and researchers who are developing technological solutions to the sustainability challenges and strategic needs of the national economy. NTTOs can help provide the following services: policy advice to relevant government ministries; scouting IP value in research by working closely with researchers; patent drafting and protection; support for technology commercialization and industrial consulting. The NTTO must also help link and match local capacity with multinational corporations while seeking local partnerships and shared development and production values.

Source: ESCWA.

Box 13. Consolidating university-industry linkages in Malaysia

Established in 2012, Collaborative Research in Engineering, Science & Technology (CREST) is a key public-private initiative in Malaysia that has started to drive growth in the electrical-electronics industry. CREST focuses on bringing together three key stakeholders, industry, academia and the Government, in collaborative R&D, talent development and commercialization.

CREST is the first research-grant provider that targets only those R&D projects that drive university-industry linkages in Malaysia's electrical-electronics industry. By providing R&D grants, CREST promotes collaboration between academia and companies in market-driven research. CREST does not operate research laboratories but focuses on funding research located either in universities or industry as nominated by each research team.

Through close interaction with industry players, CREST identifies the weak links in strategic segments and sets the direction of the types of R&D to be conducted. In addition, CREST promotes programmes that drive local firms to higher value chain governance at the regional and international levels.

Since 2012, CREST has approved 74 projects by matching grants. Universities and companies participate in every project. As of 2014, the projects had involved a total fund of about $16.5 million, 65 per cent of which had been provided by companies. Eight projects were completed in 2014, with another 18 expected to be completed the following year. The remaining 48 projects are scheduled for completion in 2016-2018. CREST is aiming to have 61 commercializable intellectual properties and to issue 299 research publications by 2018.

Source: Dutta, Lanvin and Wunsch-Vincent, 2015, p. 145.

(ii) Technology transfer offices

The introduction of Bayh-Dole-type legislation in many countries sparked an array of technology transfer intermediaries that aimed to commercialize the proceeds of public research carried out in universities and PRI. These include the following: TTOs; business incubators; business innovation centres; science parks; special agencies in chambers of commerce; industry liaison offices; proof-of-concept centres; and libraries/institutional repositories.[150]

The experience of OECD countries shows that, "most TTOs do not generate positive net returns, or break even, from patenting and licensing", which seems to have been their initial core mission. Consequently, "many TTOs have expanded their missions from simply administering technology transfer (such as managing invention disclosures and filing patents) to a range of IP management and support activities (for example, patent scouts, consulting), marketing non-patent services, administering seed funds, and creating a culture of innovation".[151]

An ESCWA project to establish national technology transfer offices (NTTOs) in the Arab region is summarized in box 12, and box 13 discusses the experience of Malaysia in consolidating university-industry links.

(iii) Open science

Open science is a new paradigm whereby unrestricted access is provided to publicly funded research. It can also be applied in the business sector to enable innovation. It allows citizens to be better engaged in scientific progress and innovation. Open science benefits from the Internet and new information technologies, which "greatly lowered the marginal cost of online publishing, data storage and archiving. This created opportunities to organize, share and reuse vast amounts of data generated by public research".[152]

The motivations for governments to develop open science include the following: it can improve efficiency in scientific research by avoiding duplication and enabling more research based on the same data; generate knowledge spillovers and create new research opportunities by exploring data to generate new scientific hypotheses; address global challenges by accessing and sharing reliable data from many countries; and strengthen the evidence base of policy.[153]

Open science offers two complementary benefits to developing countries. First, they can follow in the footsteps of developed countries and learn from their experience when elaborating their own open science policies for research carried out by universities, PRIs and firms. Second, they can freely access scientific and technical results obtained by the world's leading universities and research centres. The initiatives of some international organizations to promote global open science are mentioned in box 14.

Open science policy involves concrete initiatives, such as "the creation of the necessary online repositories... containing information on R&D projects and researchers' CVs"; mandating open access to the results of research carried out with public funds; providing financial support to cover the cost of open-access publishing; developing open government data to provide good examples and useful public data; and adapting intellectual property rules "to make copyright legislation increasingly open-science friendly".[154]

In 2007, OECD published Principles and Guidelines for Access to Research Data from Public Funding.[155] More recent policy recommendations from OECD and partner country experience include the following:[156]

- Open-science policies should be principle-based but adapted to local realities, particularly when research projects involve business-sector partners and commercial interests are present; also privacy or confidentiality concerns may apply to the treatment of certain specific classes of data;
- Consultative approaches that involve all relevant actors (researchers, government institutions, universities and research centres, libraries and data centres and business-sector organizations) are key to successful open-science strategies;
- Better incentives are needed to promote data-sharing practices among researchers. Most evaluations of universities and researchers are almost entirely based on teaching and bibliometric indicators, attributing little value to the sharing of prepublication inputs and post-publication outcomes. Extending citation mechanisms to data sets can partly address this issue;
- Clear legal frameworks for sharing publications and the reuse of data sets are needed at the national and international levels. In addition, clear guidelines around text and data mining are needed as researchers will use these tools increasingly.

(b) Increasing the role of the private sector in R&D

Moving from the status of developing to developed country is not only associated with an increase in R&D expenditure (as a percentage of GDP), but equally, with a pattern reversal whereby R&D expenditure and performance moves from the public to the private sector. The example of Korea, which has made this transition, is a case in point (box 15).

Box 14. Global open science

Some international organizations, such as UNESCO, the European Union and the World Bank, have been active in recent years in promoting open science efforts of member and, in some cases, non-member countries.

UNESCO devotes special attention to the benefits arising from open access to African countries and other developing countries, where efforts are less developed. UNESCO developed guidelines to help member countries choose the open access policy that best suits their specific context and promote the adoption of open access policies.

The World Bank has adopted a fully open access policy for the publications it produces, and is considerably advanced in providing data to all potential users and stakeholders.

The 2014-2020 European programme for science, research and innovation – Horizon 2020 – is committed to supporting open science in several ways. Researchers receiving grants from Horizon 2020 must deposit a machine-readable electronic copy of the published version or peer-reviewed manuscript accepted for publication in an open repository, although there is no specification on timing or embargo periods.

Horizon 2020 includes a pilot project on open research data. Researchers participating in the pilot will be asked to make available the data forming the basis of their research results so that such data might be used by other researchers and projects, innovative industries and citizens, and to develop data management plans.

Source: OECD, 2015c, pp. 95-96.

Increasing the private sector's share in R&D, even if part of a national innovation policy vision, can be realized only in the long term and if government innovation policy puts in place instruments that achieve the following:

- Ensure that the global environment in which companies operate provides sufficient incentives for them to increase their R&D investments and efforts;
- Introduce financial support mechanisms to reduce a company's R&D cost and impact on their bottom line;
- Increase a government's own R&D and other efforts to support companies' R&D.

None of the policy instruments on their own, or even combined, can ensure success. Global macroeconomic conditions, including political stability, and a country's global competitiveness and financial assets play an important role. Equally, a company's management and staff quality, and its willingness to contribute to a national effort (largely stirred through an open dialogue with government and workforce representatives), are crucial, as highlighted by the success stories of some Asian countries.

The policy instruments outlined above will now be discussed with a focus on the priorities for Arab countries.

(i) Exogenous factors: trade, FDI and foreign technology licensing

As the experience of Asian countries has shown, opening up to trade, FDI and foreign technology licensing are critical during the technological catch-up process. Policy should, however, strike a balance between advantages (mainly favouring foreign technology transfer) and disadvantages (mainly pressure on local companies who might be wiped out before acquiring foreign technology know-how). Selectively screening trade and foreign technology licensing and channelling FDI towards specific technologies and sectors, depending on national priorities, should be among the policy considerations.

Such screening might be difficult to apply in Arab countries, particularly in today's globalized economy, though this is debatable. Recipient countries have bargaining power—control over

access to their markets, the capacity of local companies to absorb new technologies and even compete with foreign firms, and financial clout through sovereign funds—to negotiate contracts with developed country companies holding advanced technologies, thereby enabling technology to be transferred. Arab countries, if they act as an integrated region in the manner of the EU, with their combined market size and financial and human resources, have no less a bargaining chip today than Asian countries who managed this many decades earlier.

Box 15. Moving R&D from public to private sector: the case of Korea

In the mid-1960s, Korea's per capita income was not much higher than Ghana's, its R&D spending was just 0.5 per cent of GDP, and the Government financed 80 per cent of R&D and the business sector only 20 per cent.

Because the Government was eager to have the private sector undertake more R&D, it provided incentives, such as duty-free imports for research equipment and materials, and accelerated depreciation, offered tax incentives and exempted graduates who opted to go into research from military service. These incentives, however, did not have a major impact.

It was only when foreign companies started to restrict technology licences to Korean companies because they were beginning to compete in their global markets that Korean companies began to invest heavily in R&D. This became an important bargaining tool for access to foreign technology because of the credible threat Korean companies would develop the technology themselves.

By 2004, the ratio of public to private financing of R&D had been reversed: almost 80 per cent private and only 20 per cent public, and R&D expenditures had increased to 2.7 per cent of GDP.

Source: World Bank, 2010, pp. 141-142.

(ii) Endogenous factors: effective competition and reducing bureaucracy and corruption

Endogenous factors that condition a company's investment levels in R&D arise from competition and stifling bureaucracy. 'Real competition' and lighter, more efficient bureaucracy could favour Arab companies (particularly among SMEs) willing to invest in R&D if only because they provide insurance for potential pay-back in case of success.

(iii) Tax incentives and grants to support companies' R&D

Even in advanced developed countries, government support to companies' R&D is critical. Although developing countries can borrow from instruments used by developed countries, they do not share the same constraints. Of the two major instruments, tax incentives and grants, the former are increasingly favoured in developed countries because of the automatic and neutral support they provide, while the latter are favoured in many developing and Arab countries. Weak tax systems in many Arab countries and companies' weak R&D capacity make direct grants more effective at enticing companies to develop R&D activities that they might not have pursued on their own.

(iv) Duty exemption and rapid depreciation for R&D equipment

These two instruments are particularly critical for many Arab countries with strained and limited taxation revenues from companies. Such benefits should be provided conditionally, based on R&D levels as a percentage of company revenue or contribution to developing an industrial sector considered strategic by national policy.

(v) Venture capital and commercialization of research results

Venture capital (VC) in the Arab region is still relatively weak as gauged by the number of deals (per trillion dollars of GDP in purchasing power parity (PPP)). Only in Jordan and Lebanon did this value reach the threshold of 0.1, while it is negligible (at best 0.03 for the United Arab Emirates) in four of the six GCC countries for which data is available – and considered a weak point in the Global Innovation Index (GII).[157]

More detailed analysis indicates that information technology sectors attract nearly half of VC investments,[158] due to increasing smartphone penetration rates and a growing e-commerce sector. While a positive sign—and one could add that some countries such as Lebanon have "proved attractive to the VC industry in the region" and "support from the Lebanese Central Bank has further stimulated interest in investing in start-up companies and SMEs"[159]—it remains to be seen if VC in the region will have a significant economic impact in the near future.

(vi) Increased public R&D and links between industry, public research and universities, and investment in human capital

These instruments relate to government actions that indirectly support companies by providing them with better results from public R&D and higher quality staff. The Arab Strategy for Scientific and Technical Research and Innovation suggests measures, which, if properly applied, can help to implement the three instruments, providing a detailed research agenda that might give substance to increased public R&D budgets, and concrete initiatives for the latter two. For instance, if higher education's goal is acknowledged as development and defence, "this impacts curricula and offered disciplines, students' enrolment and distribution among those disciplines, teaching method, nature of laboratories and other factors"[160] and could develop useful competencies for companies.

Moreover, the measures[161] suggested by the strategy are aimed at developing joint research activities between public and private sectors; critical if the private sector wants to take the lead and attract research talent, now predominantly in the public sector, to its payroll. Companies in Arab countries, with their generally weak R&D base, cannot but benefit from such a partnership before consolidating their own R&D capacity. This is particularly true if such companies adopt a more aggressive approach towards technology appropriation, with proper government support.

(c) Becoming part of international research networks

Scientific cooperation between Arab and foreign scientists, particularly from advanced OECD countries, as measured by the number of collaborative scientific papers, is relatively decent. The percentage for such papers was 27.3 per cent in 2005, with some countries like Morocco reaching 48 per cent. Algeria, Lebanon and Tunisia also have higher than average percentages.[162]

This collaboration, however, is taking place against a backdrop of weak overall scientific production. Quantitative research output in Arab countries (measured by number of publications per million inhabitants) is still below that of other regions, despite the ratio rising between 1990 and 2007 from 25.6 to 44.7, and far below that of developed countries (from 1026 and above). China, for example, had witnessed an increase from 7.9 to 154.4 over the same

period.[163] Research output in the Arab region has not had the profound impact on development experienced by China and other so-called Asian Tiger countries, where provision is made for an integrated national scientific community, and where economies rely on national technology policies and effective science and technology systems. Arab countries are yet to adopt similar measures.

Box 16. Global challenges and international scientific collaboration

If they are to be addressed effectively, global challenges, such as climate change, food, energy and water security, and disease pandemics, require more knowledge and new technologies.

The Global Agriculture Research Partnership of the Consortium of International Agricultural Research Centres (CGIAR) includes as partners countries with weaker STI capacities. Although specific actions may be required to build capacities in such countries, thanks to open science, there are opportunities for radical developments in the future governance of STI and help in finding solutions to global challenges. The 2015 Future Earth initiative also has a novel, regional, multi-stakeholder governing and management structure that may provide a new model for the future.

The Ebola outbreak in Africa highlighted not only the vulnerability of the poorest countries to infectious diseases but also, in a globally connected world, how difficult it can be to contain and effectively treat newly emerging ones. The development, testing and deployment of new vaccines and therapeutic medicines are essential to the public health response. In this regard, international clinical trials are critical.

The Global Earthquake Model is an example of an international science-based response to a natural hazard. It is a public-private partnership engaging a global community in the design, development and deployment of state-of-the-art models and tools for earthquake risk assessment.

Source: OECD, 2015a, pp. 98-99.

Collaboration between Arab scientists and other countries should be a high priority for innovation policies, not only to strengthen national R&D programmes but also to address global concerns via international research programmes.

OECD countries themselves are seeking such collaborations with developing countries. With BRIICS[164] countries and other emerging economies producing an "increasing share of scientific knowledge", and with stagnating science in many developing countries undermining "efforts to address global challenges",[165] OECD countries no longer are in the ascendant. Examples of such global challenges are highlighted in box 16.

Based on the above, the main policy messages for strengthening R&D are summarized in box 17.

3. Consolidating the regulatory framework for innovation

The NIS of developing countries is vulnerable due to dependency on external technology flows. Developing countries need to protect new innovators from harmful regulation, unnecessary red tape and corrupt or inefficient bureaucracy.

Innovation policies should address many aspects of the regulatory framework for innovation, as shown in the models discussed in chapter 1. Although not specifically related to the core issues of the NIS, these aspects significantly influence the system's efficiency and outcomes. They can be exogenous in nature, affecting external technology flows related to trade, FDI and public procurement; or endogenous, affecting the local environment for innovation and related to competition and intellectual property rights (IPR) rules and regulations.

Box 17. Main policy messages – 3

Strengthening research and development base

Low levels of R&D spending in Arab countries and the ratio of researchers to population necessitate multipronged policy measures to augment public research efficiency and relevance for socioeconomic needs, increase the share of private sector in R&D spending, and improve links with international research networks.

Bayh-Dole-type laws might be considered as policy instruments to favour the technology transfer of university research to industry, provided that benefits outweigh disadvantages whereby meagre public research resources are distracted from useful fundamental and social impact research. Transfer of university research is managed by TTOs, and ESCWA is implementing a project to help to establish national TTOs in Arab countries.

Open science can improve efficiency by the following: avoiding effort duplication and enabling more research on the same data; creating knowledge spillovers and opening up research opportunities to generate new hypotheses through data exploration; and helping address global challenges by sharing reliable data from many countries. Arab countries can join the movement both as contributors, particularly within a context of Arab integration, and as beneficiaries of publicly available research results and data.

Trade, FDI and foreign technology licensing are critical to help Arab countries catch up technologically. Policy should, however, weigh the ease of technology transfer enabled by full openness with the resulting pressure on local companies, which might suffer before they can acquire foreign know-how. Selectively screening trade and foreign technology licensing, and channelling FDI towards specific technologies and sectors, might be the way forward.

Although neutral tax incentives are widely used as a policy mechanism to support private sector R&D in developed countries, Arab countries might prefer the alternative research grant mechanism. A weak tax system can reduce a company's R&D capacity, making direct grants more effective, and enticing them to develop new R&D activities they might not have on their own.

Collaboration between Arab scientists and other countries should be made a high priority by innovation policies, not only to strengthen national R&D programmes but also to address global concerns via international research programmes. Advanced OECD countries are demanding such collaboration with developing countries to strengthen their capacity and help them to address global challenges related, for instance, to pandemics, earthquake modelling and agriculture.

(a) Trade, FDI and public procurement

(i) Trade

Trade contributes to technology and knowledge transfer to developing countries as a result of the following: technological know-how embodied in goods and services that "enables developing countries to employ more efficient production processes and thus raise the quality of their own products and processes"; licensing of foreign technology that "typically involves the purchase of production or distribution rights for a product and the underlying technical information and expertise for producing it"; and export activities that "generate technological spillover through interaction with foreign buyers and customers; for example, when exporters have to meet new specifications or higher standards".[166]

Despite the dismantling of trade barriers in past decades (due to bilateral and multilateral trade deals and globalization of the world economy) and the resulting increased volume,[167] many developing countries still experience high tariffs on their exports, particularly those with higher added-value, to developed countries so the latter can protect their industries. This impedes industrialization efforts and the move towards high added-value exports, and encourages developing countries to apply their own high tariffs, harming potentially useful technology transfer.[168]

There is no easy fix other than by multilateral negotiation and regional grouping (of Arab countries, for instance) to gain better bargaining power. In this context, national policies aimed at lowering tariff barriers for critical technologies should strike a balance between the benefits these might bring to technology transfer compared with losses to trade concessions.

(ii) Foreign direct investment

FDI inflows to the Arab region have fallen from the peaks reached shortly before the financial crisis of 2008. FDI hit a high of $93 billion in 2008, but was down to $45 billion in 2013. In volume, GCC countries attracted more than half (54 per cent) in 2013. The United Arab Emirates (22 per cent) and Saudi Arabia (20 per cent) received the most, with other Arab countries also enjoying meaningful shares; for example, Egypt (12 per cent), Morocco (7 per cent), Lebanon (6 per cent) and Iraq (6 per cent). Inflows towards the Arab region, however, remain small, reaching only 3 per cent of the global total in 2013. Data on intraregional inflows remain scarce but partial data selected from eight Arab countries point to low volumes, only $3.4 billion, with most from GCC countries.[169]

Of more concern is the nature of sectors targeted. According to the OECD, between 2003 and 2012, the natural resource and non-tradable sectors (mainly real estate and construction) received nearly 50 per cent more greenfield FDI flows than tradable non-resource manufacturing and commercial services. High-quality FDI—that is, FDI that creates employment, promotes transfers of technology and managerial know-how to host economies in non-oil tradable manufacturing and services, and facilitates a transition to higher value-added production and export, economic diversification and increased competitiveness—has decreased substantially, making the region one of the least integrated developing regions in global value chains.[170]

Policy that aims to improve FDI inflows quantitatively and qualitatively, apart from restoring needed political stability in some Arab countries, should address the following:

- Structural reforms. These aim to establish predictable, non-discriminatory and transparent regulatory and legal frameworks, and simpler administrative business-related procedures, to enhance the business climate and restore investor confidence;
- Regional economic integration. Towards this goal, the 2013 amendment of the Arab League Investment Agreement "reinforces existing investment protection and treatment standards... while introducing new ones (such as the right to a fair and equitable treatment and the most-favoured nation clause)".[171] In addition, it "strengthens the role of Arab League institutions to promote harmonised investment policies and disseminate investment-related information".[172] More importantly, the update introduces an improved dispute settlement mechanism to encourage better enforcement of the Agreement;

- Data collection of FDI statistics. This is achieved by adopting "a common definition harmonisation of data collection methods within and across countries".[173]

(iii) Public procurement

Public procurement represents a significant percentage of public expenditure and share of GDP, both in developed and Arab countries. OECD estimates that public procurement accounts for 29 per cent of public expenditure and 12 per cent of GDP among its member countries.[174] Estimates for the Middle East and Africa are in the same range, from 9 per cent to 13 per cent of GDP.[175]

Public procurement could be an effective tool for developing countries to acquire innovative foreign technologies, but equally, to develop demand for innovation at local level by providing opportunities and markets for innovative industries and SMEs.

Procurement policies could stimulate innovation in the three following ways:

- Procuring innovative goods and services. This is characterized by procurements specifying "clear and robust output specifications... setting functional or performance criteria, thereby leaving tendering companies room to propose solutions". Such an approach creates "strong incentives to maximize the efficiency and performance of the products and services offered, creates a market for innovative solutions and products that may otherwise not exist; and, finally, this one-time market, by example, can then trigger new demand by the private sector and eventually open up additional market opportunities";[176]
- Pre-commercial procurement. This approach goes a step further, to create innovative solutions in areas where none are available: "Pre-commercial procurement is in fact an R&D service contract, given to a future supplier in a multistage process, from exploration and feasibility to R&D up to prototyping, field tests with first batches, and finally commercialization." It is important to note that to "reduce the R&D risks and costs associated with pre-commercial procurement, one can split the process into different phases and spread it over time, with constant competition [among companies] to create a range of options";[177]
- Catalytic procurement. Here, the public sector acts "on behalf of end-users other than the public authority" to stimulate the development of innovative products. For instance, within the framework of developing energy-efficient products in the 1990s, this "involved the procurement of energy-efficient home appliances, the main end-users of which would not be public sector organizations but private individuals and households".[178]

Such approaches might be difficult to implement in many Arab countries, some of them still facing challenges in building transparent public procurement processes. Additionally, most Arab countries, particularly high-income GCC countries, have procured advanced technologies that are often oversized or do not match real needs and are underutilized.

In an Arab region with an annual GDP totalling almost $2.7 trillion, which could translate into $300 billion public procurement every year,[179] adopting innovative public procurement approaches, particularly if associated with preferential treatment of local SMEs with innovation potential, could yield immense leverage and potential impact even for a small percentage of tenders. For such an approach to

yield results, innovative SMEs need to exist and be nurtured, and the public service should develop capacity among staff to manage such complex procurement. However, this highlights the complexity of seemingly unrelated innovation policy mechanisms.

(b) Competition and intellectual property rights

Competition and IPR play complementary roles within the framework conditions affecting the innovation system. The status of IPR in Arab countries is notoriously weak as gauged by the number of patents or by intellectual property receipts as a percentage of total trade.[180]

"Strong competition encourages companies to innovate and develop new markets. Elimination of anti-competitive product market regulations is a powerful way to stimulate investment in innovation and supports the process of creative destruction."[181]

On the other hand, knowledge-based capital plays an increasingly important role in a company's innovation and resulting competitiveness; it refers to "a range of assets—typically intangible—that are based on investment in knowledge, including R&D, software and data, intellectual property, brand equity, firm specific skills, and organisational know-how".[182] Protecting these assets requires a solid IPR system complemented by an efficient competition law that ensures protection without discouraging innovation. For example:

"The Digital economy's most meaningful competition takes place among platforms created by companies that use very different business models, rather than among companies that all follow more or less the same model. Apple, Google and Microsoft illustrate this point. They all compete in the market for mobile phone operating systems, but each uses a different business model. In such contexts, competition among the platform providers may be more important to innovation and consumer welfare than competition within the platforms (such as rivalry among companies that create apps for the iPhone)".[183]

It is crucial in such a context that competition law, supported by a sound IPR system, is capable of addressing whether patents reflect genuinely novel innovations (box 18).

