



Research,
Development and
Innovation Index

Introduction

In the twenty-first century, distinct knowledge gaps still separate developed and developing countries, manifested by disparities in research, development, and innovation, as well as in progress towards achieving knowledge economies and societies. International organizations and research institutions show that this knowledge gap is widening, therefore hindering efforts to achieve sustainable human development.¹

Research and development (R&D) is among the most important drivers of a country's transition to a modern society with a knowledge economy. Notwithstanding its significant role in knowledge production, dissemination, and application, R&D should be accompanied by a complementary shift towards innovation in order to further accelerate a country's progression towards achieving sustainable development.

Countries and regions that aspire to keep pace in the knowledge era must adopt effective policies in research, development and innovation (RDI) based on reliable indicators to identify progress achieved.

The AKI therefore offers a composite index for RDI to support countries in the Arab region in monitoring their efforts and results in this regard. It builds on relevant global practices and examples while taking into account the Arab region's specific institutional, economic and social contexts.

The index makes use of the concepts and definitions provided by the Organisation for Economic Co-operation and Development (OECD) and adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) among other international organizations, whereby R&D is defined as creative work undertaken systematically in order to increase accumulated knowledge – including knowledge of people, culture, and society – and the use of this knowledge to devise new applications.² It adopts the principle of a full research and innovation cycle, aiming to measure "scientific research stages that begin with basic and

applied research and end in the development of a product, a productivity process or a new method in the context of innovative activities."³

Research and development are divided into three broad categories: basic research; applied research; and experimental development. Innovation is the introduction of a new product or a significant improvement to an existing one, whether at the level of the product itself or in terms of methods of production, marketing or organization.^{4,5}

R&D activities contribute to improving performance, reinforcing the knowledge base, and expanding its applications, as they also provide inputs for effecting progress in innovation; yet, the success of RDI systems cannot be achieved in the absence of an appropriate economic, social, and political environment, and suitably supportive ICT and non-ICT infrastructures.

Formulation process and initial structure of the index

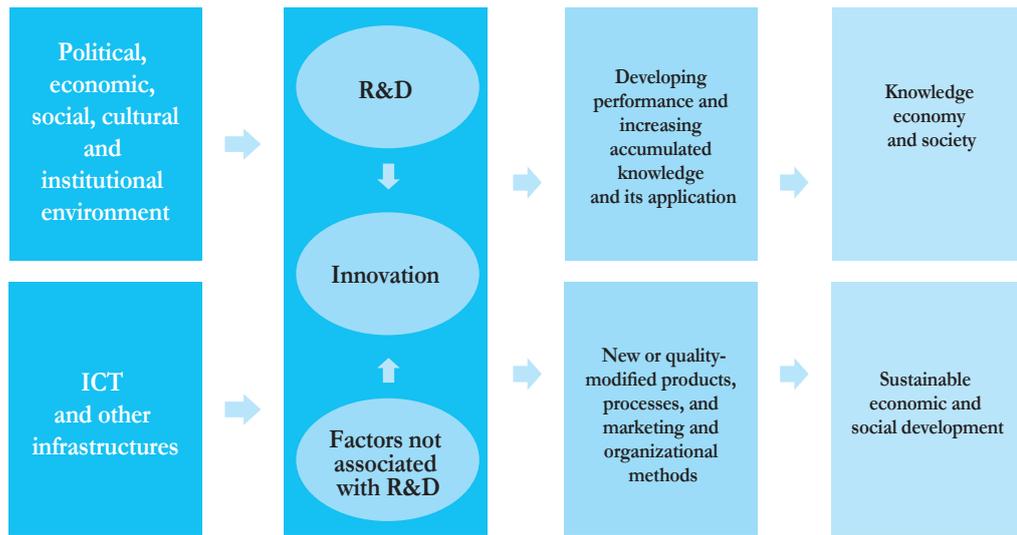
The process of selecting the pillars and variables of the composite RDI Index entailed a series of preparatory phases. Relevant databases and reports were screened to identify currently-adopted indicators (inventory and description phase) that were consequently analysed to determine their type, conceptual–technical approaches, and determinants (analysis and critiquing phase).

Previous studies have sought to measure innovation and R&D separately, taking into consideration their individual contributions to achieving knowledge-based societies. This separation, however, ignores the fact that research and development are among the key inputs of the innovation process.

The AKI therefore adopts a unique approach that formulates a composite index combining these two components in one integrated framework to support Arab knowledge production. This composite index offers the added advantage of helping to avoid any potential repetition or statistical overlap among the measured indicators. It is also designed in a way that takes

Figure 20:

Methodological framework of the RDI Index



into account political, economic, and social variables, as well as appropriate ICT and non-ICT infrastructures.