(i) Competition

Competition policies form a vast subject. Greater competition can be achieved in various ways through the "elimination of state-owned and legal monopolies, barriers to entry and exit, such as unnecessary licences and other interventions into commercial decisions such as price controls. Areas requiring close attention include abuse of dominant market positions, mergers (to assess effects on competition and potential market dominance), horizontal price-fixing agreements (cartels), vertical agreements on resale prices, and restrictions such as exclusive dealing or territorial assignment."[184]

'Normal' competition law can sometimes be complemented by so-called sector-specific regulatory authorities for some public infrastructure (for example, telecommunication, electricity and water distribution) and transport (railways and airlines), industries that were for historical reasons dominated by public monopolies. Sector regulation aims in this instance to ensure a level-playing field in the presence of an actor holding a significant market position (often, the historical monopoly operator). This is achieved by ensuring the dominant actor does not abuse their position, through technical, ad hoc rules and tariffs imposed on him by the regulator.

Box 18. Competition and patents: the view from the World Intellectual Property Organization

The objective of competition policy is to ensure a fair functioning of the market, and in particular that market entry is not unduly prevented or made difficult.

Anti-competitive practices include abusive exclusionary conduct by a dominant company, refusal to provide certain goods or to grant licenses on market conditions, charging excessive prices, vertical arrangements between suppliers and distributors, and other agreements among companies that lead to distorted competition.

There is a close link between patent rights and competition, which can be characterized by two elements: patent laws that aim to prevent the copying of patented goods, complementing competition policies by contributing to fair market behaviour; and competition laws that may limit patent rights whereby patent holders may be barred from abusing their rights. Experience shows that too-high or too-low protection of patents and competition may lead to trade distortions. The goal of preventing abuses of patent rights must be balanced against removing the rewards provided by the patent system when used appropriately.

The search for this balance between patents and competition policy objectives is reflected within the patent system, and in its relationship with competition law.

- Within the patent system, the core principles have been framed to ensure the system simultaneously fosters innovation and remains consistent with fair market rules. Safeguards and boundaries have been built into the patent system to enable it to generate patents only for those inventions most likely to serve the public interest, but should prevent those that would appear not to benefit society;
- Competition law aims to prevent undesired market behaviour, in particular the abuses of a market position. For patent rights, such behaviour would cover activities going beyond the objectives and boundaries set by the patent system.

Competition policies and laws can be important instruments to regulate potential abuses of patent rights and complement patent boundaries.

Source: http://www.wipo.int/patent-law/en/developments/competition.html.

One should, however, bear in mind that sector regulation should not perpetuate the status quo, by ensuring cartel behaviour is not taking place among actors present in the market, nor impede new actors from entering the market, particularly when they introduce competing technologies.

(ii) Intellectual property rights

The role of IP in innovation and economic development has evolved dramatically over the past two decades. The basic rationale is grounded in the belief that it is in the general interest that "people and businesses that create knowledge... have well-defined, enforceable rights to exclude third parties from appropriating their inventions and creative works, or the expression of such works, without permission".[185] It had evolved little since the industrial revolution but new technological developments and globalization have made IP pervasive.

It is not only modern technological products that heavily rely on patents (for example, "a mobile phone may have as many as

3,000 patents") but the "development of technologies such as digitization and the Internet has brought consumers into more direct and frequent contact with copyright laws by making it easier, faster and cheaper to create, duplicate and disseminate content".[186]

It is equally important that companies rely on a bundle of IP rights (see box 19 for a summary of IPR categories): "For instance, in-house software used in product design and manufacturing is common at larger companies and is typically protected by copyright, while the products themselves may be protected by patents, trademarks and, again, copyrights".[187]

The World Trade Organization (WTO) Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS), which came into force in 1995, had a major impact on developing countries' IPR policies.[188] The agreement led to pressures on them to develop TRIPS-compliant policies.

TRIPS generated debate on the benefits to developing countries[189] of introducing more stringent IPR regimes. While "some argue that strengthened IP laws help developing countries create the incentives structure and institutional framework necessary for knowledge generation and diffusion, technology transfer and private investment flows", some critics believe that "current trends in the global IP system will have a range of deleterious short- and long-term effects on developing countries, including raising the prices of essential drugs beyond their affordability by the poor, limiting the availability of educational materials for developing-country school and university students, legitimizing the piracy of traditional knowledge, and undermining the self-reliance of resource-poor farmer".[190]

Whatever the debate from a developing country perspective, recent assessments indicate that "many emerging and developing countries have implemented TRIPS to support domestic innovation".[191] The TRIPS agreement is now a well-established international framework influencing national IPR policies. Issues and recommendations related to fostering innovation through two of the IPR protection mechanisms listed in box 19, namely patents and utility models, are examined below:

- Patents. The major IPR mechanism to protect inventions, patents provide relatively long exclusivity periods of 20 years (minimum prescribed by TRIPS). It is recommended for developing countries "with [a] weak technological base" to apply the following standards for invention patents: wide exceptions, including broad research exceptions; high standards of non-obviousness and inventive steps; narrow claims; narrow "doctrine of equivalents";[192] and transparent and accessible opportunities for opposing patents;[193]
- Utility models. A "second-tier patent regime" (TRIPS is silent about it), typically "accorded to inventions which show local or regional novelty". It is worth examining "for countries where the technological base is still at an early stage of development". Such a regime could prove useful for protecting incremental or improvement innovations mainly carried out by SMEs; such a regime might also be cheaper for SMEs, as research for the originality of claims is practically absent, with the downside that claims might be unrealistically broad.[194]

Based on the above, the main policy messages for consolidating the regulatory framework for innovation could be summarized in box 19.

Box 19. Main categories of IPRs

Patents provide inventors with the right to prevent others from using, selling or importing their inventions for a fixed period (minimum of 20 years under TRIPS).

Copyright gives authors legal protection for various kinds of literary and artistic work. Copyright law protects authors by granting them exclusive rights to sell copies of their work in whatever tangible form is being used to convey their creative expressions to the public.

Trademarks are marketing tools used to support a company's claim that its products or services are authentic or distinctive compared with similar products or services of competitors.

Utility models are a form of patent protection for minor or incremental inventions. Though novelty and inventiveness are required, the criteria for conferring protection are generally less strict than for patents, and the term of protection is also shorter.

Industrial designs concern the protection of the outer appearance of a product. A 'design' connotes an element or characteristic completely separate from the object it enhances or to which it is applied.

Geographical indications identify a product as originating in the territory of a WTO member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the product is essentially attributable to its geographical origin.

Collective marks belong to an association or group whose members are entitled to use that mark to indicate the origin (possibly including a geographic name) of a product.

Certification marks belong to a certifying person or body, which, by affixing or allowing the affixing of the mark, would provide assurance with a set of rules or qualifications.

Trade secrets provide for another form of protection for commercially valuable information such as production methods or business plans. They are protected from disclosure by dishonest means but, once they are learned through legitimate means, they enter the public domain.

Source: UNCTAD and International Centre for Trade and Sustainable Development (ICTSD), 2003, pp. 27-28.

4. Supporting innovators

Innovators are primarily entrepreneurs, often seeking to establish their own initially small or, at best, medium enterprise; they need nurturing and support particularly in developing countries where market and framework conditions are often not conducive for developing new businesses.

Entrepreneurs are generally not short of good ideas on their core endeavour; however, developing a successful business also entails myriad dealings with management, industrial (testing and quality control), marketing, administrative and regulatory issues that business service structures, when provided, can help to alleviate in order to avoid unnecessary early failures.

Box 20. Main policy messages – 4

Consolidating the regulatory framework for innovation

Proper framework conditions surrounding the core fabric of an NIS are essential for both developing and Arab countries. More than in developed countries, they are critical to ensure proper technology transfer and development through trade, FDI and public procurement, and contribute to nurturing nascent innovative companies by protecting IPR and fair competition.

FDI flows towards Arab countries fell steeply from levels reached in 2008, and intra-Arab FDI flows are emerging, but negligible, based on few reliable data. Moreover, FDI inflows are weak in high technology sectors. In addition to the recommendation to channel FDI towards specific sectors, Arab countries should consider measures to establish predictable, non-discriminatory and transparent regulatory and legal frameworks, and simpler business-related procedures; reinforce and deepen regional economic integration along the principles outlined in the 2013 amendment of the Arab League Investment Agreement; and improve data collection of FDI statistics.

Fair and transparent competition is still absent in most Arab countries, reflecting the rentier economic model that favours insiders and the politically connected. This situation is fundamentally harmful for innovators and particularly young entrepreneurs whose main assets are their energy and inventiveness. Establishing a fair competition law is also an essential complement to IPR as it often contributes to fair market behaviour and limits patent rights, with patent holders barred from abusing such rights.

Patenting activity in Arab countries is weak in absolute terms and essentially dominated by non-residents in most of them. Arab countries should strengthen their patenting regimens by applying principles such as: wide exceptions, including broad research exceptions; high standards of non-obviousness and inventive steps; narrow claims; narrow "doctrine of equivalents"; and transparent, accessible opportunities for opposing patents. They might also consider developing utility models as a second-tier patent regime typically accorded to inventions that show local or regional novelty.

Another key aspect is providing direct support measures for innovators at the early stages in the development of their ideas, through proper incubation mechanisms and other means, such as knowledge vouchers.[195] It is also important to spread knowledge of support measures via proper information services. Beyond the early development stage, preferential public procurement for SMEs could be highly useful to consolidate the balance sheets of young, innovative companies.

Financing is crucial. New companies, particularly in the early development phase, should come through at least one or more critical phases—often called death valleys—whereby any interruption in financing, however temporary, could be fatal. Ensuring multiple financing sources adapted for each development phase, for example, seed funding, business angels and venture capital, is vital to their survival.

Clusters and networks, whereby companies are located in a relatively limited physical space and benefit from a favourable environment for innovation and technology diffusion, are likewise important. Clusters can be purpose-built by central government or regional/local authorities, but sometimes emerge accidentally due to favourable local circumstances.

(a) Providing business services to innovators

Although competencies to provide business services exist within the private sector, private enterprise does not always supply these services because "the necessary expertise may not be available in the social environment in which companies operate; the investment needed to produce the required service is high, and return on this investment may be slow to materialize; the private sector may be ill-placed to provide these services, because they may rely

on what is essentially a public good, such as knowledge; and, finally, such market failures are particularly widespread in low- and medium-income countries".[196]

Consequently, the public sector (at national or often regional level) often provides such services either directly or through public-private partnership schemes, which together combines "the advantages of the legitimacy and neutrality of public bodies and the business efficiency and management styles of the private sector".[197]

Categories of business services critical for innovation might include the following:

- Basic industrial services: assistance for tenders of... development organizations; assistance for direct investment abroad; assistance for inward investors; legal and financial assistance; financial services, including accounting and tax assistance; market information or other economic data; organization and participation in trade fairs and other promotional events; and partner search;
- Technology extension services: assistance for patenting and licensing, grant applications, in-house R&D activities, and subcontracting to research institutes; competitive intelligence, including technological benchmarking, technology maps, and information on emerging technologies; innovation diagnosis; review of current or proposed manufacturing methods and processes; participation in and organization of technology exhibitions; and technology brokerage;
- Metrology, standards, testing and quality control: calibration of equipment; quality certification; domestic standard; ISO (International Organization for Standardization) compliance; technical assistance; demonstration centres and test factories; energy audits; and materials engineering;
- Innovation in organization and management: assistance for enterprise creation; interim management; logistical assistance; organizational consultancy, quality and training; productivity assistance; and incubation services;
- Information and communication: advanced services for data and image transmission; assistance on communication strategies, telecom network connections, and the implementation of electronic data interchange systems; and database search.[198]

The extent to which each of these services is offered by a given business support provider and the sophistication of this offer depends largely on the network of supported companies. Providing business services is not a standard, off-the-shelf offer, particularly when it deals with innovative entrepreneurship. Consumers play a role in the production of the service.

A recent assessment of SME policies in seven Arab Mediterranean countries, though not specific to innovative SMEs, clarified the status of business support services in some major non-GCC Arab countries and is summarized in box 21.

(b) Incubation and information services for SMEs

(i) Incubation

Heightened awareness of the role played by SMEs in innovation has contributed to rising development in the past few decades of direct support measures by government and local authorities in developed and developing countries. One of the most widely used support measures for young innovative companies is business incubation.

Box 21. Business support services in the Mediterranean Arab countries

Algeria established specialized technical centres that provide expertise and feasibility studies in areas such as packaging, agro-business and metal transformation. Additional services are provided through the national upgrading programme and the support programme PME II, which promotes the utilization of ICT in SMEs.

In Palestine, specific business services that focus on export opportunities and international marketing are provided by the Federation of Chambers, the Federation of Industries, Paltrade and the Shipper's Council. The Federation of the Palestinian Chamber of Commerce, Industry and Agriculture is currently establishing a Businesswomen Support Unit, providing specific services to women, including capacity-building, start-up support and marketing courses.

In Lebanon, three business development centres, Berytech, Business Incubation Association in Tripoli (BIAT) and the South Business Innovation Center (SouthBIC), are the main bodies supporting SMEs with advice, networks, workshops and training. In addition, several shared workspaces and accelerators have appeared recently, such as Cloud 5 and AltCity. The SME Support Unit/Enterprise Team at the Ministry of Economy and Trade is working to provide a strategic framework for SMEs.

In Tunisia, the Government provides support through the industrial modernization programme. Private sector consultants and associations complement this service.

Egypt, Jordan and Morocco have well-developed markets for personalized business services, with a good level of internal competition.

In Egypt, several service providers exist, notably the Social Fund for Development (SFD) through technical support programmes, and the Industrial Modernisation Centre (IMC) through its business development programmes. These support programmes receive public, private and donor funding, and tailor support to the individual needs of the SMEs. Services are provided in different regions throughout the country.

In Jordan, SMEs can receive support through the Jordan Enterprise Development Corporation (JEDCO), the Tatweer Business Development Centre and the Amman Chamber of Industry. Services are available across the country and cover a wide range of topics.

SMEs in Morocco can receive support services from public providers such as the National SME Development Agency (for example, the Moussanada and Imtiaz programmes), several associations and private providers. A good level of competition exists among service providers.

The two main policy recommendations resulting from these assessment are as follows:

- A broadening of the range of services offered to SMEs, with more technological and personalized support, skills development through training and coaching, and strategic advice and consulting;
- The need to design these services "in a more comprehensive manner, and not only as part of ad hoc initiatives, to reduce the overlaps between different institutions offering support services to SMEs.

Source: OECD, EU and European Training Foundation (ETF), 2014, pp. 112-113.

Incubators can be supported by different sponsors (government, universities, chambers of commerce, non-profit organizations, and even for-profit agents as part of business estate ventures) and differ themselves depending on their main objective and scope of potential beneficiaries (box 22).

Box 22. Types of incubators

General/mixed-use incubators. The main goal is to promote regional industrial and economic growth through general business development. A main focus of support is local and regional access to technical, managerial, marketing and financial resources.

Economic development incubators. These are business incubators with specific economic objectives such as job creation and industrial restructuring. Their main goal is to help create new companies and nurture existing ones that create jobs.

Technology incubators. The primary goal is to promote development of technology-based companies. Usually located at or near universities and science and technology parks, they are characterized by institutionalized links to knowledge sources such as universities, technology-transfer agencies, research centres, national laboratories and skilled R&D personnel. A main aim is to promote technology transfer and diffusion while encouraging entrepreneurship among researchers and academics.

Source: World Bank, 2010, p. 86.

Arab countries, almost without exception, have implemented at least one entrepreneurship incubation structure, though some countries have been more active, both in the number of structures and amount of funding and support. High-income GCC countries, for example, spend greater amounts on incubators. Efforts have not yet yielded results, as evidenced by the measurement of new business density (the number of registered new businesses per 1,000 population aged 15-64), where Oman, Qatar and the United Arab Emirates did not fare much better than Jordan, Morocco and Tunisia. All countries also fell below the ratios of leading countries. However, implementing a comprehensive framework to evaluate efficiency and impact of incubation initiatives in the Arab region remains a work in progress; for example, ongoing efforts to elaborate KPIs for science and technology parks.[199]

Despite recent improvements in Morocco and Lebanon, Arab countries still have significant potential for improvement, with support to SMEs largely revolving only around basic services.

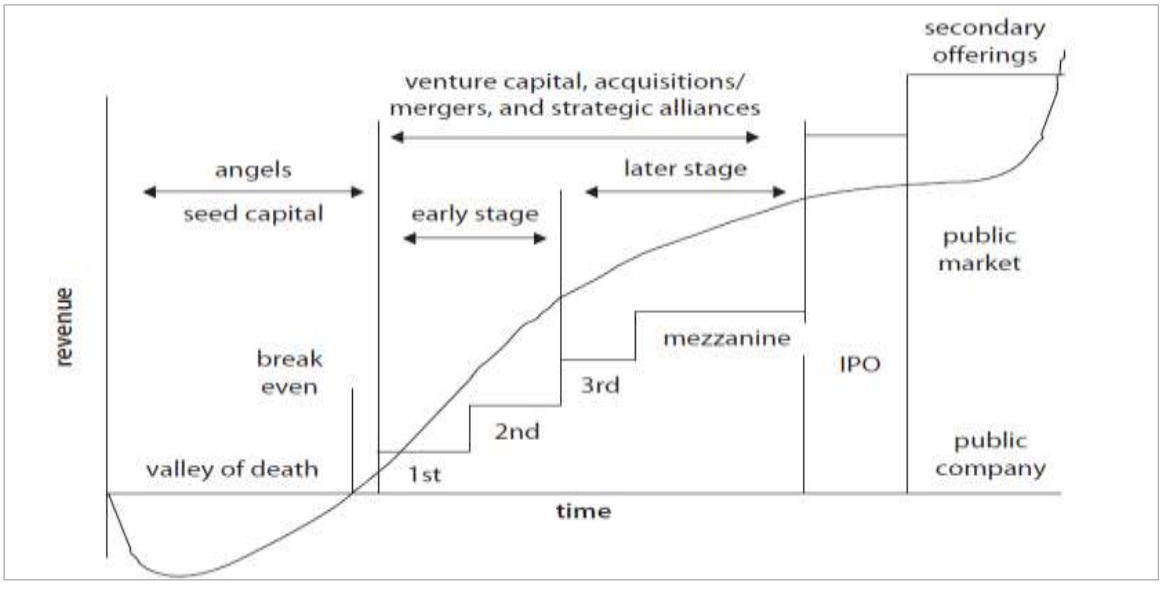
(ii) Information services

The success of support measures for SMEs depends not only on proper implementation but also on providing comprehensive and clear information for potential beneficiaries; all the more important in a context where SMEs might not spontaneously seek support themselves, or have the necessary competencies to understand the impact on their future development.

Whether through traditional or modern channels, surveyed Arab Mediterranean countries have ample room for improvement. Take, for instance, Morocco, where despite the existence of scattered online information for SMEs, a "dedicated SME portal is not yet operational, but is planned as part of the establishment of an SME observatory, currently under consideration", or Algeria, Egypt, Jordan and Tunisia, where though government provides statistical information on the enterprise population and on new laws and regulations, "a dedicated and interactive portal that provides SME-specific information does not exist". Or Lebanon and Palestine, where "information for SMEs is not systematically collected at government level and different ministries and organisations provide information, which is sometimes inconsistent".[200]

Against this backdrop, a major policy recommendation lies in substantially improving access to information services "by coordinating information provided by different agencies and by moving towards the establishment of a single online SME portal".[201]

Figure 17. Financing cycle for new technology-based companies



Source: World Bank, 2010, p. 90.

(c) Financing innovative firms

Technology-based innovative companies, depending on available revenue, go through different phases in their early life cycle, as illustrated in figure 17.

In the first phase, the so-called valley of death, the young company has exhausted early financing from research-to-industrialization support mechanisms and needs more cash to survive, pending arrival of its first commercial revenues. Even if the company still lives in relative self-sufficiency with limited expenses (including key staff salaries), bringing early prototypes to industrial-level robustness and commercialization entails costs above and beyond the scope of research grants. This is when seed capital and business angels could intervene.

Once commercial revenue starts materializing and a break-even is reached, the company requires still higher amounts of funding for further development and consolidation. This is where potential fund providers might 'take their bets' on the company's future, through VC financing, acquisition/merger by or with another company, or strategic alliances. The figure shows different 'steps' during this phase, dependant on levels of revenue.

The final phase involves the company's initial public offering with financing often by institutional investors followed by shares being traded on the public market after it becomes a publicly listed company.

An effective NIS is characterized by proper availability and maturity of all these financing resources. Innovation policies, particularly in developing and Arab countries, should address shortcomings in these resources, especially when related to the company's earlier development phases via seed capital, business angels and VC. SME general access to financing is particularly critical for innovative companies.

Venture capital is underdeveloped in Arab countries. Moreover, a survey on bank lending to SMEs conducted by the World Bank and the Union of Arab Banks in 2009 also reveals that such loans in non-GCC countries represent only 13.2 per cent of total loans provided by banks, while the ratio is around 22 per cent in high-income OECD economies and 16.2 per cent in middle-income countries.[202]

Business angel networks are particularly weak in the seven surveyed Arab Mediterranean countries, with Morocco and Tunisia faring better than others. Seed funds in the region are likewise poor.[203] Innovation policy measures that could address this include the following:

- Developing public VC funds by following the lead of some European and Asian countries. With the experience of OECD countries "inconclusive as to whether public venture capital funds supplement or lead the provision of venture capital",[204] success depends on strict governance rules;
- Supplying financial support to innovative SMEs through individuals with high net worth who provide a base for venture capital finance, "thereby acting as a substitute for institutional investors or bank finance"; applying private equity and venture capital well suited to Islamic models of finance (which prohibit interest), "as exemplified by the success of the Bahrain-based venture capital bank launched in 2005"; and, as has been introduced in some Arab countries, most recently Lebanon, providing "public guarantee instruments in cooperation with the banking sector to meet the borrowing requirements of young firms";[205]
- Developing alternative financial facilities, "in particular, business angel networks supporting companies with high growth potential in their early development phase, seed finance for innovative enterprises and equity financing for more established SMEs".[206]

(d) The role of clusters and networks

(i) Clusters and science parks

Clusters are steadily spreading as a way of organizing companies in developed and developing economies. Put simply, they combine "the advantages of competition and cooperation in groups of companies located in a relatively limited physical space". Clusters are important as they "provide a favourable environment for innovation and technology diffusion" and ensure a "larger market for workers with specialized skills, more rapid information flows and knowledge diffusion, and trust between contractual parties, which favours cooperation and specialization".[207]

Clusters might be planned by national or regional policymakers or even industrial organizations for a given industry and category of companies (generally SMEs), though clusters can be built around a few large companies that act as a magnet for many subcontracting SMEs.

Science parks are a specific category of clusters used to encourage agglomeration of companies belonging to a specific industry sector, sometimes involving technical universities and/or public research labs. They might be used by developing countries to attract foreign technology companies under preferential terms, on occasion involving tax incentives.[208]

Examples of clusters abound in the Arab region, with the Moroccan Innovation Strategy, an illustration of good practice. Here, clusters and innovation cities are an integral part of a national policy that aims to build an ecosystem for innovative companies, enterprise projects,

universities, VC and technological development centres by stimulating "the development of collaborative projects for innovation in clusters on ICT, microelectronics and mechatronics, among others".[209]

Clusters are characterized by their diversity—no two are identical—and, importantly, there is no magic formula for their success. It is also noted that science parks have not always lived up to expectations and "more cautious attitudes now prevail" towards them.[210] Success depends on good policy implementation and follow-up, but equally on external factors as summarized in box 23.

Box 23. The six main success factors of clusters

A survey of varied examples from developed and emerging countries, London Silicon Roundabout (UK), Bangalore (India), Estonia, Singapore and Boulder (USA), provide useful insights on the factors behind a successful cluster, namely:

Skilled workforce: all successful clusters have a marked edge when it comes to human capital, either local or imported. For instance, Singapore, with a small population, leveraged its national academic institutions along with a talent attraction strategy and a solid business environment, both of which have given it a strong national workforce whether indigenous or expatriate.

Accommodating policy frameworks: best interventions by government are not necessarily fiscal and taxation policies related specifically to a cluster, but rather those that support the broader inputs upon which clusters depend, such as education, infrastructure and connectivity.

The infrastructure imperative: companies need to collaborate, which in turn requires relatively efficient infrastructures that allow workers to move around quickly and cheaply. Expensive public transport, or growing congestion such as faced by Bangalore, are likely to reduce the efficiency of clusters where it matters most: the intermingling of people and ideas.

Luck and serendipity: sadly for planners, these play a key role in determining success. Luck refers to all those dynamics that could not have been brought about with foresight or purpose, but which, having existed, came to catalyse innovation. But crucially, luck does not mean there is no role for human decisions. Companies and Governments must consciously recognize the benefits that such happenstance occurrences provide, and build on them systematically to create a competitive position.

Low cost structure: low operating costs, especially rents on commercial property, have been essential drivers of a cluster's success in the early start-up phases. This applies to rental of office space but also the residential needs of workers. Other low costs can also help, such as tax breaks on innovation-related activities.

Liveability: it can cover such critical issues as public safety and political stability, good public amenities, culture and entertainment, and good schools and hospitals. These are all factors that policymakers or public institutions can influence if they want to nurture cluster success, in order to ensure their cluster appeals to top-tier skilled workers.

Source: Economist Intelligence Unit (EIU), 2015.

Box 24. Main policy messages – 5

Supporting innovators

Innovators are young entrepreneurs who need support and nurturing, important in developed countries and all the more so in developing and Arab countries. This can be achieved through complementary, set measures related to provision of business services, incubation and information services, financing (particularly early-stage) and developing networks and clusters.

Offering business services is not generally within the remit or competency of the public sector but it can establish public-private partnerships with private sector specialists to offer a range of business services to young innovative companies. Some Arab countries have established such services but they could be designed more comprehensively and not just as part of ad hoc initiatives, with more technological and personalized support for SMEs.

Arab countries, almost without exception, implemented entrepreneurship incubation structures but their impact remains generally limited. Countries should, however, support efforts to improve evaluation metrics (KPIs) of their science and technology parks, which have great potential for improvement, particularly towards more advanced services. Information services for SMEs although developed are scattered and consequently Arab countries could consider setting up one-stop centralized information portals.

Early-stage financing of innovative companies through business angels/seed capital and venture capital is nascent in most Arab countries. Although this is essentially a private sector shortcoming, public policy could help, through the following: develop public venture capital funds; take the example of other countries and provide public guarantee instruments in cooperation with the banking sector to meet the borrowing requirements of young companies; and promote business angel networks to support companies with high growth potential in their early development phase.

Clusters of SMEs and/or innovative companies are important mechanisms that, if successful, might create effective innovation ecosystems. Although implemented by many Arab countries, primarily through science parks, no known cluster has been a major success, which depends on good policy implementation and follow-up but equally on other external factors, such as skilled workforce, accommodating policy framework, cost structure, liveability, infrastructure, and luck and serendipity. Networks are a more formal type of relationship built around specific projects, and Arab countries and companies should seek to improve networking with neighbouring EU and other developed and emerging countries, as well as recognizing the importance of intra-Arab networks.

(ii) Networks

While clusters are primarily important for developing informal relationships among companies and circulating information and skilled personnel, networks involve companies working in cooperation, "though not necessarily in the same place or linked by some type of agreements".[211] In 'hard' networks, small groups of companies come together to achieve shared objectives through formal agreements, while 'soft' networks are larger groups with more flexible internal relationships.

Networks are critical for developing country companies to build relationships and acquire know-how and technology transfer from joint endeavour with their peers in developed countries. Equally, in the specific case of Arab countries, intra-Arab networks could be useful, if only to advance priority subjects identified by the Arab Strategy on Scientific and Technical

Research and Innovation. A 2013 assessment, however, albeit limited to seven Arab Mediterranean countries, indicated a limited number of initiatives in intra-Mediterranean enterprise cooperation.[212]

Although there are many frameworks helping cooperation and network-building among the EU and Arab countries of the Mediterranean basin, with the exception of some countries like Egypt, Tunisia and, more recently, Morocco, these are not sufficiently leveraged by Arab countries to fully benefit their SMEs.[213] This highlights the need for innovation policies, to emphasize building such networks with the EU and other developed and emerging countries, and for developing intra-Arab ones.

The main policy messages for supporting innovators are summarized in box 24.

C. Monitoring progress of achievement

An innovation policy aimed at developing an NIS needs a set of quantitative and qualitative targets and their related indicators, essential to ensure proper monitoring and evaluation, and policy adjustment in case of shortcomings or problems. These indicators should not only address the core fabric of the NIS – as reflected, for instance, in levels of R&D spending and innovation by each core actor – but equally the framework conditions, such as educational attainment and enrolment, trade and competition, IPR and patenting, support measures for potential innovators, and quality of the industrial landscape.

Although there is agreement about essential, innovation-related indicators applying to all countries, certain indicators, such as level of brain drain, might be more relevant for developing countries than others; for example, number of foreign doctorate students. Some global innovation indexes address developed and developing countries alike, with the same set of indicators; their results, although valid in identifying general level and sophistication of the NIS in a given country, are more important at shedding light on key factors than interpreted as an absolute ranking. Policymakers should focus on what some indicators reveal about underlying issues rather than making an idée fixe over their country's plus or minus position in any given international index.

Another key issue is the availability of innovation-related indicator data, particularly in many developing and Arab countries where it is often missing; this makes measuring the NIS status (and any related international comparison) less reliable and, more importantly, means that any underlying issues related to the indicator (for example, a weak level in some category of innovation or within a given industry sector) cannot be properly addressed by policymakers.

This section starts with a methodological discussion of monitoring and evaluation (M&E) of innovation policies, followed by a discussion of key indicators that measure the status of the innovation system. Focus is then placed on global innovation indices. They allow for useful comparisons among countries although caution is recommended on superficial or hasty interpretation of their established 'rankings'. Availability and quality of Arab countries' data, whether for specific indicators or indices, as well as what they reveal about the status of their NIS will also be discussed. Elaborating indices with indicators relevant for countries sharing common development and economic issues, and political and cultural links, is useful not only to ensure data collection but also to establish a common framework for more efficient

integration. This approach is ongoing in Arab countries with the recently proposed regional innovation scoreboard, discussed in the last section.

1. Monitoring and evaluation of innovation policies

Effective M&E should form an integral part of any innovation policy/strategy; beyond demonstrating accountability in public spending, it is needed to establish legitimacy and credibility of government intervention in the complex innovation processes, and support the learning, prioritization and improvement of policies over time.[214]

Innovation is a complex endeavour and the inherently qualitative and diffuse nature of benefits gives rise to a significant number of possible M&E measures. M&E metrics can relate to the general economic benefits or outcomes drawn from innovation policies, such as degree and variety of innovation in companies, high and medium technology in trade and value-added patenting activity. It can also address inputs, such as R&D spending levels achieved by government and companies or the number of graduates and specialists in given technology domains, and finally, the issue of measuring if innovation policies have had any significant impact; for example, improved access to financing by innovative companies, efficiency of the IPR regime or the extent of collaboration between universities, PRI and companies. Impact indicators are the hardest to determine and measure, followed by those related to outcomes.

Choosing the most appropriate metrics for M&E depends on the specific targets and dedicated means set for each innovation policy; there is no one-size-fits-all solution, particularly with impact and outcome indicators. The way forward might be to choose metrics that are relevant, measurable and feasible – if not, provide appropriate the means by developing specific innovation surveys and/or improving statistical data collection – for targets and priorities set by the policy.

This chapter discusses a large palette of innovation policy measures that address a variety of issues. It is clear no two countries at any given time have identical initial conditions, dispose of the same resource levels or have similar policy priorities. The focus on measures – and the means devoted to them – depends on each country's specific situation, and as a logical consequence, the importance acquired by any metric or indicator depends on each country.

We must not be misled, however, into believing there are no universal indicators or metrics for measuring the status of NIS. Common indicators used by many countries help improve statistical know-how and data collection methods, particularly among developing countries, and allow for comparability between countries.

2. Innovation system indicators and their data

By far the most reliable sources of indicators related to NIS – particularly for developing countries – are from the open databases of international organizations. Most notable are the following: UNESCO, mainly for R&D spending, innovation in companies, researchers and technicians, and education enrolment and attainment levels;[215] UNCTAD, for trade statistics (particularly in advanced technologies), FDI, use by business and trade of ICT services and goods, plus creative goods, services and related industries;[216] WIPO, for statistics on patent registration;[217] United Nations specialized agency for information and communication technologies (ITU), for statistics on ICT infrastructure and its

use;[218] ILO, for statistics on labour force participation and employment;[219] and the World Bank for its statistics database, and high-interest specific indicators to gauge innovation and framework conditions related to economy and growth, infrastructure and the financial sector.[220]

We illustrate, through selected indicators, aspects of Arab countries' innovation landscape and what this reveals about its NIS.

(a) R&D expenditure and human resources

Global levels of R&D expenditure (GERD) in Arab countries are low compared with their GDP; they range between 0.5 and 1 per cent and lower in some high-income GCC countries. The striking feature of Arab GDP expenditure on R&D lies in its concentration within government and higher education. Only in the United Arab Emirates (74.3 per cent) did the private sector play a role comparable with developed countries' average, while in all other Arab countries it is at best 30 per cent, well below similar countries such as Turkey (50.9 per cent in 2014) or Malaysia (60.2 per cent in 2012).[221]

The perspective as seen from the number of researchers (FTE, or full-time equivalents) per million inhabitants is similar, showing values in the range of a few hundred, with Tunisia (1,853 in 2014) and Morocco (857 in 2012) leading, but still below averages in developed countries (many at 4,000 and above). By 2014, the likes of Turkey (1,156) and Malaysia (2,051) had reached levels comparable with the two Arab country leaders.[222]

Annex tables A.4 and A.5 summarize the latest available GERD (as a percentage of GDP) and FTE researchers per million inhabitants data for Arab countries, and their breakdown between private sector, government, higher education and other sources for funding and researchers' localization.

(b) Innovation in companies

The OECD Oslo Manual (2005)[223] already outlined in chapter 1 is a landmark work defining sound methodology for carrying out innovation surveys along the lines of a broad definition of innovation that encompasses not only products and services but also marketing and organization. Beyond OECD countries, Oslo Manual methodology is now followed by a number of emerging and developing countries, and since July 2014 their survey data results have been available from the UNESCO Institute for Statistics (UIS) database. This provides company innovation survey data for only one Arab country, Egypt. Although one cannot draw general conclusions about the region from a single country, it is the largest by population and the one that started industrialization in the nineteenth century.

Table 10 summarizes Egypt's data for 2010 on innovation in the manufacturing sector, broken down by company size and type of innovation.

The percentage of all companies carrying out innovation in Egypt is significantly lower than the averages of many developed and emerging countries, whose percentages lie in the broad 30-60 per cent margin.[224] Innovation is concentrated mainly in large companies, a pattern observed for all innovations; in particular the percentage of smaller companies carrying out innovation is low, whereas it is much higher, 41.4 per cent and 23.9 per cent, in Malaysia and Turkey, respectively. With innovation categories, the low percentages for marketing and particularly organizational innovation are striking, again markedly different from Malaysia and Turkey, at 37.7 per cent and 31.5 per cent for organizational innovation. Turkey, it must be pointed out, experienced a significant increase in that area between 2010 (23.9 per cent) and 2012.

Table 10. Innovative firms in the manufacturing sector in Egypt, 2010 (percentage)

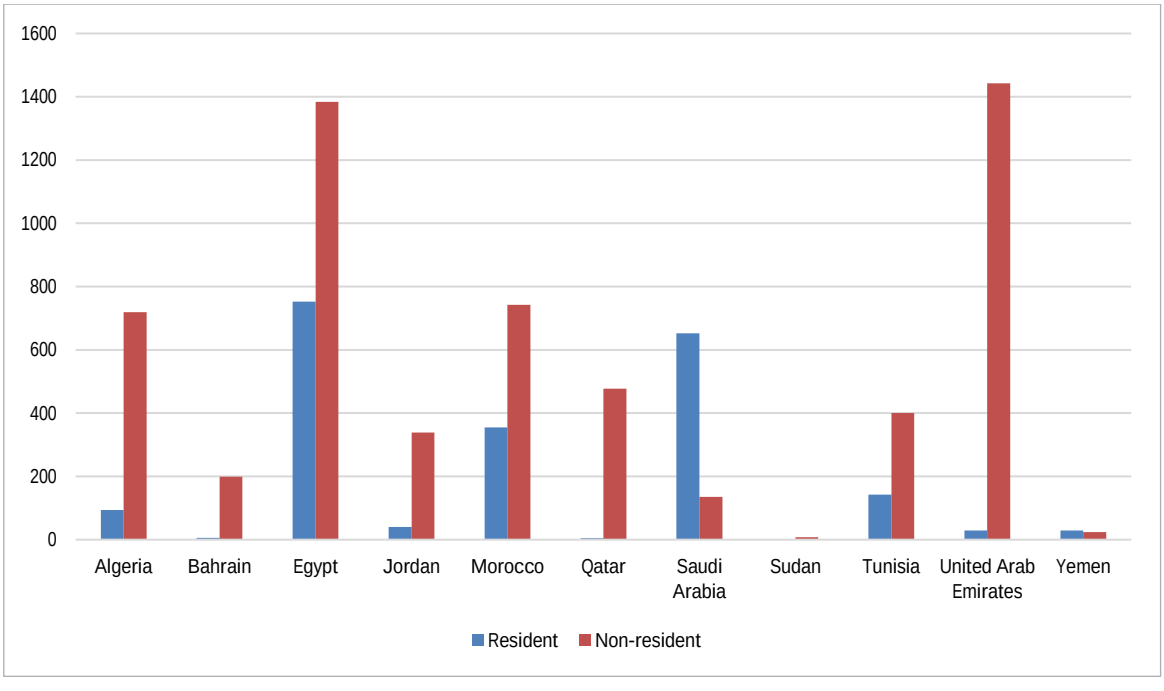
	Innovative firms	Product innovation	Process innovation	Organizational innovation	Marketing innovation
All	9.35	6.15	8.27	3.69	6.48
Large firms	26.2	17.73	24.82	7.8	14.89
Medium firms	14.4	9.73	11.67	6.61	7
Small firms	6.8	3.57	6.55	2.38	6.55
Micro firms	1.9	1.59	1.32	1.32	2.91

Source: UNESCO, 2016.

(c) Patenting

Due to the negligible amount of R&D carried out by Arab companies it is little wonder the number of filed patents is low in most countries for which data are available, as shown in figure 18. What is striking is the dominant role played by non-resident patent filing. Saudi Arabia is the exception, although in 2011 it had two thirds of its near 1,000 patents filed by non-residents. Data for 2013 and 2014 shows a reversal of the trend, with lower total patent filing.[225]

Figure 18. Total patent applications, direct and PCT national phase entries, Arab countries, 2014



Source: World Intellectual Property Organization (WIPO) Statistics database, 2014. Available from http://www.wipo.int/ipstats/en (accessed 15 November 2016).

(d) High-tech exports

The share of high-tech exports (as a percentage of total manufactured exports) is similarly low and, importantly, demonstrates the chaotic evolution of many Arab countries (figure 19). Before discussing individual countries, it should be noted that high-income and upper-middle-income countries (which include many of those listed) averaged 19.17 per cent and 17.9 per cent over the period, while Arab countries' global average stood at only 1.84 per cent.

It is relevant to observe the decline of Morocco and Tunisia, the two leading countries in 2006, although the last value of Tunisia might be due to a statistical glitch; Lebanon, the third Arab country in 2006, showed an impressive jump in 2010 but two years later returned to its previous level, slightly above 2 per cent.

Countries that evolved over the period, the United Arab Emirates and Oman were, respectively, first and third among Arab countries in 2014; this may have been due to a high volume of re-exports (particularly for the United Arab Emirates in its position as a regional hub).[226] Jordan showed an impressive increase between 2008 and 2010 but then declined, returning to values only slightly higher than in 2006.

One could conclude that the high-tech trade of Arab countries is characterized by high volatility at low levels; two tendencies can, however, be observed: the decline of regional leaders Morocco and Tunisia, and the surge of the United Arab Emirates and Oman.

3. From indicators to indices

Assessing the status of an NIS necessitates grouping indicators along logical cluster issues where such a combination might provide added value in understanding and eventual guidance for policymakers.

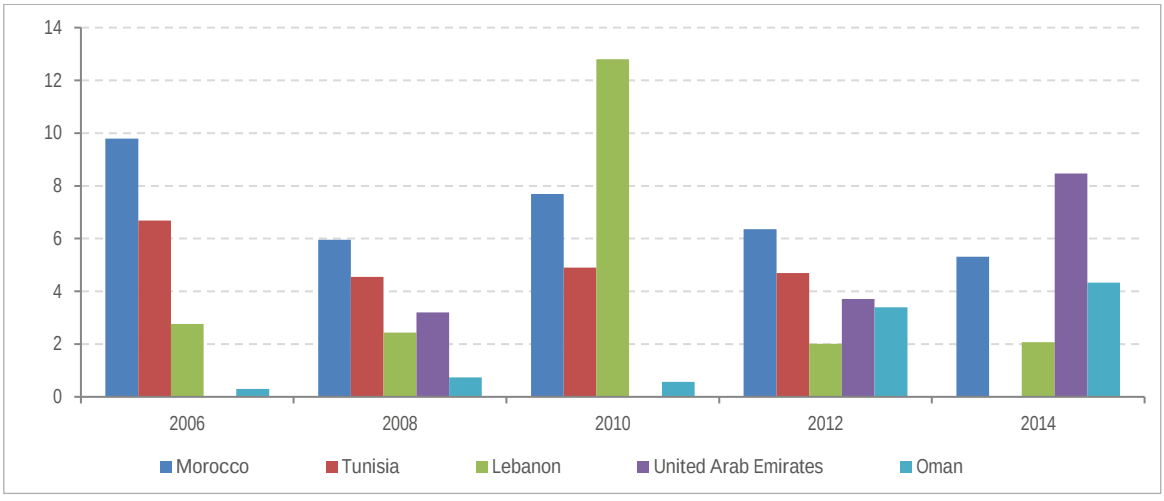
This is the approach adopted by the OECD STI scoreboard[227] which, through a set of 260 indicators (some still experimental and not largely available even among advanced OECD countries), addresses issue clusters related to developing knowledge talents and skills, connecting to knowledge, unlocking innovation in companies, competing in the global economy and empowering society with science and technology. The prime objective is not to rank countries or develop composite indicators, but to "provide policymakers and analysts with the means to compare economies with other of a similar size or with a similar structure and monitor progress towards desired national or supranational policy goals".[228]

Clearly, the choice of major issues – and their detailed subheadings – with related indicators addressing them is not neutral. It depends on OECD countries' socioeconomic and NIS situation at any given point in time, as well as a vision, explicit or implied, on the role of science and technology in its development.

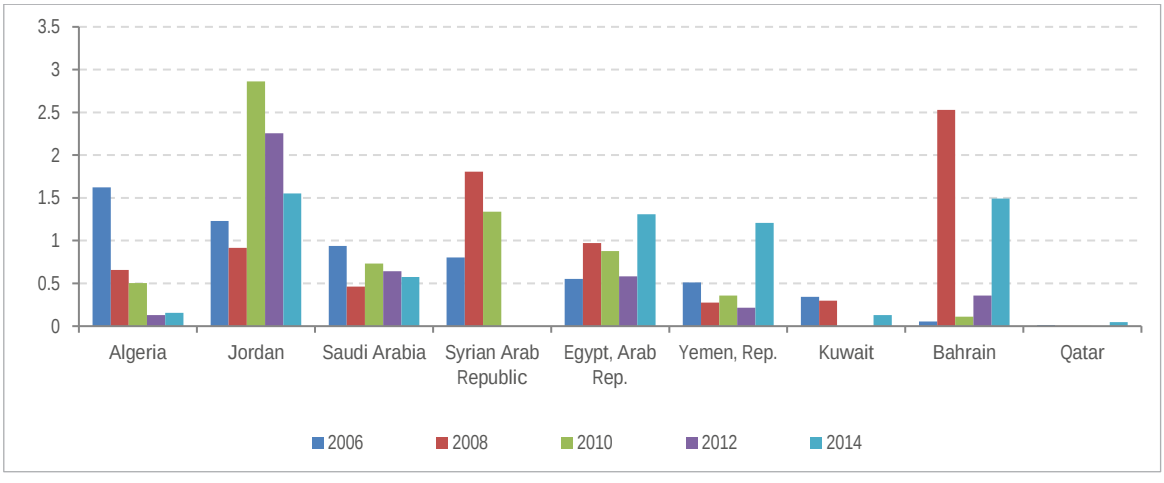
Enlarging this vision to a global scale with developed and developing countries (countries with different social and cultural situations) results in two sets of difficulties: the first is methodological, where any choice of focus issues can never be universal and – whether on purpose or not – favours countries more likely to fit with the implied socioeconomic model; the second issue is of practical nature, whereby finding a common set of indicators, under the same rigorous statistical definition, is near impossible. Compounding this, many international indices aim to provide a global 'score value' (through a certain combination of individual indicator values) resulting in a country ranking.

Figure 19. Share of high-technology exports as a percentage of total manufactured exports, Arab countries, 2006-2014

(A) Leading countries



(B) Other countries



Source: World Bank Statistics Database. Available from http://data.worldbank.org (accessed 15 November 2016).

This could be applicable to many international indices beyond STI; it is, however, particularly critical here as STI encompasses a variety of framework issues and some are of a universal nature, such as education, absence of corruption, quality public services and infrastructure, and even forward-looking entrepreneurship values.

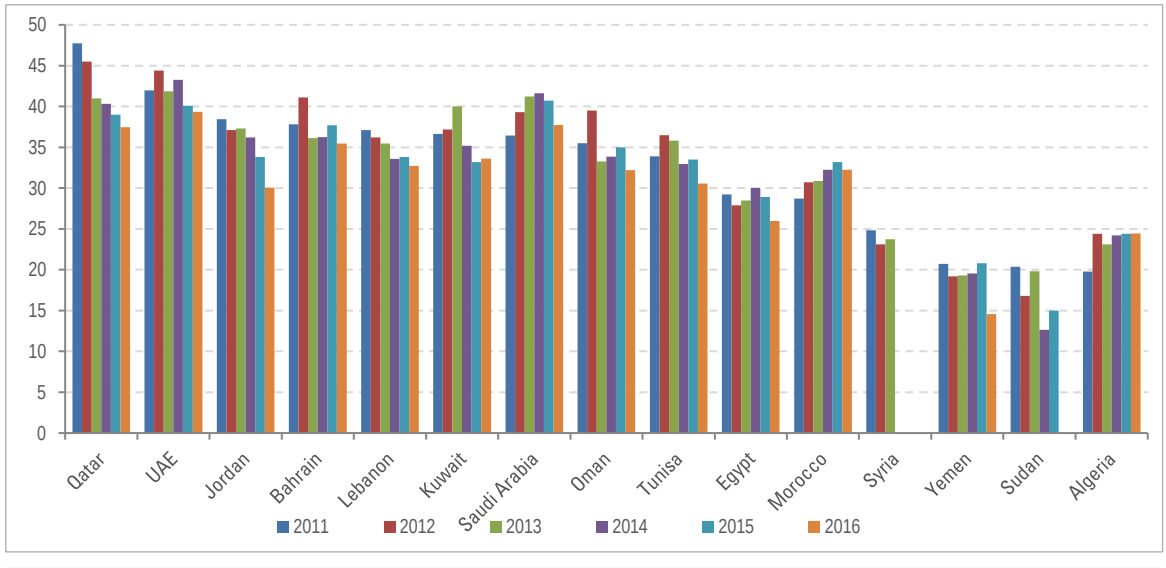
Consequently, and in similar vein to the OECD scoreboard and the European Innovation Scoreboard,[229] Arab countries could seek to establish their own innovation index focusing on issues of common concern and agree on a set of supporting indicators; this is the approach of the Arab Innovation Index that will be discussed in the next section.