To validate the RDI Index, individual consultations were organized and a workshop was held with Arab researchers and experts in the fields of research, development and innovation.

Revisions

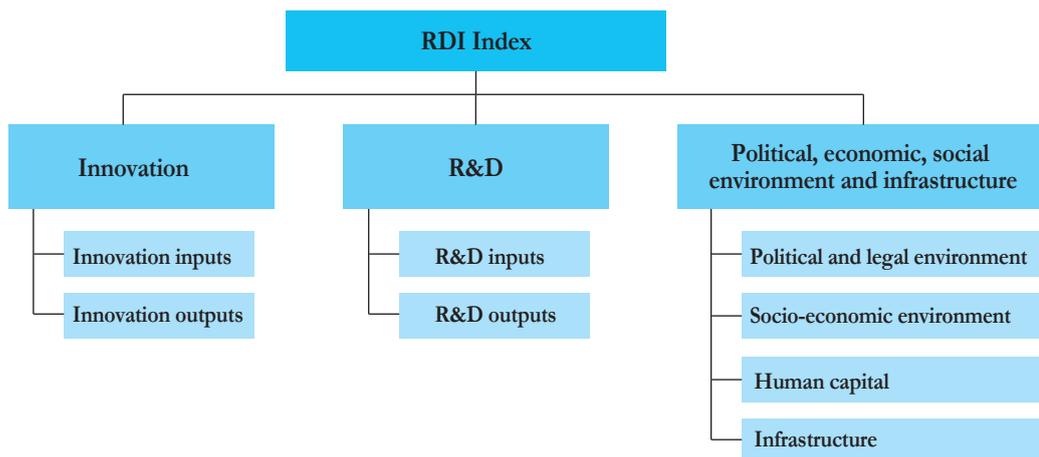
The 2015 RDI Index was reviewed in two respects: the variables related to *R&D inputs* and *outputs* were fined-tuned to capture available

data. Second, the *innovation* pillar was adjusted, taking into account the technological and non-technological elements of innovation in industry and in the services sector. This pillar was supplemented with variables that measure both the enabling environment and infrastructure, and outputs in terms of creative products. The review included the following steps:

- 1) Studying regional and international tools that measure RDI in conjunction with the enabling environment to better reflect the specificities of the Arab Region in the index. Inputs and outputs of the index have also been updated based on the review.

Figure 21:

The structure of the 2015 RDI Index



- 2) Ensuring the availability of data and verifying the conceptual framework, methodological approach, and estimation methods of the index.
- 3) Reviewing the relationship between R&D and innovative production, especially considering that R&D may serve as a main input for innovation, as described above. However, since innovation may also occur outside the R&D system, the index now includes variables for measuring the inputs and outputs of innovation that are external to the goods and services production processes.
- 4) Reviewing the relative weights of the pillars, sub-pillars and variables to ensure they reflect the objective and methodology of the index as well as experts' feedback.

The 2015 RDI Index was based on the vision adopted by the UNESCO and the Oslo Manual developed by the OECD, which maintains that innovation primarily occurs in the production processes of goods and services, as it is then divided into technological innovation (products and production methods that are new or