Prior to that, Arab countries' position in the Global Innovation Index (GII), a largely established index that measures the status of innovation systems worldwide, and data availability are briefly discussed. The GII, with its set of 82 indicators (annex table A.1), is more comprehensive and representative of country diversity than previous efforts, such as the World Bank's Knowledge Economy Index (KEI), which is based on 12 scorecard indicators,[230] and the innovation pillar of the WEF's Global Competitiveness Index,[231] which is based on seven (six of them resulting from survey questions addressed to the business community in each country).

First published in 2007, the GII is now in its ninth edition,[232] covering innovation in 128 countries. The GII framework is organized under seven pillars. Five are dedicated to innovation inputs, namely institutions, human capital and research, infrastructure, market sophistication and business sophistication, and two to innovation outputs, namely knowledge and technology, and creative. Each pillar is evaluated through a set of indicators (815) with a total of 82 indicators. Most are based on single or composite indicators from the databases of international organizations, with five drawn from WEF executive opinion surveys.

The evolution of Arab countries' global index value in the GII (from 2011 to 2016) is summarized in figure 20. Table 11 summarizes country rank for each of the seven GII pillars in the 2016 survey.

Figure 20. Arab countries GII scores, 2011-2016



Source: Author's compilation based on INSEAD's GII reports 2011-2016. Available from https://www.globalinnovationindex.org/ (accessed 10 August 2016).

Table 11. Scores in GII pillars, Arab countries, 2016

Country (global rank)	Institutions	Human capital and research	Infrastructure	Market sophistication	Business sophistication	Knowledge and Technology Outputs	Creative outputs
United Arab Emirates (41)	22	41	23	42	24	*86*	*70*
Saudi Arabia (49)	*72*	32	39	38	66	*75*	47
Qatar (50)	34	59	16	68	*78*	*88*	49
Bahrain (57)	55	68	29	*91*	59	61	*74*
Kuwait (67)	75	72	48	50	*127*	51	64
Lebanon (70)	*91*	76	84	*99*	63	74	51
Morocco (72)	74	61	45	*98*	*125*	72	67
Oman (73)	41	52	51	*90*	*124*	*95*	79
Tunisia (77)	70	45	70	*123*	*107*	89	81
Jordan (82)	63	86	79	*115*	*116*	79	78
Egypt (107)	*123*	82	82	110	*122*	94	97
Algeria (113)	113	79	86	117	118	100	122
Yemen (128)	126	111	128	111	128	124	125

Source: Author's compilation based on individual country profiles, appendix I (Dutta, Lanvin and Wunsch-Vincent, 2016).

Figure 20 illustrates a phenomenon often encountered in international indices, where high-income GCC countries take lead positions due to their resources, political stability and smaller-scale populations. The GII highlights a nuance whereby four countries (Jordan, Lebanon, Morocco and Tunisia) managed to obtain comparable scores with three GCC countries (Bahrain, Kuwait and Oman) over six years of the survey; the reason will become clear when analysing countries' relative weak/strong points.

Qatar, Saudi Arabia and the United Arab Emirates appear to be in a class of their own; Qatar was the regional leader in 2011, but its rank has gradually fallen as Saudi Arabia has significantly improved, while the UAE remained relatively stable and overtook Saudi Arabia as leader in the last edition. It is relevant, however, to note that even the top three Arab countries (and their remaining GCC peers) are below the regression GII/GDP curve[233] and considered underperformers relative to their GDP levels.

Scores for the human capital and research pillar highlight were particularly strong in some non-GCC countries, and weak in GCC ones. Conversely, infrastructure is a strong point in GCC countries but even some non-GCC ones fare well. The essential weakness in Arab countries is concentrated within the market and business sophistication pillars. This is logical, reflecting weak R&D and innovation in the private sector of all Arab countries (GCC inclusive); only the UAE among the GCC and the region has business sophistication as one of its strong points. The last two pillars, for innovation outputs, reveal weak areas, particularly in knowledge and technology,

related for instance to patents, high-tech manufacturing and exports, and FDI (annex figure A.1).

Beyond substantive issues, it is worth considering indicator data availability. Many developing and Arab countries lack data on a significant number of GII's 82 indicators. Table 12 summarizes for each Arab country the number of indicators for which it has no data under each of the seven GII pillars.

The global median value of 17 unavailable indicators represents a significant 20 per cent-plus of total indicators. Egypt, Morocco and Tunisia show a percentage lower than the regional average, and it is worth noting the data improvement of Qatar in the last edition, with only seven unavailable indicators. Qatar apart, other GCC countries are in no better shape, with values close to the median; Yemen is the exception with a significantly above-median value, though this is concentrated under the last four pillars.

Data unavailability is not evenly split between the seven pillars; institutions and infrastructure, and to a certain extent the market sophistication pillar, illustrate relatively good availability for Arab countries.

Unavailability is mainly concentrated under the fifth and sixth pillars and to lesser extent, the second and seventh; a third of business sophistication indicators and quarter of those for knowledge and technology outputs are missing. Correlation between data unavailability and weak performance (table 11) could be established for the fifth and sixth pillars but less so for the seventh. Despite good data availability, scores are weak under pillar four, that of market sophistication.

Table 12. Unavailable indicators per GII pillar, Arab countries, 2016

Country	Pillar 1 (8)	Pillar 2 (12)	Pillar 3 (10)	Pillar 4 (10)	Pillar 5 (15)	Pillar 6 (14)	Pillar 7 (13)	Total (82)
Algeria	0	5	0	4	5	2	1	17
Bahrain	0	5	0	1	8	3	1	18
Egypt	0	2	0	0	0	1	2	5
Jordan	0	3	0	0	7	4	3	17
Kuwait	0	2	0	1	6	4	4	17
Lebanon	0	3	1	0	5	6	2	17
Morocco	0	2	1	0	2	2	1	8
Oman	0	2	0	2	4	3	3	14
Qatar	0	0	0	1	2	2	2	7
Saudi Arabia	0	1	0	1	6	4	3	15
Tunisia	0	0	0	0	4	2	3	9
United Arab Emirates	0	3	0	1	6	4	3	17
Yemen	0	4	3	4	8	4	5	28
Median value	0	2	0	1	5	3	3	17

Source: Author's compilation based on individual country profiles, appendix I (Dutta, Lanvin and Wunsch-Vincent, 2016).

While no data on an indicator is generally a bad sign for the issue it measures (for example, absence of data on GERD performed by business, or number of patent filings, are rarely good news for business sophistication), this is far from a general rule. Sometimes lack of data, particularly among high-income countries, can be due to poor statistics work or, more mundanely, bad communication between the country and international organizations in charge of centralizing data at global level.

MENA Innovation Scoreboard

The European Investment Bank, through the Centre for Mediterranean Integration and in cooperation with the Islamic Educational Scientific and Cultural Organization (ISESCO), the ESCWA Technology Centre (ETC) and the Arab League Educational, Cultural and Scientific Organization (ALECSO), has since 2013 worked on defining and elaborating an innovation scoreboard for the MENA region. Nine Arab countries[234] have joined the initiative, which will gauge capacity within a country's innovation system and compare it with those of other Islamic countries outside the region.[235] Partners and representatives of involved countries met four times between 2013 and 2016, with international and regional organizations such as OECD, the European Union and AIDMO attending selected meetings.

The MENA Innovation Scoreboard will complement other scoreboards defined either at international level, such as the Global Innovation Index[236] and the Knowledge Economy Index,[237] or at regional level, Asia's Creative Productivity Index[238] and the European Innovation Scoreboard.[239] Countries in the MENA region felt a tailor-made index was required to address their own specificities, and the objectives of the meetings were to reach understanding about a national innovation system, discuss indicators for such a system, define the framework and overcome gaps in data availability for the selected indicators.

The indicators, some 40 in total, were grouped under two pillars: input and enablers, and output and impact. The first pillar was subdivided into human resources, knowledge enablers and business enablers; the second into value-added potential of the private sector, quality of scholastic output, business impact (to measure the innovativeness of the business sector), and intellectual asset formation (that is, generating intellectual property rights and intangible capital). The name was also changed to Innovation Meter for MENA-Countries. Table 13 gives the details.

The Innovation Meter relies mostly on recognized international resources for the definition of its indicators, including the United Nations (UNStats), UNESCO, the World Bank, ISO and selected business surveys. With the lack of timely data in the region, the index also uses 'alternative' indicators that measure the same phenomenon. For example, for the quality of scholastic output, not all countries participate in the monitoring survey Trends in International Mathematics and Science Study (TIMSS), so to have a measurement alternative, scores like the performance of Graduate Management Admission Test (GMAT) tests or the Graduate Record Examinations (GRE) are used.

Table 13. Structure of the Innovation Meter for MENA countries

Input and enablers	
1.	Human resources
1.1	Annual tertiary graduates as a percentage of the population 15-64 years
1.2	Percentage tertiary-level graduates in technical/science curriculum
1.3	Total outbound tertiary-level students as a percentage of tertiary graduates
1.4	Total personnel in R&D as a percentage of 15-64 years olds
1.5	Percentage secondary students enrolled in vocational programmes
2.	Knowledge enablers
2.1	Inbound international tertiary-level students as a percentage of tertiary graduates
2.2	Foreign Direct Investment (BoP) net inflows as a percentage of GDP
2.3	Gross national spending on R&D/GDP
2.4	GERD financed by business as percentage of GDP
2.5	Percentage of companies with licensed-in technology from foreign companies
3.	Business enablers
3.1	Domestic credit to the private sector (% of GDP)
3.2	Ease of getting credit (credit registry coverage, % of adults)
3.3	Business survey: companies using banks to finance investments (% of companies)
3.4	Business survey: proportion of investments financed by banks
3.5	Private equity investment value as a percentage of GDP
3.6	Ease of starting a business (time required in days)
Output and impact	
4.	Value-added potential by entrepreneurial sector
4.1	Sum total of ISO 9 001, 14 001, 22 000 registration last available year related to GDP
4.2	New business registration per 1 000 population 15-64 years, latest available year
4.3	Industry value added as percentage of GDP
4.4	ICT service exports as a percentage of GDP
4.5	Agriculture value added per worker (2005 $)
4.6	Charges for the use of intellectual property, receipts (BoP, current $) as % of GDP
5.	Quality of scholastic output
5.1	Eight grade achievements sum total math and science scores
5.2	GMAT-score last available year
5.3	Total of GRE scores in last available year
5.4	H-index for citation impact last available year
5.5	International scientific co-publications per 100 000 tertiary graduates
5.6	Number of universities in QS-1000 rankings per million inhabitants
6.	Business impact
6.1	Companies with ICT enabling business model creation (% of total)
6.2	High-tech merchandise exports as % of merchandise exports
6.3	Medium-tech exports as % of exported merchandise goods
6.4	ICT good exports (% of total exports), last figure 2013
6.5	Percentage of companies (>10 employees) introducing new products
6.6	Percentage of companies (>10 employees) introducing new goods
7.	Intellectual asset formation
7.1	Resident patent applications per million inhabitants
7.2	International PCT applications via WIPO administered treaties per million inhabitants
7.3	US patent and trademark office: utility patent granted per million inhabitants
7.4	Resident trademarks registrations per million inhabitants 15-64 years
7.5	Industrial design registrations per million inhabitants 15-64 years
7.6	Citable documents per million inhabitants

Source: Compilation by ESCWA.

Box 25. Main policy messages – 6

Monitoring progress of achievement

Monitoring and evaluation (M&E) should be an integral part of any innovation policy/strategy. Choosing the most appropriate metrics for M&E depends on the specific targets and dedicated means set by a country's policy.

Major indicators that measure innovation policies exist but they generally address spending on R&D, innovation carried out by companies, high-tech exports and patenting, and the quality and quantity of graduates, especially in technical and scientific disciplines.

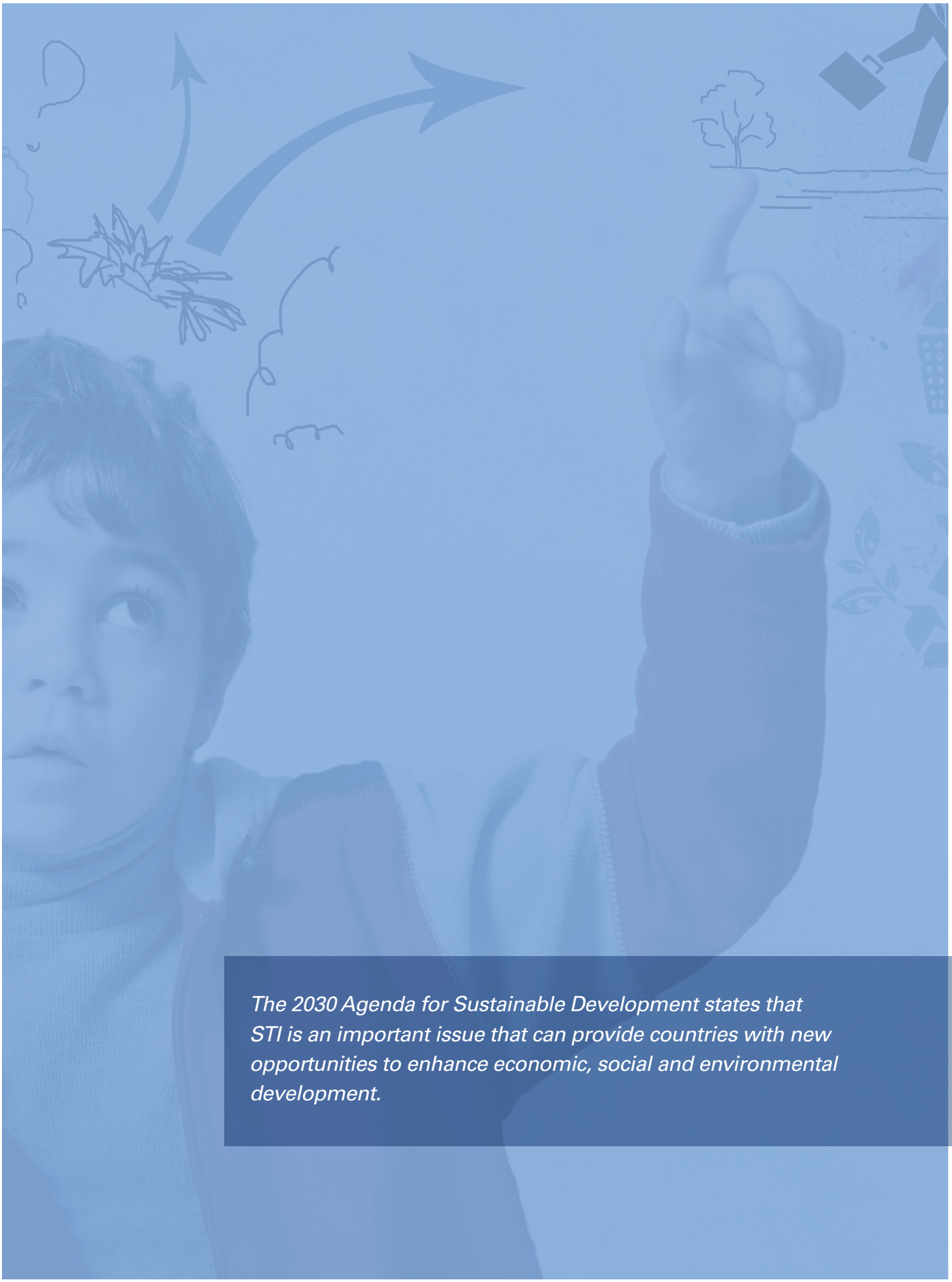
Innovation indices combining many indicators allow country comparisons at international level. The resulting rankings should, however, be handled cautiously as they often reflect issues relevant to the most advanced countries, who are in a category of their own.

Available data related to innovation policies for Arab countries highlight, with few exceptions, low levels of spending on R&D, patenting and high-tech exports. Aside from one, Arab countries, particularly high-income GCC members, are considered innovation underperformers relative to their GDP levels.

They must improve statistical data collection for innovation-related indicators, particularly company innovation surveys and detailed spending levels on R&D. Quantitative and qualitative indicators on educational outcomes and vocational training should also be developed due to the high prevalence of youth unemployment (even those with tertiary education) and brain drain in the region.

At the fourth meeting, partners together with the involved countries agreed on the need to: collect appropriate and actual data for the selected indicators; conduct frequent surveys on specific areas, in particular innovation behaviour in the industrial sectors; translate the Innovation Meter to Arabic; and obtain political visibility and support. See box 25 for the main policy message on monitoring progress.

3. Adaptation of Innovation Policies for Promoting Specific Sectors to Achieve the 2030 Agenda for Sustainable Development



The 2030 Agenda for Sustainable Development states that STI is an important issue that can provide countries with new opportunities to enhance economic, social and environmental development.

3. Adaptation of Innovation Policies for Promoting Specific Sectors to Achieve the 2030 Agenda for Sustainable Development

Research and practice have shown that innovation, particularly in technology, is a driver of economic growth, improved productivity and efficiency, job creation and sustainable development. Done together, efforts towards sustainable development that engage all – but particularly women, youth and marginalized groups – will provide new momentum to the process.

Innovation gives impetus to productivity, inclusive economic growth and job creation, as well as being a requirement for innovative implementation modalities, creative private sector solutions and financing schemes for development.

In September 2015, the United Nations General Assembly adopted the 2030 Agenda for Sustainable Development, a landmark decision that calls on all countries to advance the welfare of their citizens in a sustainable manner to ensure the long-term viability of development and growth.[240]

The 17 SDGs defined by the agenda (annex table A.2) address economic, social and environmental issues and lie at the convergence of international agendas: the millennium development goals (MDGs) of 2000[241] and the Rio Agenda 21 set in 1992 and reaffirmed by the World Summit on Sustainable Development in Johannesburg a decade later.[242] The World Summit on the Information Society (WSIS) and the 10-year review (WSIS+10) adopted an ICT for development agenda,[243] with action lines that play an important role in meeting the SDGs through modern technologies.[244]

This chapter looks at how innovation policies in the Arab region should be adapted to try to fulfil the SDGs. It will also discuss examples of how such policies could support specific issues of sustainable development of particular importance to Arab countries, including youth employment, climate change and social innovation.

ESCWA has planned a series of innovation studies for selected SDGs in its programmes for the coming years. Examples in this chapter are presented to demonstrate the relevance of innovation policies for realizing the SDGs.

A. Adapting innovation policies to address the SDGs

1. Why technology and innovation policy matter for the SDGs

(a) Technology and SDGs

As stated in the 2030 Agenda, science, technology and innovation (STI) can provide countries with new opportunities to enhance

economic, social and environmental development. In order to benefit it is necessary to optimize STI capacities and initiatives across national and thematic development platforms.

Countries and stakeholders will work to achieve the 17 SDGs with their 169 targets over the next 15 years as part of the new agenda.[245] Innovation was included in Goal 9, "build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation", and technology in Goal 17, but when considering the targets of other goals it becomes clear that STI activities should be used to help achieve them.

Some of the goals name specific STI-related targets, such as Goal 7 targets (a) and (b) on energy research, technology and infrastructure. STI-related targets are also found in Goals 1, 8, 12 and 14. In the other goals, such targets are less pronounced, but as scientists, technologists and innovators, it is possible to perceive how STI could contribute. One example can be found in Goal 2, where targets on better production systems can be helped by using new technologies and innovative processes. Other goals where STI could be considered are 4, 6, 11, 13 and 16. This cross-cutting nature of STI within the SDGs echoes the Heads of State observation that STI is essential to many areas of concern in sustainable development.

Technology is far from neutral, and often a double-edged sword. While socioeconomic development is linked to technology change, this could either be a source of conflict or a means for improved social cooperation.[246] It is therefore essential for developing countries, given the new agenda, to foster technologies that are more sustainable. The question remains whether innovation in technology will provide the answer to sustainability.

The latest United Nations Global Sustainable Development Report (GSDR) asked leading scientists and experts the following two questions related to technology and the SDGs: "There are many technology challenges for achieving the SDGs and lots of expectations for technology solutions. Against this background: (i) What are the most promising actions or policy elements for optimal leveraging of technology for the SDGs and 'leaving no one behind'? (ii) Which technologies and what level of their performance and deployment will be most crucial until 2030?"[247] Respondents identified five main technology clusters, biotechnologies, digital technologies, nanotechnologies, neuro-technologies and green technologies. Each holds opportunities for fulfilling the SDGs, including improved crops, resource efficiency, global data sharing, CO_2 mitigation, renewable energy, clean air and water, as well as potential threats, such as unequal benefits and massive job losses, rising inequalities, irreversible health and environmental impact, and potential military use.[248] Annex figure A.1 summarizes these technologies with their respective opportunities and threats.

(b) Innovation policies and SDGs

On the question of leveraging technology for the SDGs, survey respondents provided proposals that fall under four cluster themes, as summarized in table 14.

Table 14. Selected proposals by respondents for optimal leveraging of technology for the SDGs and leaving no one behind

Theme	Summary proposals	Action level
Strengthening national systems of innovation to accelerate technology progress	• Systematically strengthen national systems of innovation, especially in developing countries; • Incremental and radical technology and infrastructure performance improvements – all are needed; • Barriers to technology deployment and diffusion in developing countries to be removed and R&D investments to be increased; • Coherent and comprehensive techno-economic policies are needed; • STI literacy needs to be strengthened in every country to create knowledge-based, innovative societies that utilize scientific evidence to help inform policy.	National
Plans, road maps and integrated assessment	• National and international action plans and technology road maps for achieving the SDGs individually and together; • Science road maps, technology road maps and R&D road maps to agree on priority actions of the science and engineering communities; • Technology investments need to be significantly increased; • Share information and advice among countries on policies, actions and partnerships; • Communication, education and public awareness-raising are essential, especially among consumers.	National and global
Putting technology at the service of inclusion	• Access to affordable, modern technology for everyone, especially in developing countries; • Inclusive innovation policies to promote equity; • Technology assessment and foresight to understand potential implications of new technologies and guide policy; • Taking into account the interests of underserved populations throughout the innovation process, and promoting access and use of assistive technology for people with disabilities; • On-the-ground solutions and technological innovations to be considered a core component of livelihood strategies.	Global, national and local
Building institutions that support sustainable technology progress	• Institutions need to be reformed to re-orient innovation systems towards sustainable development; • Support for R&D and incentives for deployment of cheaper technologies with systemic benefits, including off-grid electricity systems, e-mobility and novel antimicrobial medicines, and institutions to promote development of low-cost local technology solutions based on community knowledge; • Promote urban innovation units, living labs, open science and science parks to harness localized, inclusive innovations; • Better data need to be collected, openly shared and analysed with, for instance, partnerships at city and national levels that could bring together and share disaggregated data.	Global, national and city

Source: Adapted from DESA, 2016a, p. 45.

The first cluster addresses challenges faced by developing countries when implementing their national innovation policies while at the same time dealing with specific SDG-related goals.

Many suggested policies and actions relate to improving conditions for proper appropriation and leveraging of technologies at the service of social and sustainability goals – beyond the

obvious economic goals that are part of any 'classical' innovation policy. For instance, though incremental and radical technology and infrastructure performance improvements might seem contradictory at first, according to the GSDR, "even in the case of successful radical new solutions, incremental improvements after initial market deployment are essential".[249] As an example, the rapid success of mobile telephony in many developing countries, even the least developed, was a radical technological change. For this to bear all its fruit, incremental improvement is necessary in mobile usage both horizontally (in society at large), and vertically (through specific relevant applications built on top of it), in order to leverage it for the SDGs.

The second cluster addresses issues related to country plans for the next 10 to 20 years. Developing long-term technological foresight is difficult in developed countries and is even more challenging in developing ones facing shortages of national competencies and proper experience in dealing with new – and even older – technologies. Hence the importance of a global dimension, in addition to the national one, to address these issues. One suggestion concerns information and advice sharing among countries on policies, action and partnerships that can be implemented through the multi-stakeholder STI forum and online platform of the UN Technology Facilitation Mechanism (TFM).[250] Establishing a regional mechanism among Arab countries, sharing a common culture and facing similar challenges, should constitute a useful complement to the global TFM.[251]

The third cluster addresses the challenge of ensuring technology includes rather than excludes people, particularly vulnerable and disadvantaged categories (noting that scientists responding to the survey did not disregard this negative potential of new technologies). Underserved populations should be systematically taken into account throughout the innovation process. A positive way to address this, away from small-scale charity and philanthropy, lies in the ability of end-users to adapt technologies to their own needs in new settings. A kindred suggestion lies in considering social innovation related to innovation for marginalized groups, and for solving the immediate needs of society as part of an innovation policy.

The last cluster, on building institutions that support sustainable technology progress, addresses the adaptation of policies/strategies affecting the NIS to include social and sustainability challenges within their objectives and usual way of doing business. Actions at global level could also complement national and local efforts through new technologies, such as big data offering a myriad of new information and tools that will help in monitoring and promoting the SDGs. Although these measures act at the operational level of the NIS they can dramatically enhance the social and inclusive impact of any innovation policy.

Needless to say, adaptation of national innovation policies to address the SDGs will vary in different countries. Policies and actions listed above are by no means at the same level of priority for every country, nor are they exhaustive.

(c) Arab countries specific priorities and issues related to the SDGs

It is crucial that stakeholders are able to provide input into how the SDGs are implemented at regional and national levels. ESCWA plays a key role in the regional process whereby issues related to policies aimed at fulfilling the SDGs are discussed. Recent regional forums,[252] and the first Arab Sustainable Development Report

(ASDR), published by ESCWA and the United Nations Environment Programme (UNEP),[253] clarified issues faced by countries when implementing SDGs and the socioeconomic, developmental and environmental challenges they face. The ASDR adopted an analysis framework consisting of four nested issue clusters on:

- Human dignity and well-being;
- Sustainable and resilient societies;
- Peace, governance and institutions;
- Means of implementation and partnerships for sustainable development.[254]

Table 15 summarizes the messages of the ASDR for each of the clusters.

Table 15. Main messages of the ASDR on the four SDGs issue clusters

Human dignity and well-being
• The rentier structure of the economy in most countries means that growth has little impact on human well-being; • Unemployment remains the highest in the world, with moderate gains for women offset by commensurate losses for young people; • Inequality of opportunity and income has fuelled conflict in several countries, creating waves of refugees and internally displaced persons (IDPs) who have been plunged deeper into poverty; • Failure to match educational achievement with comparable employment and gender outcomes is due in large part to the incapacity of the region's economies to generate employment, in addition to problems regarding the quality of education and its relevance to the labour market.
Sustainable and resilient societies
• The population of the Arab region has grown significantly in the past decades, exceeding 377 million in 2014. The 215 million people living in Arab cities and urban areas require large public investments in infrastructure to provide essential services; • The agricultural sector is by far the largest consumer of water in the region while water productivity and irrigation efficiencies are well below global averages; • The consumption of resources such as water and energy is increasing at rates that cannot be sustained, and new approaches are urgently needed; • Climate change is exacerbating the intensity and frequency of extreme weather events and the region is more likely than others to be affected by rising temperatures; • Marine and terrestrial ecosystems are facing significant pressures due to misuse and biodiversity degradation. Vegetation cover is shrinking.
Peace, governance and institutions
• By 2015, the Arab region had overtaken South Asia as the least peaceful part of the world. Conflict and criminality have led to hundreds of thousands of fatalities and massive displacement; • Although improvements have been made in the majority of Arab countries with regard to the separation of powers, conditions have worsened in terms of misuse of public funds and cronyism.
Means of implementation and partnerships for sustainable development
• The financing gap for achieving sustainable development, particularly for middle-income countries, can be narrowed through tax and subsidy reforms and by rationalizing military expenditure; • The Arab region remains mostly a user of technology, with knowledge generation remaining very low relative to the rest of the world and even to developing countries. The little knowledge that is generated is not benefiting the productive sectors due to weak and undiversified economies; • The region's share of the world's non-oil exports remains modest and it is less economically integrated than other world regional groupings; • Statistical capacity in the Arab region remains limited. The situation will be exacerbated with the anticipated 100+ global indicators to be used for monitoring the SDGs. The data gap has prevented governments from fully benefiting from evidence in replacing failed policies.

Source: ESCWA and UNEP, 2015, pp. 20-23.

2. Innovation policy adaptation to address the SDGs

The main challenge of the SDGs lies in their holistic nature, which encompasses economic, social and environmental goals. An innovation policy adapted to address the SDGs need not include new components within its framework (as discussed in chapters 1 and 2), but rather, a broadening of focus from exclusively economic goals to those that are also social and environmental. The adapted innovation policy takes into account a more diverse range of actors, considers regional and global dimensions and integrates the concepts of openness and inclusiveness.[255] Box 26 highlights the activities on social innovation at regional level by the United Nations Development Programme (UNDP) through the Innovation for Development initiative.

Box 26. UNDP Innovation for Development activities

According to UNDP, technology is a powerful enabler and vessel for innovation although the two are not exactly equal. To bring about enhancements in people's lives, the UNDP Innovation Facility was launched in 2014 to leverage innovation for development. UNDP has been using **new approaches** such as setting up innovation laboratories with governments to redesign public service delivery, and using foresight to improve planning processes and behavioural insights to facilitate policymaking. Globally and on the regional Arab level, the five themes of operation have been poverty eradication, environmental protection, peace building, disaster management and gender equality. Egypt, Morocco, Sudan and Tunisia have implemented activities that tap on innovation for solving social problems, empowering youth and engaging citizens through innovation labs, competitions and analysing big data.

Source: http://www.undp.org/content/undp/en/home/ourwork/development-impact/innovation.html.

This section elucidates selected innovation policy domains where addressing the SDGs enhances the importance of existing instruments or their significant modification/adaptation.

(a) Provide visionary leadership for STI as an integral component of SDG strategies

A successful innovation policy needs a high-level commitment at government level and a 'whole-of-government' approach. This becomes more significant when SDGs are integrated within policy goals. For example, the Republic of Korea's Science and Technology Basic Plan, to alleviate inequality and unemployment and help the country cope with its ageing population and environmental challenges, emphasizes the role of the so-called creative economy in economic growth and the well-being of society while focusing on incentivizing innovation among SMEs and entrepreneurs.[256] This is a country in a post-catch-up phase concerning technology, having reached levels identical to developed countries; when countries are in pre-catch-up phase, as is the case for Arab countries, STI programmes and activities that target the three dimensions of sustainability are needed to ensure that technology appropriation and introduction in society is not made for one dimension (often economic) at the expense of the other two.

Green-growth strategies, for instance, can provide useful complementary policy tools, including measures to support developing green technologies, such as standards and certificates for environmentally friendly products and carbon labelling, and financial measures, tax rebates and other purchasing and incentive programmes. The last measure might be applied in public procurement processes to support innovation and the green economy.

(b) Address social economy when building an enabling environment for STI

Good governance and a proper regulatory framework are essential conditions for a successful innovation policy. They are also necessary for producing quality science and innovation for sustainable development. As well as establishing an enabling environment for STI, proactive approaches are needed, ones that suit developing countries directly addressing the SDGs, such as encouraging social economy and collaboration between academia, research centres and industry, with emphasis on local socioeconomic needs. Two examples highlighting these approaches are illustrated in box 27.

(c) Provide funding for social and environmentally relevant projects

Funding innovation is a key instrument of innovation policy, particularly in developing countries where most R&D is carried out by the public sector. Encouraging innovation in companies and developing public R&D on social and sustainability subjects are therefore important in developing countries seeking to leverage STI to fulfil the SDGs. One useful policy tool is the innovative public pre-commercial procurement, which might be used to create demand for products and services for social or environmental benefits. The United Kingdom uses such an approach for public tenders aimed at developing products suitable for the environmental needs of developing countries, as discussed in box 28.

Public procurement can also provide incentives for the private sector to address environmental and social issues by setting specific criteria in procurement frameworks. For example, Singapore recently announced specific certifications for procured products, such as high-energy efficiency for electrical products and printing paper produced from sustainable forestry management (carrying the Singapore Green Label).[257]

Box 27. Social economy and collaborative innovation: examples from Malaysia and Indonesia

Malaysia

In 2015, the Government of Malaysia launched the Malaysian Social Enterprise Blueprint 2015-2018, a three-year road map for developing a social enterprise ecosystem that seeks more impact-driven entrepreneurs who create a social and environmental as well as an economic impact. The blueprint's objective is to develop the Malaysian Global Innovation and Creativity Centre as a key institutional component of the ecosystem. The centre's mandate is to encourage the social enterprise sector through a mix of financial and non-financial support to social entrepreneurs.

Indonesia

Over the past two decades, Indonesia's Directorate General of Higher Education has initiated more than 20 schemes to fund university research and community service activities. Since the early 1990s, it has fostered stronger university-industry-government collaboration and partnership to fulfil the country's economic development strategy. Partnerships that have resulted from this include the following: service and training contracts among universities; government-supported university patent applications; collaborative R&D efforts between universities and industry; networking events to forge connections between industrialists and academics; industry collaboration for education; incubation/entrepreneurship education for students; SME participation in university activities; and the establishment of science parks close to universities.

Source: ESCAP, 2016, pp. 31 and 33.

Box 28. Pre-commercial procurement for social and environmental benefits

The Small Business Research Initiative (SBRI) was launched by the United Kingdom Government to experiment with pre-commercial procurement. SBRI uses a process to connect public sector challenges, including social and environmental challenges, with innovative ideas from industry. This provides companies with business opportunities and guides them towards new economic growth channels, while enabling improved responses to these challenges.

As part of the initiative, the Department for International Development (DFID) launched a competition to develop an affordable solar-powered irrigation pump that could be deployed to developing regions around the world, particularly sub-Saharan Africa. DFID utilized the SBRI approach instead of issuing a traditional tender to the market for available products, allowing a higher level of innovation among companies to provide the product.

Source: ESCAP, 2016, pp. 51-53.

(d) Provide incentives for talent to address social and environmental issues

Developing talent in schools, universities, enterprises or government has positive impact on the status of the NIS and consequently SDGs. Policy can play a decisive role in incentivising this available talent to address social and environmental issues.

A challenge-driven university model, for example, places students up against difficult problems and challenges for which there are no established answers. They are pushed to tap into diverse disciplines, work in teams and collaborate with non-academic organizations in order to find appropriate solutions. Such a model is not a replacement for traditional education but acts as a useful complement, preparing students for real-world needs.[258] This model and similar approaches have the potential to build student abilities, skills and focus to meet the ambitious targets of the SDGs.[259]

The idea behind challenge-driven models has the potential to develop into other initiatives such as a global online campus connecting projects with challenges. Such a virtual campus could offer challenges for each of the 17 SDGs with projects focusing on the local dimension of problems, like gender equity or access to sanitation. An online platform would provide access to data, research and groups of other students globally working on similar issues.[260] Arab universities could well implement such an approach and collaborate to establish just such a virtual campus to address SDG challenges.

Another policy adaptation option is to provide incentives and obligations for enterprises to go beyond corporate social responsibility (CSR) towards embracing 'shared value'. This would create economic value while explicitly incorporating social and environmental outcomes in the decision-making process.[261] A rare example of a policy measure that unlocks shared value in enterprises has occurred in India, as highlighted in box 29.

(e) Inclusive innovation

Inclusive innovation allows the development of innovation driven and made for the needs of poor and marginalized populations particularly in low-income developing countries. The paradigm could also be extended to displaced populations in conflict situations as is the case in some Arab countries. Although it pre-dates the 2030 Agenda, inclusive innovation is an important approach to address the SDGs because it allows for improved economic and social well-being of large numbers of marginalized populations and addresses sustainability issues with innovations that are 'frugal' in their use of natural resources.

Box 29. Unlocking shared value in enterprises: the example of India

The Ministry of Corporate Affairs in India issued the National Voluntary Guidelines in 2011 in an attempt to encourage responsible business practices and mainstream disclosure and reporting on environmental, social and governance metrics. The guidelines provide businesses with a framework for a 'triple-bottom-line' approach (economic, social and environmental).

Further, India is the first country to enact a law on corporate giving, a solid move towards shared value creation. The 2014 law mandates companies with a certain turnover and profitability to spend 2 per cent of their net profit on activities across several categories, which include hunger and poverty, education, health, gender equality and women's empowerment, skills training, environment and social enterprise. Companies complying with this law are required to report on their activities.

Source: ESCAP, 2016, p. 78.

Inclusive innovations can be of different types. Pro-inclusive innovations depend on existing technologies, products and services modified to answer the needs of lower- and middle-income groups. Frugal innovations preserve only the most critical functionalities of a product, retaining core quality characteristics but at a lower unit price. Grass-roots innovations are inclusive, emphasizing the empowerment of lower-income groups. They may be undertaken by the poor or supported by other actors in the innovation system, including universities, non-governmental organizations (NGOs) and private companies.[262] Table 16 provides examples of these types of innovations.

Policies aimed at supporting inclusive innovations could address the following issues: direct formal innovation systems towards the poor; promote grass roots; improve absorptive capacity of low-income groups; drive more effective use of innovations among low-income groups; and reduce structural barriers to inclusive innovation.[263] New technologies, in particular ICTs, have increased opportunities to develop inclusive innovations; for example, financial services provided through mobile phones can bring about improved financial inclusion.[264] Additionally, scaling up inclusive innovation should leverage the private sector's interest in providing solutions that serve the growing middle-income groups in emerging economies.[265] Looking at the Arab context, this could mean that transitioning away from the rentier economy model generates jobs and supports economic actors seeking innovations that enlarge their customer base and contribute to their economic and social inclusion.

B. Innovation policies to support SDG-relevant sectors in Arab countries

Three sectors are identified in this section as priorities for the Arab region: youth employment (Goal 8), climate change (Goal 13), and social innovation (to address several social goals addressed by SDGs). Innovation policies on their own would not comprehensively cover these issues; they require complementary policy measures beyond the scope of STI. They are discussed to encourage Arab policymakers to consider the following sectors with some urgency, in addition to generic adaptation of innovation policies to address SDGs.

Table 16. Examples of pro-inclusive and grass-roots innovations

	Nature of Innovation		
	Service innovation		Product innovation
Pro-Inclusive Innovation	**Empresas Públicas de Medellín** A utility company providing energy and water services. Low-income users can use prepaid cards to pay for the service according to their cash flow. Households do not pay fixed installation costs. **Innovation**: pay-per-use method. **Operator**: public utility company. **Sector**: energy and water. **Country**: Colombia. **Scale**: 43 000 low-income users have been connected since implementation in 2007.	**Narayana Health** One of India's largest health-care services providers, Narayana Health offers low-cost cardiac surgeries and other health-care services to the poor. It also caters for isolated communities via telemedicine. **Innovation**: business process innovations aimed at decreasing surgery costs. Use of ICTs to establish health-care centres in remote locations for poor rural communities. **Operator**: private corporation. **Sector**: health care. **Country**: India. **Scale**: 6 200 beds are spread across 23 hospitals in 14 cities, up from an initial 300 beds in 2001.	**MoneyMaker irrigation pump** Low-cost manpowered irrigation pumps. **Innovation**: no electricity or fuel required for functioning and operating cost is lower. **Operator**: U.S.-based NGO (KickStart). **Sector**: agriculture. **Country**: Kenya, Mali and Tanzania. **Scale**: pumps are distributed in local shops and sold to other NGOs for wider diffusion in the three countries.
Grass-roots Innovations	**Honey Bee Network** The Honey Bee Network links grass-roots innovators from low-income groups. **Sector**: all sectors relevant to livelihood of low-income groups. **Innovation**: the network has developed an extensive database documenting innovations by the poorest, including in agricultural practices (e.g. natural pesticides), machinery and other sectors. The aim is to foster the diffusion of knowledge to a wider group of potential users. The Honey Bee Network also supports the protection of inventors' intellectual property and the commercialization of marketable innovations by connecting informal innovators with formal institutions, including universities and public research institutions. **Country**: India; similar networks in China and other countries. **Scale**: the Honey Bee Network led to the creation of India's National Innovation Foundation, an autonomous body aimed at providing institutional support to grass-roots innovation. The network's newsletter is printed in seven Indian languages. **Grass-roots involvement**: the poor are the innovators and are recognized as such. They determine the conditions of use of their creation, as well as its eventual commercialization and scale-up.		**Sanitary napkin machine** A low-cost sanitary napkin-making machine that produces affordable sanitary pads for very poor women. **Sector**: health and manufacturing. **Innovation**: improves women's health and provides them with economic activity. **Country**: India. **Scale**: present in 1 300 villages in 23 states across India and developing abroad. **Grass-roots involvement**: developed by an uneducated worker, India's National Innovation Foundation helped him apply for intellectual property rights and provided the means for the innovation to reach scale.

Source: OECD, 2015b, p. 11.

1. Youth employment

In 2016, the youth unemployment rate in the Arab region remained the highest globally, at 30.6 per cent.[266] This has been increasing for the past five years but is expected to drop slightly in 2017. Gender differences are notable when it comes to unemployment, with the gap between

young men and women one of the largest in the Middle East (27.6 percentage points more for females, compared with 20.3 in North Africa). This is thought to be the result of sociocultural and education factors. Thus, although in some countries the female participation rate in tertiary education is higher than that of males, the employment rate is lower.

According to the Arab Youth Survey,[267] the main explanation given as to why people join undesirable groups, like the self-proclaimed Islamic State in Iraq and the Levant, was insufficient jobs and opportunity for young people. Lack of perspective among Arab youth was perceived to be one of the reasons behind Arab uprisings in 2011. Many underlying factors have not abated, particularly youth unemployment, which deteriorated in Arab countries between 2010 and 2014, from 25 per cent to 29.7 per cent, and up to 42 per cent in Egypt.[268] The implications of war and conflict can be devastating, from law and order breaking down to violence, increased fragility, economic deterioration and a decrease in education rates and quality.[269] These also lead to increased unemployment, especially among young women. In situations of conflict, family responsibilities place an increased burden on women who are often faced with hardship, poverty and discrimination. Women and girls also have decreasing access to education because preference is given to males when opportunities are available.

Although a 'youth bulge' in almost all Arab countries has led to increased numbers of youth seeking work, contrary to other developing regions this has not translated into the so-called demographic dividend, where extra labour input leads to increased economic growth. And this was in spite of continuous and decent levels of spending on education and improved attainment in most Arab countries.[270] Even with low female labour force participation,[271] other structural factors should be sought to explain the high levels of unemployment in general, and higher youth unemployment in particular.

The Arab Human Development Report 2016, Youth and the Prospects for Human Development in a Changing Reality,[272] argues that development models and economic structures in Arab countries have failed. Although countries have shown steady improvement in overall human development, this has not necessarily translated into increased productivity and growth. Governments continue to be the largest employers in the region but with increased fiscal pressure and strain on people employed in unproductive jobs, public sector employment is becoming unsustainable. The report proposes that Arab countries look inwards, not abroad, to address youth unemployment, one of the elements of youth disempowerment. This is achievable through policy reform that is inclusive, youth-centric and considers new economic growth models with proven complementarities on a regional scale to generate decent, sustainable jobs.

A flagship report, Rethinking Economic Growth: Towards Productive and Inclusive Arab Societies, published by the International Labour Organization (ILO) and UNDP after the Arab uprisings, rethinks economic growth in the region with a view to developing inclusive Arab societies particularly for youth.[273] It has led to some key findings on the current state of high unemployment in the region, particularly among youth,[274] with some suggested policy directions. The findings and policy aims of this report focus on issues relevant to innovation policies in the overall context of SDGs.

The low-skill, low-productivity, low-wage Arab economies can be explained through the following:

- Running counter to the established wisdom of skills mismatch, there is no demand for skills in the Arab region. Employers determine jobs, production techniques and skills, and would usually undertake the training themselves rather than pay for education and skill-building;[275]
- Levels of labour productivity growth in the MENA region averaged only 1.2 per cent and 1.1 per cent, respectively, in the period 2003-2013, compared with 8 per cent in East Asia, 5.5 per cent in South Asia and 2.3 per cent in sub-Saharan Africa;[276]
- The MENA region had the steepest fall among world regions in the share of wages as a percentage of GDP, decreasing from a base of 100 in 1998 to 79 per cent (2004) and 66 per cent (2006).[277]

The origins of this situation can be attributed to economic reforms conducted in the late 1980s, which reduced the importance of public investments on the assumption private investments would increase. Private investments, however, remained at low levels. By the same token, trade policies have favoured liberalization, overlooking the need to preserve local production with a notable impact on the economy. Public spending provided little support for the domestic economy/industry/ manufacturing, with most going on imports. Additionally, in some countries, privatization of state-owned enterprises did not result in a truly competitive private sector but rather the formation of enterprises controlled by insiders, including political elites.[278]

Among suggested remedies for high unemployment levels – in general, and among youth, particularly the educated – the following are relevant to innovation policies.

(a) Macroeconomic policy coherence aimed at economic growth and shared benefits

The policy package should pay equal attention to the rate and quality of economic growth. The move towards a model led by the private sector needs to take account of the public sector's role, by exploring complementarities through public-private partnerships. The private sector should also operate in a competitive and transparent environment. The incentive programmes for private investments (including FDI) should not only be associated with quick private returns. Markets that function properly should, in principle, promote both economic growth and social justice; benefits are not exclusive to a few profitable enterprises, but rather, profits are raised through productivity gains from fair competition, greater transparency and freer entry into various economic sectors. This market environment will encompass all.[279]

Innovation policy measures can contribute to the implementation of these macroeconomic reforms. As discussed in the previous chapter, encouraging companies to invest in R&D, addressing the framework conditions for innovation, and supporting innovators are all measures that result in productivity gains. This cannot take place without qualified employment, particularly among educated youth. When productivity gains become the driving factor behind an enterprise's success, they translate into higher wages rewarding qualification.

Government can also play a role by investing in innovation. One avenue is the development of innovative e-government services likely to improve overall efficiency. Despite efforts made by many Arab countries in this domain,[280] such investment should eventually translate into global efficiency and increased productivity of public services.

Arab governments should also invest in risk-prone or long-return projects in which the private sector is reluctant to participate. Government-backed investments could be an opportunity to generate direct employment opportunities for youth, and develop technological expertise and qualified jobs in a myriad of local subcontracting small and medium enterprises.