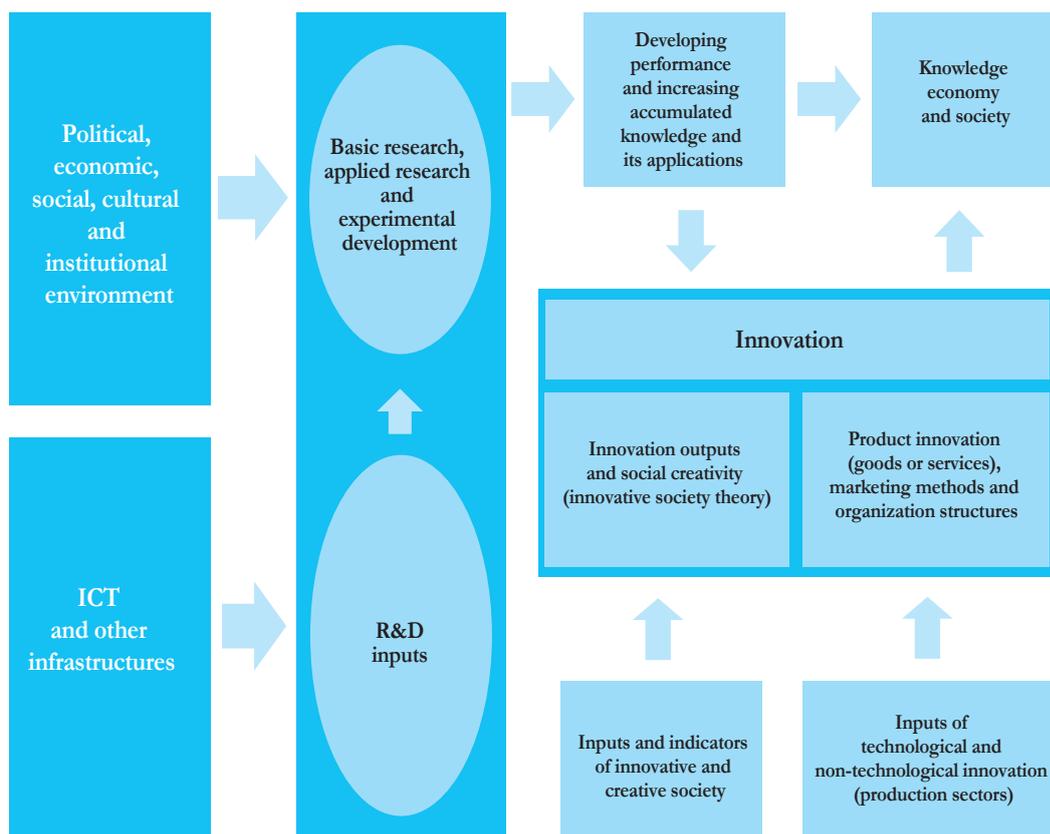
of enhanced quality), and non-technological innovation (new marketing and organization methods).⁶ Despite the validity and accuracy of this methodology, several analytical studies have shown that many innovated products and methods are developed outside national R&D systems in societies characterized by modern technological features. As such, a country's potential in innovation is based on building a creative society capable of introducing change and novelty in addition to developing new products and production processes.⁷ This line of thought is consistent to a large extent with that of the Global Innovation Index, the European Union Innovation Index and the Asian Creative Productivity Index.

The above-mentioned review led to a revision of the methodological framework of the RDI, marked in particular by recognition of the following:

- 1) The contribution of basic research, applied research, and experimental development to improving performance and increasing

Figure 22:

The revised methodological framework of the RDI Index



accumulated knowledge, in terms of both theory and practice, as well as to supporting innovation (within the overall framework of R&D).

- 2) The need to incorporate variables measuring technological and non-technological innovation, as well as others representative of the characteristics of a creative society under the innovation sub-pillars.
- 3) The contribution of the RDI system to building the foundations of a knowledge economy and society and in supporting efforts for attaining sustainable development.
- 4) The dependence of a country's success in RDI on the availability of conducive economic, social, political, cultural and institutional environments, in addition to the existence of a suitable infrastructure.

Based on the conceptual and methodological foundations above, the general structure of the AKI 2015 (R&D, innovation and political, economic and social environment and infrastructure as the three main pillars) was retained, with changes applied to the *innovation* pillar and to the R&D *outputs* sub-pillar as well as the addition of some variables.

Revisions applied to the main structure

Regarding the *research and development* pillar, a new component *institutional framework of scientific research* was added to the R&D *outputs* sub-pillar to better reflect the quality of scientific research institutions and the collaboration between universities and industries in R&D.

Secondly, the *innovation* pillar was modified to comprise two new sub-pillars. The first sub-pillar, *innovation in production*, refers to technological innovation (products and processes) and non-technological innovation (marketing and organizational methods). The second sub-pillar, *social innovation*, includes variables used to measure a society's capacity for innovation and creative production.

Each of the sub-pillars is comprised of two components – *inputs* and *outputs* – that in turn are comprised of several sub-components.

Theoretically, the *inputs* component under the *innovation in production* sub-pillar is composed of

a sub-component related to *innovation activities*, in addition to a second sub-component related to *information sources and institutional cooperation* and a third sub-component related to *financial support*. The *outputs* component, on the other hand, is divided into *technological* and *non-technological innovation* sub-components defined by variables representing innovative products, production and marketing methods, in addition to the general influence of innovation on the system of production and the factors hindering innovation in the production process.

On a practical level, the absence of data related to these two components culminated in a failed statistical analysis, which consequently led to the total disablement of the *innovation in production* sub-pillar.

The inputs of the *social innovation* sub-pillar are defined by: the knowledge base and competition rules that characterize the commodity and services markets; private and public sector business environments that are favourable to innovation; and by other factors such as total spending on computer software and exports in cultural and creative services. The outputs of this sub-pillar comprise the *social impact of innovation*, *knowledge dissemination*, and *creative outputs in the fields of culture, media, and entertainment* sub-components.