When all of the above are implemented within a new macroeconomic policy context, innovation policy measures could contribute to a change in the nature of economic growth in Arab countries and the distribution pattern of its benefits.

(b) Well-designed employment policies and active labour market programmes

Active labour market policies (ALMPs) include employment services, career guidance, job counselling, labour market information and support for micro and small enterprises. ALMPs can help reintegrate youth who are in the forefront of regional developments. Promoting opportunities for youth entrepreneurship can boost economic growth and create jobs. In pursuing such outcomes, the regulatory environment would need to be improved to make it easier for businesses, especially smaller ones and those in the informal economy, to operate and grow.[281]

Although entrepreneurship does not have one globally adopted definition, herein it refers to seizing a business opportunity that involves innovation and may entail a level of risk. Not all business owners are entrepreneurs and not every person has the skills to be one. Mechanisms for supporting entrepreneurs and start-ups, such as incubators, accelerators and available seed funding and other types of investments, are important components of an entrepreneurship ecosystem, and could balance the fragility of these new businesses.

Although ALMPs in the Arab region are outside the remit of innovation policies per se, they can contribute to their success. ALMPs primarily strive to (re)integrate people into the job market whether or not this entails innovative activities. Innovation policy measures, however, can naturally be included within the larger remit of an ALMP; developing an enabling regulatory framework for business and supporting innovative entrepreneurship of youth, and small and microenterprises, are all innovation policy instruments. Innovation should not be understood in a narrow technological sense; it entails any activity that brings something new to the market or develops an organizational or marketing approach, and is not necessarily associated with R&D at the frontier of knowledge or even any R&D at all. The coverage of innovation policy instruments for the purpose of ALMP is much larger than one might take from a narrow definition of innovation.

Consequently, innovation policies should be closely coordinated with ALMPs and, in the case of Arab countries, contribute to their efficiency and relevance.

(c) Increased quality and greater relevance of education and training

Although skills mismatch does not fully explain high levels of Arab youth unemployment, particularly among the educated, it is nonetheless a significant cause. Two major factors hinder the employability of Arab youth. The first is related to the general quality of education outcomes and the second to the relevance of skills to the labour market, which is composed of formal employment in public and private sectors, and informal employment. This labour market is dominated by the public sector

and characterized by low-productivity and low-income informal employment. More than one third of employers in the region say that inadequate skills are a major impediment to business growth and operation.[282]

Average scores for Arab countries participating in international tests, such as TIMSS[283] or the Programme for International Student Assessment (PISA), are below the international average, while "the share of inequality in test scores accounted for by family background and community characteristics (inequality of opportunity) is high in several countries".[284] Regarding the relevance of developed skills, although enrolment levels in tertiary education for science programmes are acceptable in many Arab countries, ranging from 11.9 per cent in Jordan to 44.7 per cent in Tunisia,[285] and comparable with developed countries, these figures do not tell the whole story.

Arguments for providing pre-employment skills do not account for the dynamic nature of labour markets. Technology advances and globalization have resulted in a situation by which technical information doubles every five years. So by the time students on a four-year degree reach the third year of study, half of what they learned in the first year may be outdated. Even if armed with a degree from the best university, the quality of a qualification and potential employability depends on a capability to adapt to the fluidity of the future labour market – with its projections that "today's youth will have had 10-14 jobs by the age of 38, and that one in two workers will have been with their current employer for less than five years".[286]

To keep pace with a dynamic labour market requires a capacity for lifelong learning – provided there is a conducive environment – autonomy and independent thinking. In other words, all qualities required from a future innovator. Tomorrow's workers need to define their own jobs whether they are self-employed or working for companies. It is wrong to assume such attitudes are required only for highly skilled workers; even middle-skilled workers, those with vocational training, need to adapt to this evolving situation.

There are therefore two challenges Arab countries must address, and both are connected to innovation policies. The first is to improve the quality of school education from early levels, through changing education methods, building student autonomy and 'learning by doing'. Education system reform needs to address educational content and programmes, maintain school infrastructure, build skills that meet market needs, and provide relevant career advice. It also needs to address social issues such as bullying and sexual harassment, costs of learning resources and geographical proximity. As one speaker at a multinational company shareholder meeting nicely summed up: "We are teaching students to do jobs that do not yet exist, using technologies that have not been invented, in order to solve problems we do not yet know are problems."[287]

The second challenge lies in developing successful vocational training. Governments in the region have made continuous but often ineffective attempts to introduce vocational education at secondary level. For example, in Yemen, vocational training and education are still weak, with minimal participation by women (13 per cent in 2007).[288] Employers say they prefer to carry out the training themselves rather than rely on the slow pace of education development in public centres, with learning often based on a trainer's knowledge, not what current production requires. Provision of pre-employment training should be employer-driven and based on job requirements.[289]

Successful vocational training requires support and a coherent development framework that involves the private sector in its financing and management.[290] Innovation policy measures can help develop a company's capability to engage in such a role, which is normally delegated to their technical or R&D departments. Innovation policy is also involved in developing proper links and coordination between companies, communities and the education system.

2. Climate change

The Arab region illustrates the potential adverse impacts of climate change on social, economic and environmental levels; characterized by its unique geography, it is one of the most vulnerable to future effects of climate change but economic reforms have been indifferent to the environmental challenge and the deterioration of natural resources.[291] While historically frequent, the intensity of drought episodes has increased in a region already home to some of the world's largest and harshest desert lands. Reduced rainfall makes it extremely vulnerable to degradation and desertification that in turn destroys the biological potential of land at a time when growing populations are in need of increased productivity and development.[292]

Anecdotal evidence on the effects of climate change in the Arab region abound. As reported in The Economist: "Iraq now averages a sand or dust-storm every three days," while in July 2016, "Basra's temperature reached 53.9 degrees Celsius, a record beaten, fractionally, only by Kuwait and California's Death Valley – and the latter figure is disputed." Much of the problem is man-made: "…over-irrigation has dried up lakes and turned seas into dustbowls. The Dead Sea is shrinking by a meter a year… War and urbanization have combined to chase rural people from the land. Desertification and sandstorms lift radioactive war detritus into the air. War stops people from taking counter-measures, such as planting trees."[293]

Addressing climate change requires a variety of measures including mitigation, education and R&D, all relevant to innovation policies.

(a) Mitigation

All Arab countries are signatories to the United Nations Framework Convention on Climate Change (UNFCCC), an international environment treaty that requires all parties to work towards reducing greenhouse gas (GHG) emissions and/or enhancing GHG sinks. As a result, the region has seen a number of efforts using renewable energy and other environment-friendly solutions. Examples include: commercializing wind energy production in Egypt; solar heating in Morocco, Palestine and Tunisia; compressed natural gas introduced as transport fuel in Egypt; green building councils in the UAE and Egypt; a forestation programme in the UAE; Masdar, the first zero-carbon city, in Abu Dhabi; a carbon capture and storage project in Algeria; and Jordan's duty and tax exemptions on imported hybrid cars.[294] Most Arab countries identified adaptation and mitigation actions in their nationally determined contributions and submitted them to UNFCCC in 2015, with emission reduction targets partly subject to available financial resources and appropriate technologies.

Although commendable, projects remain dispersed and separate. An overarching policy is needed at national and regional levels in order to achieve optimal results for mitigation efforts. Several developed countries have adopted green growth strategies and integrated green innovation and green technologies into their STI strategies.[295] Clean energy, through an increase in the share of

renewable energy – the energy sector is responsible for 40 per cent of GHG emissions – and the greening industry, via eco-innovations reducing the use of natural resources and release of harmful substances, are two major axes of innovation policies that play a crucial role in climate change mitigation.

Examples of clean energy and greening initiatives from OECD countries are highlighted in box 30. Policy priorities for green innovation and technology differ among countries, depending on economic specialization, competiveness goals and social objectives.[296] Arab countries might look to integrate the following approaches, according to their priorities and national capabilities, within innovation policies.

(b) Education, research and development

The importance of climate change education lies in its ability to shape and change the way people think and act. It raises awareness and builds human/institutional capacity for mitigation, adaptation, impact reduction and early warning.[297] For instance, UNESCO's Climate Change Education for Sustainable Development programme (box 31) illustrates the importance of education beyond the necessary technological solutions, policy measures or financial instruments.

Box 30. Clean energy and greening industry initiatives in OECD countries

Clean energy policies seek to increase both the supply and demand for renewables as part of transition plans towards reduced GHG energy supply. Examples include:

- Canada's Economic Action Plan 2013 has expanded the tax incentives that encourage businesses to invest in clean energy generation and energy efficiency equipment. The plan applies an accelerated capital cost allowance, which encourages investment in particular assets, to clean energy generation equipment;
- Italy has established a low-interest fund to promote energy efficiency. It has also introduced incentives to encourage the use of renewable sources for producing electricity and thermal energy. A decree issued in 2013 simplifies authorization procedures for innovative bioenergy plants.

Greening industries through eco-innovation initiatives involve technological and non-technological change. Eco-innovation policy instruments include regulations, economic incentives, negotiated agreements, public procurement and eco-labels, as for example:

- Denmark has established a Fund for Green Business Development which gives grants to cover: innovation and redesign of company products, cradle-to-cradle; development of new business models; promotion of sustainable materials in product design; sustainable transitions in the fashion and textile industry; reduction of food waste; and sustainable products based on non-food biomass. The fund also promotes green industrial symbiosis, whereby waste or reserves of a given resource (for example, water or materials) of one company become a resource of another;
- The United States is spurring private-sector innovation by developing new standards on fuel efficiency and GHG emission in light vehicles as well as medium- and heavy-duty vehicles. These standards will be developed over the years 2017-2025. The country has also realized the government is an important catalyst for innovative energy technologies being the largest consumer of energy at national level.

Source: OECD, 2014b, pp. 145-146.

Box 31. UNESCO Climate Change Education for Sustainable Development programme

Through the programme, UNESCO aims to educate people on the impact of global warming, thereby increasing 'climate literacy', particularly among the young. It strengthens the capacity of Member States to provide quality climate change education and innovatively integrate it into school teaching and non-formal education programmes through media, networking and partnerships.

UNESCO responds to climate change through education within the framework of the Global Action Programme (GAP) on Education for Sustainable Development (ESD).

Source: UNESCO, Climate Change Education, n.d. Available from http://en.unesco.org/themes/education-sustainable-development/cce (accessed 13 August 2016).

Developing R&D capacity will ensure the supply of technologies relevant for green growth and proper modelling of climate change effects, and inform evidence-based policymaking. Capacity in the Arab region is still lacking, and countries rely on external global climate models for measuring and assessing climate change, though significant progress is being achieved with regional climate modelling capacities and projections that draw upon global modelling outputs. Work has been conducted within the framework of the Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR),[298] which has informed more than 24 regional climate projections. Much has to be done to support the drafting of peer-reviewed journal articles based on these outputs, which can in turn be used by the Inter-Governmental Panel on Climate Change (IPCC) for global reports.

Efforts have been pursued with the Center of Excellence for Climate Change Research (CECCR) at King Abdulaziz University, the King Abdullah University of Science and Technology (KAUST), the Moroccan Météo (Directorate of national meteorology) and other bodies interested in climate change research in the Arab domain, such as the Swedish Meteorological and Hydrological Institute and the Cyprus Institute. Given the significant interest and potential to develop Arab leadership in this area, high priority should be given to supporting further research and developing capacities to inform global, regional and national action in Arab innovation policies.

Government spending[299] on energy and environment R&D activities varies hugely among developed countries. For instance in 2013, Germany and Japan were top spenders on environment-related R&D (at nearly $750 million in PPP) while the United States spent only $466 million and Korea $317 million. With energy, it is Japan who comes first, with $3.6 billion in PPP followed by the United States ($1.7 billion) and Germany ($1.36 billion), again all in 2013.[300] Spending levels on energy R&D are still at higher scale than those on environment, reflecting priorities in the development of efficient and renewable energies.

(c) Role of local innovation for climate change

Technology transfer under the UNFCCC was guided by its Article 4.5: "The developed country Parties... shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention." To this end, a technology mechanism, made up of a policy arm, the Technology Executive Committee (TEC), and an operational arm, the Climate

Technology Centre and Network (CTCN), was established in 2014 during COP16 (edition 16 of the Conference of the Parties, or signatory national states, of the UNFCCC).

The CTCN's mission is to stimulate cooperation and help develop and transfer technologies to the developing countries – the aforementioned Parties – that want them. In coordination with National Designated Entities (NDEs), which ensure country requests reflect national circumstances and priorities, it works in partnership with UNEP and UNIDO and 12 independent, regional and global consortium partner organizations with expertise in climate change technologies.

The Green Climate Fund (GCF) was established as the operating entity of the financial mechanisms under the UNFCCC in 2013. Currently, it has $10.3 billion in pledges and aims to reach a target of $100 billion by 2020 to assist developing countries implement adaptation and mitigation projects proposed in their nationally determined contributions.

The milestone UNFCCC agreement adopted in December 2015 by the Conference of Parties (COP21) in Paris "recognizes the need to strengthen knowledge, technologies, practices and efforts of local communities and indigenous peoples related to addressing and responding to climate change".[301] Initiatives by local authorities and communities to address climate change are taking place both in developed and developing countries and the role of such initiatives is considered as key by leading specialists.[302] During the COP 22 that took place in Marrakech, Morocco in November 2016, countries pledged over $23 million to the Climate Technology Centre and Network (CTCN) which was established as the implementation arm of the Technology Mechanism under the UNFCCC to support developing countries with climate technology development and transfer. In addition, during the COP the Global Environment Facility (GEF) announced that in 2016 over 30 projects for cutting emissions with technology transfer objectives, with $188.7 million from the Green Climate Fund (GCF) and $5.9 billion in co-financing.[303]

For instance Ethiopian Pastoralists are reported as having developed various strategies to adapt to climate change like for instance selection of livestock species, crop cultivation and other local adaptation to deal with prolonged droughts.[304] In developed countries, the New York State is integrating climate adaptation across different levels of government. Its Climate Smart Communities (CSC) programme supports communities in their efforts to reduce GHG emissions and improve climate resilience with an objective of reducing emissions by 40 per cent and 80 per cent for 2030 and 2050, respectively. The programme essentially provides free technical assistance and guidance on energy efficiency and renewable energy, offering communities a platform for exchange and allowing them to be better positioned to compete for funds.[305]

Another development lies in the adoption of the Compact of Mayors to address climate change, by UCLG, which is the Global network of Cities, Local and Regional Governments in 2014. This compact aims to establish standards for data collection, reporting processes for local climate action in order to consistently and reliably assess progress, and an evidence base of the greenhouse gas impact of city action.[306]

Arab countries' Innovation policies should encourage local authorities to develop climate change initiatives and, beyond, also local communities with the support of NGOs, with provision of financial support and expertise. Such initiative can develop concrete expertise

and local know-how on issues related with climate change adaptation and mitigation. Bilateral or international cooperation frameworks (like the UCLG discussed above) to share knowledge and expertise with developed and developing countries.

3. Social Innovation

Social innovation is an important component among solutions that address SDGs. It has the potential for finding innovative approaches towards socioeconomic problems that global policies often fail to foresee or address adequately.

In contrast to classical innovation occurring in firms and public research laboratories, the bottom line of social innovation is inclusiveness, although it might entail economic benefits and generation of employment opportunities. Social innovation also entails the development of new organizations and might introduce new behaviour and attitudes that permeate the functioning of the whole society, in such domains as health, education and the environment.

Social innovation is essential when systems fail to solve problems and institutions are unable to cope.[307] Another driver for social innovation lies in the existence of a widening gap between what societies need and what governments, the private sector and civil society can offer.

Social innovations can be triggered by visionary individuals, social movements or innovative organizations.[308] Because of the development of social networks and the Internet, it has become possible to organize open innovation platforms[309] whereby people worldwide can exchange ideas and weigh the pros and cons of innovative solutions. The openIDEO[310] is one such example. International and national aid agencies discuss specific challenges for a designated period of time (usually three to five months) and seek out-of-the-box solutions. Winning solutions get the opportunity of support and finance from the organizations involved for prototyping and pilot deployment. In August 2016, for example, an active challenge sponsored by UKAID focused on improving and expanding education and learning opportunities for refugees around the world.

International organizations, including the United Nations, are leveraging social innovation to encourage youth imagination and motivation. In the Arab region, as part of preparations for the Arab Human Development Report 2015, the regional UNDP office organized a social innovation camp in Amman, Jordan, during June 2015. The main purpose of the camp was to provide a platform for young women and men to propose innovative solutions for key development challenges facing the region. Box 32 summarizes the main results of the camp, highlighting solutions that the young women and men proposed.

Examples of Social Innovation and Entrepreneurship abound in the Arab region according to some anecdotal searches.[311] However, it remains to be seen if they have reached a critical mass or had a large impact.

(a) Spreading the Culture of Social Innovation

Prior to concluding on how social innovation might be supported effectively and scaled up by public policy frameworks, it is useful to highlight the important role played by spreading a culture of social innovation. That culture can be built on the basis of (1) dispelling a key misconception about social innovation, (2) highlighting social innovation behavioural and organizational impact, and (3) explaining that social innovation is a general public good within the context of developing and Arab countries.

Box 32. Social innovation camp for the Arab region

The Social Innovation Camp for the Arab Region was organized by UNDP in Amman during June 2015. The main objective of the camp was to provide a platform for youth from the Arab region to suggest innovative solutions that address key development challenges facing the region. The camp drew upon thematic areas identified in the Arab Human Development Report (AHDR) 2015. Participants prioritized the areas as follows: (1) education, (2) employment and entrepreneurship, (3) health, (4) civic engagement, (5) religion and identity, (6) leadership by young women and participation in public space, plus (7) conflict and peace building.

Design thinking methodology was at the core of the innovation camp. The methodology is a tool for problem solving based on a creative process. Solutions proposed by the participants included a mobile innovation tent to reach children deprived of formal education in remote areas; an online educational platform to supplement school teaching; a wide awareness campaign on priority health issues; and an online employment platform connecting employment seekers with employers/companies. Other proposed ideas included a digital game to promote entrepreneurship skills amongst youth; a mobile application to connect volunteers with NGOs, government and the private sector; a volunteering caravan to spread awareness on volunteering values and culture; a social media campaign to counter sectarianism; an online platform to inspire girls and young women to engage in public space; and a NGO for female empowerment by shattering stereotypes.

Details on the solutions and the camp are available from https://www.unteamworks.org/es/Arab-Youth-Social-Innovation.

Source: UNDP, Youth innovate to address development challenges in the Arab region, 21 June 2015. Available from http://www.sa.undp.org/content/saudi_arabia/en/home/presscenter/articles/2015/06/21/regional-camp.html.

(i) Are social innovations only for the poor and marginalized?

A major misconception lies in the belief that social innovations are essentially for the poor and marginalized, and are bound to remain at the margins of global socioeconomic impact. That misconception is belied by evidence from some famous social innovations including, for example, the introduction of the National Health Service in the United Kingdom[312] and the National Security System in France shortly after the Second World War. Those innovations had a profound impact not only on the economy and efficiency of the health-care system[313] but also on workers' social rights and the relationship with their employers, including a definition of what formal employment entailed. Social innovations also straddle many borderline cases, moving from initial non-profit to profit sectors. For example, models of distance learning were pioneered in social organizations and later adopted by businesses.[314]

(ii) Social innovations introduce new modes of organizations and behaviour

Social innovations when introduced often lead to new modes of organization and behaviour as an essential complement to technologies. For example, rising life expectancy "requires new ways of organizing pensions, care and mutual support, new models of housing and urban design, and new methods for countering isolation". Climate change "demands new

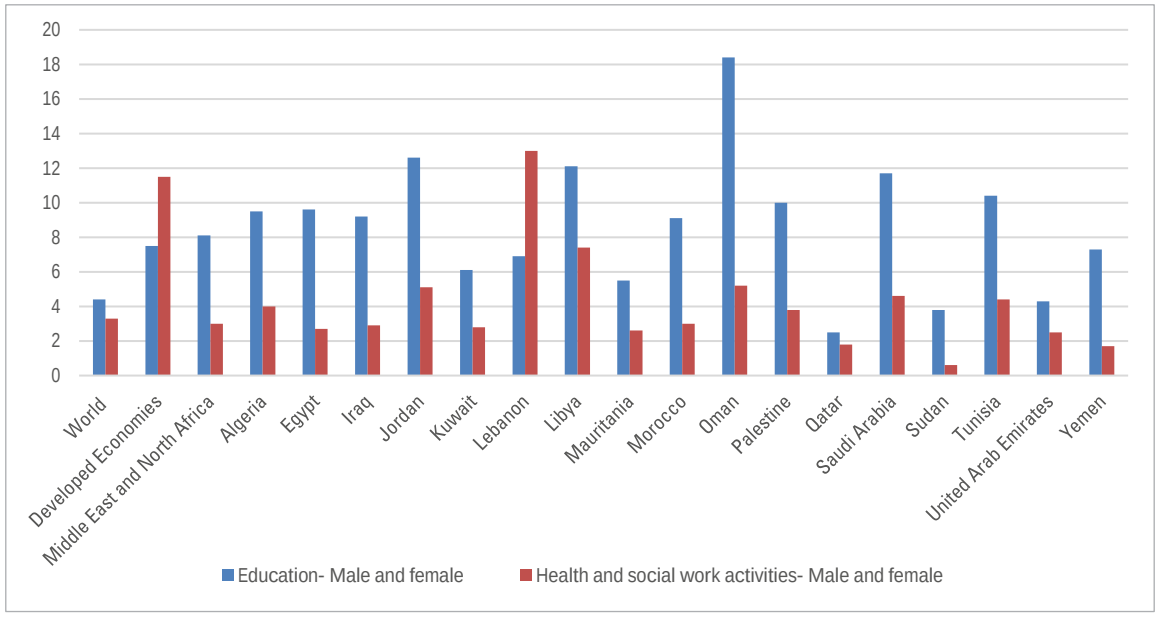
thinking on how to reorder cities, transport systems, energy and housing to dramatically reduce carbon emissions". "[T]technology has a decisive role to play – but so will social innovations that help to change behaviour." Increased diversity of countries and cities "demands innovative ways of organizing schooling, language training and housing to prevent segregation and conflict".[315]

(iii) Social innovations as a public good

Social innovations are particularly needed as a public good when formal social services are underdeveloped. Figure 21 summarizes the percentage of employment in Arab countries in education and health and social work activities, and highlights much lower percentages in Arab countries for the latter category of employment than those of developed countries, with the exception being Lebanon.

Although higher percentages of employment in education (compared to averages in developed countries) have not necessarily led to better educational outcomes, as already discussed, and most likely reflect the quantitative challenge of youth bulge,[316] it is even less likely that much lower employment in health and social work activities reflects much higher efficiencies. There is great potential for social innovation to improve the situation of health and social services qualitatively and quantitatively within Arab countries, particularly among those facing conflict situations and are the sources and/or recipients of displaced populations.

Figure 21. Employment in education and health and social work activities (per cent), Arab countries, 2013



Source: Available from http://www.ilo.org/legacy/english/weso/2015/WESO_jan2015.xlsx.
Note: In ILO regional sub-divisions, Middle East and North Africa include all listed Arab countries, plus Iran with Mauritania included under Sub Saharan Africa. The source does not provide data for Bahrain and Syria.

(b) Supporting social innovation

Implementing social innovation itself requires innovative and open approaches. Successful social innovators have skills that make them good talkers and good listeners, able to understand the needs of a variety of people. Empathic skills are crucial for the successful implementation of social innovation projects. Box 33 highlights some practical tips for implementing social innovation projects, particularly by leveraging modern social media and internet platforms.

Box 33. Practical tips for developing social innovation projects

The challenge: Start describing the project in broader terms and gradually move on to more specific details.

Narrative: Describe your challenge as if you are telling a story.

Ideas equal solutions: Not all ideas solve problems but many do.

Achievement: Describe your desired outcome. Think in terms of a procedural or cultural goal rather than outlining what a successful solution might look like.

Incentives: Boosting participation and motivation dictates how much knowledge you want participants to share.

Potential resistance: You will never be able to predict everything in advance, but studying other projects that have used similar methods could show you how to avoid resistance.

Participants: Choose. Think big if you work online as there is no limit for participants.

Source: Kreutz, n.d.

However, social innovations will not thrive and expand without a supportive environment. Some countries have begun to widen their strategies for innovation beyond science and technology to encompass services and social organizations. Those strategies require systemic conditions to prevent social innovation measures from remaining pilot studies only, and to help them enter production, gain market share, and scale up.[317]

Such efforts might involve the following:

- Leadership and structures suited to innovation. As social innovation is often bottom-up, a great role is played by leaders in the field (local or national government, agencies on the ground) to support such innovations and support their scaling up;
- Finance focused on innovation. The previous section discussed the many mechanisms though which governments, VC and other forms of financing can support R&D in firms and innovative start-ups. Such mechanisms should be extended to encompass social innovations as well;
- Public policy frameworks that encourage innovation. There are no established public policy frameworks to support social innovation, but good practices from the experience of some developed countries as outlined in box 34 might serve as guide for Arab countries.

(c) Competitions and awards for promoting social innovation

Support mechanisms, including accelerators dedicated to social innovation, whether at the sector level (education, health, and e-government), city or region level, or global virtual level (the openIDEO, for example, as mentioned above) might serve to support social innovators, plus provide funding and scaling up for high-growth potential innovations.

Box 34. Public policy to support social innovation

In Finland, the government's main advisory body on science, innovation and research (SITRA) recommended that innovativeness should be made a criterion for competitive bidding associated with public procurement. The body also recommended that a proportion of funding for departments be clearly designated for innovation and development activities, interpreted widely to include innovation in services.

In the UK, various methods have been used to support social innovation, among them:

- More developed markets for social solutions, including outcome-based funding models (which reward organizations for reducing recidivism, keeping people in jobs, or improving the experience of chronic disease sufferers) and greater competition and contestability;
- Decentralization of power and money, allowing communities greater freedom to shape their own solutions;
- Zones in the main public services allowing spaces for public, private and non-profit organizations to break nationally set rules and test out new ideas.

Source: Mulgan and others, 2007, p. 38.

Social innovation awards launched by governments, international organizations, and/or the private sector also play an important role. For example, the MIT Enterprise Forum in the Arab Region launched an "Innovate for Refugees" competition, seeking proposals for technology projects that serve the needs of refugees living in hardship, including health care, food, shelter, security, education and energy. Winning teams are rewarded with cash prizes and mentorship to implement their projects successfully. Arab private sector companies finance the competition with the support of United Nations agencies (UNHCR and UNICEF). Finalist teams include Evaptainers, a Moroccan project for a mobile and modular evaporative cooler, ideal for low-income and off-grid areas, that can triple or quadruple the shelf life of most produce. Another finalist is ProjectZayed from the United Arab Emirates. The project provides a remote educational platform designed to educate less fortunate children using Cloud-based services and mobility solutions. It is hoped that such initiatives will develop further in the region and go beyond the narrow scope of CSR. International organizations working in the region, as well as Arab governments and Arab firms, could enlarge such contests to develop services for refugees and displaced populations in a true win-win partnership where the social bottom-line of the former two could meet the financial one of the latter, leading to larger scale deployment of such innovations.

4. Conclusion

This study presented a framework for Arab countries to draw inspiration and guidance during their formulation or update of innovation policies, strategies or plans.

Prior to presenting the framework itself, the study discussed what innovation, NIS and innovation policies entail, highlighting the need for a systems approach that addresses core issues plus the surrounding framework conditions for an innovation system to thrive and provide socioeconomic benefits.

Our discussion of the experience in developed countries highlighted policy priorities and approaches that, despite often very different circumstances, are useful in order to draw lessons from established best practices. Next, lessons drawn from Asian countries and examples of countries that have managed successful catch ups with developed countries were reviewed. That discussion shed an interesting light regarding the role of government and the control of trade and FDI in terms of catch-up success. Those countries managed to build what Joseph Stiglitz (2015) termed "learning societies", based on the lessons of modern economic growth stemming from the industrial revolution of the nineteenth century. Arab countries should ponder the lessons from Asian countries by rethinking the role of the state and by adopting a more critical view of one-size-fits-all prescriptions for full and unfettered openness to trade and investment that allegedly "automatically" lead to effective technology transfer and appropriation.

In the final part of chapter 1, some innovation policies in selected Arab countries were summarized. Some of those policies (and their related strategies and plans) were ambitious, particularly when devised by high-income GCC countries. All policies reflected a sincere political vision to leverage STI in the service of socioeconomic development. Equally, those policies more or less addressed the main established components required to build an effective NIS. It is too early to draw conclusions regarding the effectiveness of the policies, however, because many are still at an early stage. But some caution should be raised: (1) Some objectives seem overly ambitious and disconnected from the underlying core and framework conditions of the NIS (2) Some countries have devised numerous, overlapping plans and strategies that are not consistent or well coordinated.

Chapter 2 dealt with the core subject of the current document, providing a framework for the formulation of innovation policies in Arab countries. The first part addressed the innovation policy vision, which should elucidate the what for, by which means and by whom questions, plus set well-defined targets with measurable indicators. A clearly defined policy vision should be supported by a steering committee, generally chaired by a member of the high-level authority that endorsed the vision. The steering committee needs to be able to provide arbitration should there be conflict or differences of interpretation among stakeholders and/or administrators.

Beyond methodology issues, and each country-specific situation, chapter 2 suggested high-level priorities for innovation policies in Arab countries. Those were drawn from analysis of major socioeconomic concerns and shortcomings, plus issues associated with the status of innovation common to many Arab countries.

The second part of chapter 2 addressed a variety of policy measures that aimed to consolidate the main components of the NIS in relation to education, R&D, framework conditions, and support for innovators. Recommendations for innovation policy measures were made for Arab countries based on best practices achieved elsewhere. The final part of chapter 2 addressed the important issues of M&E innovation policies and indicators/indexes in terms of national, regional and international benchmarking. While M&E and benchmarking have different purposes, they share the need for reliable innovation-related indicator data. The situation of Arab countries is far from ideal in terms of data collection, particularly in relation to innovation output indicators, and global rank among countries in relation to their respective GDP levels. The Innovation Scoreboard for the MENA region, the discussion of which concluded chapter 2, might pave the way for better data collection within Arab countries, which most likely would lead to increased innovation success.

Chapter 3 addressed the impact of the 2030 Agenda for Sustainable Development and its associated SDGs on innovation policies. Put simply: Can we continue with "business as usual" in implementing innovation policies, particularly in the difficult context of Arab countries, given that social and environmental concerns need to be considered as well as economic ones? The answer is: No. Innovation policies in Arab countries should be adapted to address burning social and environmental issues, particularly those highlighted in the first Arab Sustainable Development Report. Youth employment, climate change and social innovation should be prioritized.

Asian countries that managed to catch up and reach similar levels of industrial development as Western Europe and the United States did not necessarily share the same philosophical and cultural values of the West. However, Asian countries seem to have benefited from favourable sociopolitical environments that enabled them to adopt similar scientific attitudes and methods. The Arab region, although closer to the West geographically, does not necessarily benefit from the same favourable political conditions. In addition, the Arab region lost valuable time in unproductive arguing between polarizing attitudes of outright opposition or near identification with the West's values,[318] arguments that still prevail.

The Arab region needs a new social contract between Governments and their citizens if STI policies are to be successful in improving education outcomes, linking R&D with socioeconomic needs, supporting entrepreneurship, letting a dynamic private sector thrive and creating employment opportunities. The region would also benefit hugely from integration among its countries,[319] which could strengthen its human, material and cultural capital. Leveraging STI to deepen regional integration would bring concrete solutions to the tremendous development and environmental challenges faced by Arab countries.

Annex

Table A.1 The Global Innovation Index composition

1. Institutions	**3 Infrastructure**
1.1 Political environment	***3.1 Information and communication technologies (ICTs)***
1.1.1 Political stability*	3.1.1 ICT access*
1.1.2 Government effectiveness*	3.1.2 ICT use*
1.2 Regulatory environment	3.1.3 Government's online service*
1.2.1 Regulatory quality*	3.1.4 E-participation*
1.2.2 Rule of law*	***3.2 General infrastructure***
1.2.3 Cost of redundancy dismissal, salary weeks	3.2.1 Electricity output, kWh/cap
1.3 Business environment	3.2.1 Electricity output, kWh/cap
1.3.1 Ease of starting a business*	3.2.3 Gross capital formation, per cent GDP
1.3.2 Ease of resolving insolvency*	***3.3 Ecological sustainability***
1.3.3 Ease of paying taxes*	3.3.1 GDP/unit of energy use, 2005 PPP$/kg oil equivalent
2 Human capital and research	3.3.2 Environmental performance*
2.1 Education	3.3.3 ISO 14001 environmental certificates/billion PPP& GDP
2.1.1 Expenditure on education, per cent GDP	**4 Market sophistication**
2.1.2 Government expenditure on education/pupil, secondary	***4.1 Credit***
2.1.3 School life expectancy, years	4.1.1 Ease of getting credit*
2.1.4 PISA scales in reading, maths & science	4.1.2 Domestic credit to private sector, per cent GDP
2.1.5 Pupil-teacher ratio, secondary	4.1.3 Microfinance gross loans, per cent GDP
2.2 Tertiary education	***4.2 Investment***
2.2.1 Tertiary enrolment, per cent gross	4.2.1 Ease of protecting investors*
2.2.2 Graduates in science and engineering, per cent	4.2.2 Market capitalization, per cent GDP
2.2.3 Tertiary inbound mobility, per cent	4.2.3 Total value of stocks traded, per cent GDP
2.3 Research and development (R&D)	4.2.4 Venture capital deals/trillion PPP$ GDP
2.3.1 Researchers, FTE/million population	***4.3 Trade and competition***
2.3.2 Gross expenditure on R&D, per cent GDP	4.3.1 Applied tariff rate, weighted mean, per cent
2.3.3 Global R&D companies, average expenditure Top 3, million $US	4.3.2 Intensity of local competition†
2.3.4 QS university ranking, average score Top 3*	4.3.3 Domestic market scale, billion PPP$

5 Business sophistication	6.2.1 Growth rate of PPP$ GDP/worker, per cent
5.1 Knowledge workers	6.2.2 New businesses/thousand population 15-64
5.1.1 Knowledge-intensive employment, per cent	6.2.3 Computer software spending, per cent GDP
5.1.2 Firms offering formal training, per cent firms	6.2.4 ISO 9001 quality certificates/billion PPP$ GDP
5.1.3 GERD performed by business, per cent GDP	6.2.5 High- & medium-high-tech manufactures, per cent
5.1.4 GERD financed by business, per cent	***6.3 Knowledge diffusion***
5.1.5 Females employed with advanced degrees, per cent total employment	6.3.1 Royalty and licence fees receipts, per cent total trade
5.2 Innovation linkages	6.3.2 High-tech exports less re-exports, per cent
5.2.1 University/industry research collaboration†	6.3.3 Communications, computer and information services exports, per cent total trade
5.2.2 State of cluster development†	6.3.4 FDI net outflows, per cent GDP
5.2.3 GERD financed by abroad, per cent	**7 Creative outputs**
5.2.4 JV-strategic alliance deals/trillion PPP$ GDP	***7.1 Intangible assets***
5.2.5 Patent families filed in 3+ offices/billion PPP$ GDP	7.1.1 Domestic residents trademark applications/billion PPP$ GDP
5.3 Knowledge absorption	7.1.2 Madrid trademark applications/billion PPP$ GDP
5.3.1 Royalty and license fees payments, per cent total trade	7.1.3 ICTs & business model creation†
5.3.2 High-tech imports less re-imports, per cent	7.1.4 ICTs & organizational model creation†
5.3.3 ICT services imports, per cent total trade	***7.2 Creative goods and services***
5.3.4 FDI net inflows, per cent GDP	7.2.1 Cultural and creative services expenditure, per cent total trade
5.3.5 Research talent, per cent in business enterprises	7.2.2 National feature films/million population 15-69
6 Knowledge and technology outputs	7.2.3 Global entertainment and media output/thousand population 15-69*
6.1 Knowledge creation	7.2.4 Printing and publishing manufactures, per cent
6.1.1 Domestic residents patent applications/billion PPP$ GDP	7.2.5 Creative goods exports, per cent
6.1.2 PCT resident patent applications/billion PPP$ GDP	***7.3 Online creativity***
6.1.3 Domestic residents utility model applications/billion PPP$ GDP	7.3.1 Generic TLDs/thousand population 15-69
6.1.4 Scientific and technical articles/billion PPP$ GDP	7.3.2 Country-code TLDs/thousand population15-69
6.1.5 Citable documents H index*	7.3.3 Wikipedia monthly edits/million population 15-69
6.2 Knowledge impact	7.3.4 Video uploads on YouTube/population 15-69

Source: INSEAD, 2016.
Notes: *: composite index indicator. †: opinion survey indicator.

Table A.2 The SDGs

Goal 1. End poverty in all its forms everywhere
Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
Goal 3. Ensure healthy lives and promote well-being for all at all ages
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5. Achieve gender equality, empowering all women and girls
Goal 6. Ensure availability and sustainable management of water and sanitation for all
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10. Reduce inequality within and among countries
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12. Ensure sustainable consumption and production patterns
Goal 13. Take urgent action to combat climate change and its impacts*
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all, and build effective, accountable and inclusive institutions at all levels
Goal17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Source: A/RES/70/1.
Note: * The United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.

Table A.3 Measures to develop and consolidate the VET system[a]

Updating curriculum and pedagogy. One key measure to develop a national VET system is to closely adjust curriculum and pedagogy, balancing practical skills pedagogy with theoretical skills and competencies to "foster adaptability and absorption of new knowledge", particularly in a context of rapidly evolving technologies and a knowledge-based economy. Three pedagogical tools appear promising: "work placement with an entrepreneur as part of the school program, establishment of student enterprises, and compulsory development of a business plan that includes planning specified production, assessing the market, and writing a cost and financing plan".
Developing Dual Modes of Training. "Dual systems link the school and the firm as the two places of learning and focus on work-based learning to acquire vocational competencies. The German dual system can serve as the archetype." Although the system has shown its effectiveness[b], it is not easy to implement, because: "[F]irst and foremost, local enterprises must be willing and able to provide training. Second, the system requires careful organization, in-company practical training, and supervision." Some major Arab firms might be able to play such a role, but not the majority of Arab SMEs. Arab countries might consider implementing the system as a first step with such firms, if only to provide a role model for other firms.

Implementing National Qualification Frameworks. A National Qualification Framework (NQF) adopts an output-based approach by assuming that "individuals bear responsibility for training". That approach started in English-speaking developed countries, including Australia, New Zealand and the UK[c], but is now being adopted by other countries, including Turkey[d]. "[A NQF] can lead to cost-effective training by focusing on outcomes regardless of how the skills are obtained, whether in classrooms or out of school. NQFs stress the competencies acquired, not the avenues or the institutions that teach the skills. NQFs can also promote job mobility and therefore increase labour market efficiency."

Developing Competence-Based Training. That could be a more realistic, or shorter term, measure to implement by developing countries than NQF. Two developing African countries, Tanzania and Zambia, among others, have introduced competence-based training. In a similar, although, simpler way than NQF, competence-based training "shifts the emphasis from what courses a trainee has taken and when to what the trainee can do". Nonetheless, even competence-based training "is complex and includes the development of standards-based on-the-job analysis" of skills and "puts pressure on instructors and centre management to deliver these skills". The Tanzanian experience, for example, showed that it would be useful "to publicize the concepts widely so that they are understood by enterprises, parents, and trainees".

[a] The list of measures discussed here is taken from World Bank, 2010, pp. 184-186.
[b] The sought-after Made in Germany stamp from high-tech products to simple pencils is one of the results of the system.
[c] The concept is closely related to that of chartered professionals long prevailing in English-speaking and Commonwealth countries, as well as in the United States.
[d] OECD, 2014b, p. 248. Turkey implemented a NQF in 2014.

Table A.4 GERD as a percentage of GDP and breakdown by financing source, Arab countries, latest available year

Country	GERD per cent GDP	per cent financed by business enterprises	per cent financed by government	per cent financed by higher education	per cent financed by abroad	per cent financed unspecified source
Algeria (2005)	0.07	-	-	-	-	-
Bahrain (2014)	0.1	21.8	41.5	21.2	12.4	1.1
Egypt (2014)	0.68	8.1	91.7	-	0.2	-
Iraq (2014)	0.04	1.8	98	-	-	-
Jordan (2008)	0.43	-	-	-	-	-
Kuwait (2013)	0.3	1.4	92.5	0.17	1.2	-
Morocco (2010)	0.71	29.9	23.1	45.3	1.7	-
Oman (2013)	0.17	24.5	48.6	24.4	0.01	2.3
Qatar (2012)	0.47	24.2	31.2	36.6	2.4	-
Saudi Arabia (2014)	0.07	-	-	-	-	-
Sudan (2005)	0.3	-	-	-	-	
Tunisia (2014)	0.64	18.5	77.5	-	4	-
UAE (2014)	0.7	74.3	25.7	-	-	-

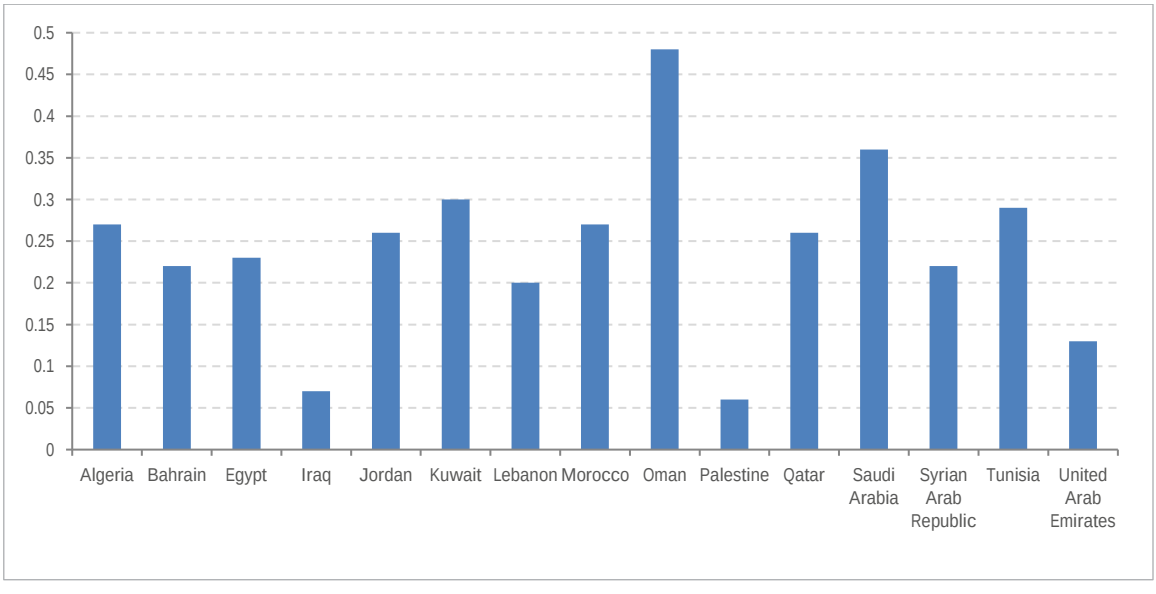
Source: UNESCO, 2016.
Note: -: indicates zero or not available (depending on context).

Table A.5 Researchers (FTE) per million inhabitants and breakdown by sector, Arab countries, latest available year

Country	Researchers (FTE) per million inhabitants	per cent in business enterprises	per cent in government	per cent in higher education	per cent in private non-profit
Algeria (2005)	168	-	13	87	-
Bahrain (2014)	362	0.4	7.7	91	-
Egypt (2014)	682	5.5	36.2	58.2	-
Iraq (2014)	68	2.1	29	69	-
Kuwait (2012)	128	-	100	-	-
Morocco (2012)	857	9.3	3.4	87.2	-
Oman (2012)	170	20.2	45.6	34.2	-
Palestine (2010)	322	-	29.4	55.8	14.7
Qatar (2012)	597	28	33.4	38.6	-
Tunisia (2014)	1,803	3.6	6.6	89.7	-

Source: UNESCO, 2016.
Notes: -: indicates zero or negligible (depending on context).

Figure A.1 Medium-tech and share of high-tech industry value added in total value added, Arab countries, 2013 (percentage)



Source: http://unstats.un.org/sdgs/indicators/database/?indicator=9.b.1 on the basis of data from the United Nations Industrial Development Organization (UNIDO).

Table A.6 Crucial emerging technologies for the SDGs until 2030 (Scientific Community Survey)

Technology cluster	Crucial emerging technology for the SDGs until 2030	Opportunities in all SDG areas, including:	Potential threats, including:
Bio-tech	Biotechnology, genomics, and proteomics; gene-editing technologies and custom-designed DNA sequence; genetically modified organisms (GMO); stem cells and human engineering; bio-catalysis; synthetic biology; sustainable agriculture tech.	Food crops, human health, pharmaceuticals, materials, environment, fuels.	Military use; irreversible changes to health and environment.
Digital-tech	Big Data technologies; Internet of Things; 5G mobile phones; 3-D printing and manufacturing; Cloud computing platforms; open data technology; free and open-source; Massive open online courses; micro-simulation; E-distribution; systems combining radio, mobile phone, satellite, GIS, and remote sensing data; data sharing technologies; including citizen science-enabling technologies; social media technologies; mobile Apps to promote public engagement and behavioural change; pre-paid system of electricity use and automatic meter reading; digital monitoring technologies; digital security technology.	Development, employment, manufacturing, agriculture, health, cities, finance, absolute "decoupling", governance, participation, education, citizen science, environmental monitoring, resource efficiency, global data sharing, social networking and collaboration.	Unequal benefits, job losses, skills gaps, social impacts, poor people priced out; global value chain disruption; concerns about privacy, freedom and development; data fraud, theft, cyber-attacks.
Nano-tech	Nano-imprint lithography; nano technology applications for decentralized water and wastewater treatment, desalination, and solar energy (nanomaterial solar cells); promising organic and inorganic nanomaterials, e.g., graphene, carbon nanotubes, carbon nano-dots and conducting polymers graphene, perovskites, Iron, cobalt and nickel nanoparticles, and many others.	Energy, water, chemical, electronics, medical and pharmaceutical industries; high efficiencies; resources saving; CO_2 mitigation.	Human health (toxicity), environmental impact (nanowaste).
Neuro-tech	Digital automation, including autonomous vehicles (driverless cars and drones), IBM Watson, e-discovery platforms for legal practice, personalization algorithms, artificial intelligence, speech recognition, robotics; smart technologies; cognitive computing; computational models of the human brain; meso-science powered virtual reality.	Health, safety, security (e.g., electricity theft), higher efficiency, resource saving, new types of jobs, manufacturing, education.	Unequal benefits, de-skilling, job losses and polarization, widening technology gaps, military use, conflics.
Green-tech	**Circular economy:** Technologies for remanufacturing, technologies for product life-cycle extension such as re-use and refurbishment, and technologies for recycling; multifunctional infrastructures; technologies for integration of centralized systems and decentralized systems for services provision; CO_2 mitigation technologies; low energy and emission technology.	Environment, climate, biodiversity, sustainable production and consumption, renewable energy, materials and resources; clean air and water; energy, water and food security; development,	New inequalities, job losses, concerns about privacy, freedom and development.

Technology cluster	Crucial emerging technology for the SDGs until 2030	Opportunities in all SDG areas, including:	Potential threats, including:
	Energy: Modern cookstoves with emissions comparable to those of LPG stove; Deployment of off-grid electricity systems (and perhaps direct current); mini-grids based on intermittent renewables with storage; advances in battery technology; heat pumps for space heating, heat and power storage and electric mobility (in interaction with off-grid electricity; smart grids; natural gas technologies; new ways of electrification; desalination (reverse osmosis); small and medium sized nuclear reactors; biofuel supply chains; solar photovoltaic, wind and micro-hydro technologies; salinity gradient power technology; water saving cooling technology; LED lamps; advanced metering. **Transport:** Integrated public transport infrastructure, electric vehicles (e-car and e-bike), hydrogen-fueled vehicles and supply infrastructures. **Water:** Mobile water treatment technology, waste water technology, advanced metering infrastructure. **Buildings:** Sustainable building technology, passive housing. **Agriculture:** Sustainable agriculture technology; Innovations of bio-based products and processing, low input processing and storage technologies; horticulture techniques; irrigation technologies; bio-organometallics which increase the efficiency of biomimetic analogs of nitrogenase. **Other:** Marine Vibroseis, artificial photosynthesis.	employment; health; equality.	
Other	Assistive technologies for people with disabilities; alternative social technologies; fabrication laboratories; radical medical innovation; geo-engineering technologies (e.g. for iron fertilization of oceans); new mining/extraction technologies (e.g., shale gas, in oceans, polar, glacier zones); deep sea mining technologies.	Inclusion, development, health, environment, climate change mitigation, resource availability.	Pollution, inequalities, conflict.

Source: DESA, 2016a.

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Endnotes

Executive summary

1 Innovation is mentioned explicitly in Goal 9 as well as targets 9.4, 9.5 and 9.b. In Goal 8, two targets explicitly mention innovation: 8.2 and 8.3. Innovation is also linked to other goals, especially those containing targets on STI, which are: Goal 1 on combating poverty, Goal 5 on gender equality, Goal 7 on energy technology research and sustainable services, and target 12.a. Finally, Goal 17 has three targets linked to innovation: 17.6, 17.7 and 17.8.

2 United Nations Department of Economic and Social Affairs (DESA), 2016a.

3 Organisation for Economic Co-operation and Development (OECD) and Eurostat, 2005.

4 A/RES/70/1.

5 DESA, 2016a.

6 Economic and Social Commission for Asia and the Pacific, ESCAP, 2016, p. 5.

Introduction

7 OECD, 2014b, p. 16.

Chapter 1

8 Further discussions on the "Cultural Foundations of the Industrial Civilization" (Nef, 2009).

9 Other dramatic advances in biotechnology, nanotechnologies and cognitive sciences, and their convergence with information technologies, could lead to a new industrial revolution (OECD, 2014b).

10 OECD and Eurostat, 2005.

11 Ibid.

12 United Nations Conference on Trade and Development (UNCTAD), 2011; OECD, 1996, pp. 14-15.

13 Although this evolution initially concerned advanced developed economies, the fact that UNCTAD adopted this approach to support developing economies in their implementation of STI policies means at the very least that developing economies cannot 'backtrack' to an older framework, particularly in the context of a globalized economy.

14 Evolutionary economists emphasize the study of endogenous novelty within economic systems, how it emerges, spreads across the economy and, once widely adopted, creates new conditions for the future change of the system itself (UNCTAD, 2011).

15 UNCTAD, 2011.

16 Ibid., p. 8.

17 Ibid.

18 Ibid., pp. 7-8.

19 OECD, 2014b.

20 Ibid., pp. 21-22.

21 UNCTAD, 2011, p. 8.

22 World Bank, 2010, p. 60.

23 Goedhuys and others, 2015, p. 82.

24 UNCTAD, 2011, p. 9.

25 Atkinson, Ezell and Information Technology and Innovation Foundation, ITIF, 2015, p. 90. Assertion made on the basis of a McKinsey study issued in 2010.

26 UNCTAD, 2011, p. 9.

27 Goedhuys and others, 2015, p. 82.

28 OECD, 2014b, pp. 70-71.

29 Atkinson, Ezell and Information Technology and Innovation Foundation (ITIF), 2015, p. 91.

30 World Bank, 2010, p. 11.

31 UNCTAD, 2010, 2011 and 2014.

32 Atkinson, Ezell and ITIF, 2015, p. 96.

33 Ibid.

34 For more information on STI measurement frameworks, see Marine, 2015.

35 Goedhuys and others, 2015, p. 86, note 19.

36 UNCTAD, 2011, p. 9.

37 A value chain comprises all the activities required to take a product from concept, through design and production, to delivery to the consumer. When those activities have to be coordinated across countries, it is called a global value chain (GVC).

38 OECD, 2014b. The most recent survey covered 34 OECD countries and 12 emerging and associate

countries. The innovation policy platform indicates that the questionnaire will become an STI policies database and will incorporate other countries.

39 Country-specific "hot issues" can be found in the STIP database.

40 OECD, 2014b, p. 194.

41 Ibid., p. 195.

42 Ibid., p. 197.

43 Ibid., p. 198.

44 Ibid., p. 199.

45 Ibid., pp. 131-134.

46 Programme for the International Assessment of Adults Competencies (PIAAC); http://www.oecd.org/skills/piaac/.

47 OECD, 2014b, pp. 237-240.

48 Ibid., pp. 236, 238.

49 Ibid., p. 242.

50 OECD, 2014b, p. 244.

51 China's figure should be considered in the light of the fact that many Chinese firms are still state-owned.

52 OECD, 2014b, p. 159.

53 Ibid., pp. 177-178.

54 Ibid., p. 153.

55 OECD, 2014b, pp. 153-155.

56 Ibid., pp. 174-176.

57 Ibid., p. 179.

58 UNCTAD, 2007, p. 51.

59 Gross fixed capital formation (GFCF) measures the value of acquisitions of new or existing fixed assets by the business sector, Governments and 'pure' households (excluding their unincorporated enterprises), less disposals of fixed assets. GFCF is a component of the expenditure on gross domestic product (GDP), and shows something about how much of the new value-added in the economy is invested rather than consumed.

60 OECD, 2013a, p. 29.

61 Achcar, 2013, pp. 65-80.

62 OECD, 2013a, p. 30.

63 TFP, or multifactor productivity, is a variable that accounts for effects in total output growth relative to the growth in traditionally measured inputs of labour and capital.

64 OECD, 2013a, pp. 31-32.

65 UNCTAD, 2007, p. 66.

66 UNCTAD, 1994, pp. 49-76.

67 Ibid., p. 50.

68 UNCTAD, 2007, pp. 60, 66.

69 Sohn, Yong Chang and Song, 2009, p. 29.

70 Ibid.

71 Ibid.

72 Ibid., p. 51.

73 Ibid., p. 54.

74 OECD and World Bank, 2012.

75 Egypt, 2016.

76 مصر، وزارة التعليم العالي والبحث العلمي، 2015.

77 World Bank, 2016.

78 Egypt, 2014.

79 Egypt, Technology, Innovation and Entrepreneurship Center, 2011.

80 Egypt, Ministry of Communications and Information Technology (MCIT), 2016.

81 Egypt, MCIT, 2014.

82 http://inform.gov.jo/en-us/By-Date/Report-Details/ArticleId/247/Jordan-2025 (accessed 15 August 2016).

83 Jordan, Higher Council for Science and Technology, 2013.

84 In August 2016, 1 JOD = $1.41.

85 Jordan, Higher Council for Science and Technology, n.d.

86 Jordan, Ministry of Information and Communications Technology, 2014.

87 Moroccan Investment Development Agency, 2013.

88 UNESCO, 2016.

89 In August 2016, 1 MAD = $0.10.

90 Moroccan Investment Development Agency, 2013.

91 Morocco, Direction de la Recherche scientifique et de l'innovation, 2014.

92 See http://www.courdescomptes.ma/upload/wysiwyg/files/ASSESSMENT%20OF%20%C3%A2%E2%82%AC%C5%93DIGITAL%20MOROCCO%202013%20STRATEGY.pdf.

93 Saudi Arabia, King Abdulaziz City for Science and Technology, 2012.

94 NDPs are available from http://www.mep.gov.sa/en/knowledge-resources/.

95 Saudi Arabia, King Abdulaziz City for Science and Technology, 2012.

96 Agence d'évaluation de la recherche et de l'enseignement supérieur, a public French agency in charge of evaluating research and higher education activities.

97 In August 2016, 1 SAR= $0.27.

98 Saudi Arabia, Ministry of Communications and Information Technology, n.d.

99 United Arab Emirates, Ministry of Cabinet Affairs, 2015.

100 United Arab Emirates, 2015.
101 The indicators and their targets are available from https://www.vision2021.ae/en/national-priority-areas.
102 Available from http://www.uaeinnovates.gov.ae/docs/default-source/pdfs/government-innovation-framework-en.pdf?sfvrsn=2.
103 Hall, 2011.
104 Solow, 1956.
105 Mohnen and Hall, 2013.
106 Cameron, 1998.
107 Mohnen and Hall, 2013.
108 Fernald, 2014.
109 Gerguri and Ramadani, 2010.
110 Capello and Lenzi, 2013.
111 Cameron, 1998.
112 See http://www.alecso.org/en/2016-04-06-07-56-24.html.

Chapter 2

113 The term political should be understood here in its most basic etymological sense as 'relating to common good' whether this relates to a country, region, community, industrial sector or single company.
114 The success stories of Japan and other Asian countries (chapter 1) are good illustrations of this new role of government.
115 A possible objective and its associated indicator could be to have the private sector share of the nation's total R&D (GERD) effort to 50 per cent over after 5 years or have GERD reaching 1 per cent of GDP after 5 years.
116 Hanafi, Arvanitis and Hanafi, 2013.
117 ESCWA, 2014b; Achcar, 2013.
118 OECD, 2014b, pp. 110-123.
119 Marine, 2015.
120 جامعة الدول العربية، 2014.
121 Hanafi, Arvanitis and Hanafi, 2013.
122 ESCWA, 2014b, p. 72.
123 Zahlan, 2012, p. 117.
124 Ibid.
125 UNESCO, 2016.
126 For more information on the Shanghai Ranking of World Universities, see http://www.shanghairanking.com/ARWU2015.html.
127 See http://www.arab-hdr.org/akr.
128 Data from https://esa.un.org/unpd/wpp/ (accessed 15 November 2016).
129 For more information on the impact of climate change on civil unrest, see https://www.unescwa.org/publications/syria-war-five-years.
130 Zahlan, 2012, p. 133.
131 World Bank, 2010.
132 Ibid., p. 171.
133 For more information on PISA, see http://www.oecd.org/pisa.
134 World Bank, 2010, p. 172.
135 Ibid.
136 OECD, 2015a, p. 52.
137 Many of these are methods still used in developing and most Arab countries.
138 The education system, even in advanced developed countries, is known for its inertia due to its size (it is often the largest State administration); changing its course is akin to moving a large tanker vessel: a slow, delicate manoeuvre.
139 World Bank, 2010, p. 183.
140 For VET country profiles for the Arab region, see http://www.unevoc.unesco.org/.
141 For more information see http://ec.europa.eu/eurostat/statistics-explained/index.php/Vocational_education_and_training_ statistics.
142 World Bank, 2010, p. 192; Dumont, 2006.
143 OECD, 2015a, p. 62.
144 Ibid., p. 63.
145 Marine, 2015, pp. 26-27.
146 World Bank, 2010, p. 194.
147 Only 10 Arab countries have available data on FTE researchers in the UIS database.
148 Hanafi, Arvanitis and Hanafi, 2013.
149 Dutta, Lanvin and Wunsch-Vincent, 2015, pp. 105-111. The name is from legislation introduced in the United States in 1980 that provided recipients of federally funded research (universities, public laboratories, SMEs) intellectual property rights over the inventions they developed as a result of the funding. Similar laws were introduced by other countries, among them China recently.
150 OECD, 2015a, p. 101.
151 Ibid., pp. 101-102.
152 Ibid., p. 94.
153 Ibid., pp. 94-95.
154 Ibid., p. 96.
155 Available from http://www.oecd.org/science/sci-tech/38500813.pdf.

156 The following points are edited excerpts from OECD, 2015a, p. 97.
157 Dutta, Lanvin and Wunsch-Vincent, 2015, p. 344. Values given are for 2014 as measured by Thomson Reuters.
158 MENA Private Equity Association, 2015.
159 Ibid.
160 جامعة الدول العربية، 2014، ص 24.
161 Ibid., pp. 26-27.
162 Zahlan, 2012, p. 99.
163 Ibid., pp. 50-51.
164 In OECD terminology BRIICS is an acronym for emerging countries Brazil, Russia, India, Indonesia, China and South Africa.
165 OECD, 2015a, pp. 97-98.
166 World Bank, 2010, p. 108.
167 Imports and exports of goods and services as a percentage of world GDP grew from 12 per cent in 1960 to 30 per cent prior to the financial crisis of 2008 (see http://data.worldbank.org).
168 World Bank, 2010, pp. 109-112.
169 OECD, 2014a.
170 Ibid., pp. 7-8.
171 https://www.oecd.org/mena/competitiveness/OECD%20Study_Amended%20Arab%20League%20Investment%20Agreement%20(English).pdf.
172 Ibid.
173 OECD, 2014a, pp. 11-12.
174 http://www.oecd.org/gov/ethics/public-procurement.htm.
175 World Bank, 2010, p. 126.
176 Ibid.
177 Ibid., p. 127.
178 Ibid., pp. 128-129.
179 Considering an average ratio of 11 per cent of GDP spent in public procurement.
180 Dutta, Lanvin and Wunsch-Vincent, 2016, p. 374. Among the best countries this value reaches high percentage points. In Egypt (2007) and Tunisia (2013) it was at 0.25 per cent and 0.1 per cent, respectively, while other Arab countries have lower values or unavailable data.
181 OECD, 2015a, p. 70.
182 Ibid., p. 71.
183 Ibid., p. 71.
184 World Bank, 2010, p. 118.
185 OECD, 2015a, p. 112.
186 Ibid.
187 Ibid., p. 113.
188 For more information, see https://www.wto.org/english/res_e/publications_e/trips_agree_e.htm.
189 UNCTAD and International Centre for Trade and Sustainable Development (ICTSD), 2003, p. 6.
190 Ibid., p. 4.
191 OECD, 2014b, p. 228.
192 UNCTAD and International Centre for Trade and Sustainable Development (ICTSD), 2003, p. 72.
193 Ibid., p. 66.
194 Ibid., pp. 66-67.
195 World Bank, 2010, p. 85. A knowledge or innovation voucher is a coupon that entitles an SME to a number of free consultancy/research visits to large, knowledge-intensive organizations.
196 Ibid., p. 75.
197 Ibid., p. 77.
198 Ibid., p. 75.
199 For more information on KPIs see http://cmimarseille.org/highlights/regional-workshop-developing-key-performance-indicators-evaluate-science-and-technology.
200 OECD, EU and ETF, 2014, pp. 114-115.
201 Ibid., p. 120.
202 OECD, EU and ETF, 2014, p. 122.
203 Ibid., p. 126, 128. This is compared to Israel's score of 4.
204 World Bank, 2010, p. 91.
205 Ibid., p. 92.
206 OECD, EU and ETF, 2014, p. 135.
207 World Bank, 2010, pp. 93-94.
208 Ibid., p. 98. Although it seems that in some countries like China, such parks, due to their proliferation, are now banned from offering tax incentives.
209 OECD, EU and ETF, 2014, p. 143.
210 World Bank, 2010, p. 98.
211 Ibid., p. 99.
212 جامعة الدول العربية، 2014.
213 OECD, EU and ETF, 2014.
214 OECD, 2015a.
215 http://data.uis.unesco.org/.
216 http://unctadstat.unctad.org/EN/Index.html.
217 http://www.wipo.int/ipstats/en/.
218 http://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.
219 http://www.ilo.org/global/statistics-and-databases/lang--en/index.htm.
220 http://data.worldbank.org/indicator.
221 UNESCO, 2016.

222 Ibid.
223 Efforts for the elaboration of sound methodologies for firm-level innovation surveys started in the 1980s and led to the first edition of the *Oslo Manual* in 1992.
224 UNESCO, 2016. For example, Malaysia's 53.5 per cent (2011) and Turkey's 26.9 per cent (2012).
225 UNESCO, 2015, p. 443.
226 The GII contains an indicator on 'high-tech exports less re-exports as a percentage of total trade' with values as low as 0.1 and 0.3, the United Arab Emirates and Oman, respectively (INSEAD, 2015, p. 257, 293).
227 OECD, 2015d.
228 Ibid., p. 3.
229 The EIS is limited to the European Union and includes 25 indicators; although it establishes a ranking of countries its aim is closer coordination and convergence among European Union countries.
230 The KEI has not been maintained by the World Bank since 2011. Available from http://data.worldbank.org/data-catalog/KEI.
231 https://www.weforum.org/reports/global-competitiveness-report-2014-2015.
232 Dutta, Lanvin and Wunsch-Vincent, 2016.
233 Ibid., p. 32.
234 Arab countries that joined the MENA scoreboard initiative are: Egypt, Iraq, Jordan, Lebanon, Morocco, Oman, Palestine, Qatar and Tunisia.
235 Turkey and Malaysia.
236 https://www.globalinnovationindex.org/.
237 https://knoema.com/atlas/topics/World-Rankings/Knowledge-Economy-Index/Knowledge-Index.
238 https://www.adb.org/publications/creative-productivity-index-analysing-creativity-and-innovation-asia.
239 http://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en.

Chapter 3

240 A/RES/70/1.
241 http://www.un.org/millenniumgoals/.
242 https://sustainabledevelopment.un.org/index.php?page=view&nr=23&type=400.
243 For the WSIS summit (2003 and 2005) documents and their subsequent follow-up process, see http://www.itu.int/wsis.
244 International Telecommunication Union (ITU), 2015.
245 DESA, 2016a.
246 Ibid., p. 42.
247 DESA, 2016a, p. 42.
248 Ibid., pp. 53, pp. 119-124.
249 Ibid., p. 46.
250 A/RES/70/1.
251 Could be similar to what happened in the domain of ICT where, as a follow-up to WSIS 2005, the global Internet Governance Forum (IGF) was established in 2006, and the Arab IGF in 2012 as a complementary forum following the lead of other regions.
252 Arab Forum on Sustainable Development, Amman, May 2016, Available form https://www.unescwa.org/arab-forum-sustainable-development-2016.
253 ESCWA and UNEP, 2015.
254 Ibid., pp. 18-19.
255 ESCAP, 2016, p. 5.
256 Ibid., p. 16.
257 Ibid., p. 53.
258 Mulgan, Townsley and Price, 2016.
259 ESCAP, 2016, p. 75.
260 Mulgan, Townsley and Price, 2016, p. 16.
261 ESCAP, 2016, p. 77.
262 OECD, 2015b, pp. 10-11.
263 Foster and Heeks, 2015, p. 6.
264 For a discussion on Arab countries, see Marine, 2015, pp. 41-42.
265 OECD, 2015b, p. 30.
266 ILO, 2016b.
267 For more information, see http://www.arabyouthsurvey.com/en/findings.
268 The Economist, 2016a.
269 ILO, 2016a.
270 UNESCO, 2015, pp. 430-469.
271 Al Jondi, 2015.
272 United Nations Development Programme (UNDP), 2016.
273 ILO and UNDP, 2012.
274 The ratio of youth/total unemployment is not significantly different in Arab countries compared with other regions (at 2.5-3 value average). It is the underlying total unemployment (11.5 per cent in 2014), among the highest in the world, particularly when compared with lower- and middle-income countries at half this value, which raises problems. http://data.worldbank.org/indicator/SL.UEM.TOTL.ZS?start=2010 (accessed 8 August 2016).
275 ILO and UNDP, 2012, pp. 82-83.
276 Al Jondi, 2015, p. 10.

277 Ibid., p. 11.
278 ILO and UNDP, 2012, pp. 20-21.
279 Ibid., p. 26.
280 DESA, 2016a. In the last United Nations E-Government Survey, five Arab countries (all GCC) rank among the top 50 countries (top Arab country is Bahrain, at 24); in the E-Government Development Index, five countries were ranked between 50 and 100 (out of 193). The survey highlights the role of whole-of-government approach and open government data for the fulfilment of SDGs.
281 ILO and UNDP, 2012, p. 27.
282 World Bank. 2013.
283 TIMSS stands for the Trends in Mathematics and Science Study and is an international assessment framework.
284 ILO and UNDP, 2012, p. 28.
285 UNESCO, 2015, p. 441.
286 Ibid., p. 79.
287 ILO and UNDP, 2012, p. 79.
288 ILO, 2009.
289 ILO and UNDP, 2012, p. 79.
290 Ibid., p. 80.
291 United Nations Environment Programme, Regional Office for West Asia (UNEP/ROWA), 2015, p. 2.
292 Ibid., p. 5.
293 The Economist, 2016b.
294 UNEP/ROWA, 2015, pp. 10-11.
295 OECD, 2014b, p. 143.
296 Ibid.
297 UNEP/ROWA, 2015, p. 13.
298 RICCAR is a joint United Nations-League of Arab States initiative involving 11 implementing partners along with national institutions in the 22 Arab countries. It is coordinated by ESCWA and financially supported by the Swedish International Development Cooperation Agency (SIDA) and the German Federal Ministry for Economic Cooperation and Development (BMZ).
299 Refers to government budget appropriations or outlays for R&D (GBAORD).
300 OECD, 2014b.
301 FCCC/CP/2015/L.9.
302 Interview with Professor Andrew Jordan on Climate Change and Local Innovations by SYKE, 23 March 2015.
303 United Nations Framework Convention on Climate Change (UNFCC), 2016.
304 GebreMichael and Kifle, 2009.
305 https://www.theclimategroup.org/sites/default/files/new_york_case_study_v8.pdf.
306 https://www.uclg.org/en/node/23789.
307 Mulgan and others, 2007, p. 9.
308 Ibid., pp. 13-17.
309 Although "open innovation platform" is related to "open innovation" discussed in Section II, it refers equally to the platform and the submitted and resulting innovative ideas.
310 For more information see https://openideo.com/.
311 A recent compilation is available from http://news.arabnet.me/impact-social-entrepreneurship/ (accessed 19 August 2016).
312 Mulgan and others, 2007.
313 The United States did not introduce a similar system, resulting in an expensive and quintessentially unequal health system that continues to cause controversy.
314 Mulgan and others, 2007, p. 8.
315 Ibid., p. 9.
316 In many Arab countries, the state is the employer of last resort, as has been discussed previously.
317 Mulgan and others, 2007, p. 36.

Chapter 4

318 For a seminal text on the debates dominating Arab intellectual life from the early nineteenth century to the middle of the twentieth century, see Hourani, 1983.
319 On Arab integration, see ESCWA, 2014a.

The aim of this study is to provide decision makers in Arab countries with a framework for the formulation of policies for economic growth and achievement of the 2030 Agenda for Sustainable Development. It takes its inspiration from internationally recognized frameworks, the experience and best practices of developed countries, and the strategies employed by emerging economies to achieve technological and social development comparable to those of advanced countries.

The study looks at how to address innovation challenges in the region and shape related policy to fulfil the Sustainable Development Goals (SDGs). In particular, it explores how innovation policy can be applied to tackle key issues such as youth employment and climate change. In coming years, ESCWA will publish a series of follow-up reports on the role of innovation in specific sectors and in relation to particular SDGs.

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