The relative weights distributed under the R&D *outputs* sub-pillar were modified after the addition of the component representing the *quality of the R&D institutional framework*. The two components, *scientific publishing* and *patents*, were assigned a relative weight of 35 percent each. The *institutional framework of scientific research* component was allocated a relative weight of 20 percent. Whereas the fourth component, *balance of payments for ICT products*, was reduced to a relative weight of 10 percent.

As for the *innovation* pillar, theoretically speaking, its relative weight (30 percent of the RDI Index total relative weight) is meant to be equally distributed between its two sub-pillars: *innovation in production* and *social innovation*. However, due to the lack of data in relation to *innovation in production* in the Arab countries at this stage, the *social innovation* sub-pillar will be solely allocated the total relative weight of the *innovation* pillar.

Table 6:**Changes applied to variables in the 2015 RDI Index[†]**

Variable	Modification
Research and development pillar	
GERD by type of activity (basic research, applied research, experimental development)	Replaced*
GERD by source of funds(%)	Replaced*
Educational attainment: at least master's or equivalent (SCED 7 or higher), population 25+ years, both sexes	Added
Quality of scientific research institutions	Added
University-industry collaboration in R&D	Added
PCT patents, applications/million population	Added
Innovation pillar	
DTF score for getting credit (0-100)	Added
DTF score for protecting minority investors (0-100)	Added
Stocks traded, total value (% of GDP)	Added
Tariff rate, applied, weighted mean, all products (%)	Added
Trade (% of GDP)	Added
Intensity of local competition	Added
GERD financed by abroad (%)	Added
State of cluster development	Added
High-tech net imports (% of total trade)	Added
ICT services imports (% of total trade)	Added
Foreign direct investment, net inflows (% of GDP)	Added
Number of trademark applications issued to residents by the national office (per billion PPP\$ GDP)	Replaced*
ICT services exports (% total trade)	Added
Intellectual property protection	Added
Enabling environment and infrastructure pillar	
Employment in knowledge-intensive services (% of workforce)	Moved**
Domestic credit to private sector (% of GDP)	Moved**
GERD financed by business enterprises as a percent of GDP	Moved**
Expenditure on education as % of total government expenditure (%)	Replaced*

* The variable has been replaced with another one. For more information, refer Table A6 in the Annex.

** The variable has been moved to another pillar in the index. For more information, refer to Table A6 in the Annex.

[†] The names of the pillars have been updated to include changes resulting from the 2016 revisions.

The relative weights of the *inputs* and *outputs* within social innovation were assigned in accordance with the objective of the index and based on consultations carried out with innovation experts.

Table A6 in the Annex shows all details on the redistribution of weights for both pillars.

Revisions applied to the variables

New variables were incorporated in the *research and development* pillar. A variable, *GERD performed by government as a percentage of GDP* was added under the *R&D inputs* sub-pillar, given the importance of governments' support for this sector in Arab countries. Another variable,

educational attainment of at least master's or equivalent for population of 25 years and above, was added under the same sub-pillar to stress the role of human resources in improving R&D. Three variables were added to reflect the institutional and organizational framework of research under the R&D outputs: These include *quality of scientific research institutions, university-industry collaboration in R&D, and applications for PCT patents.*

The *innovation* pillar underwent a significant structural revision this year. A list of new variables were added to the inputs of its *social innovation* sub-pillar. These include: *domestic credit to private sector as a percentage of GDP, DTF score for getting credit, DTF score for protecting minority investors, total value of stocks traded, tariff rate applied on all products, trade as a percentage of GDP, intensity of local competition, knowledge-intensive jobs as percentage of workforce, GERD financed by abroad, state of cluster development, high-tech net imports as a percentage of total trade, ICT services imports as a percentage of total trade, net inflows of foreign direct investment as a percentage of GDP, and finally GERD performed by business enterprise as a percentage of GDP.*

The *outputs* of the *social innovation* sub-pillar include the following new variables: *annual percentage of GDP per capita growth, medium and high-tech MVA share in total manufacturing, ICT services exports as a percentage of total trade, and intellectual property protection.*

Three variables in the 2015 Index were divided into ten new ones. The new variables are: *GERD for basic research, GERD for applied research, GERD for experimental development, GERD financed by business enterprise, GERD financed by government, GERD financed by higher education, GERD financed by private non-profit, GERD financed by not specified source, expenditure on tertiary education as percentage of government expenditure on education, and government expenditure on tertiary education as percentage of GDP.*

The changes made to the variables of the 2015 AKI RDI Index are displayed in Table 6.

Revised structure (2016 version)

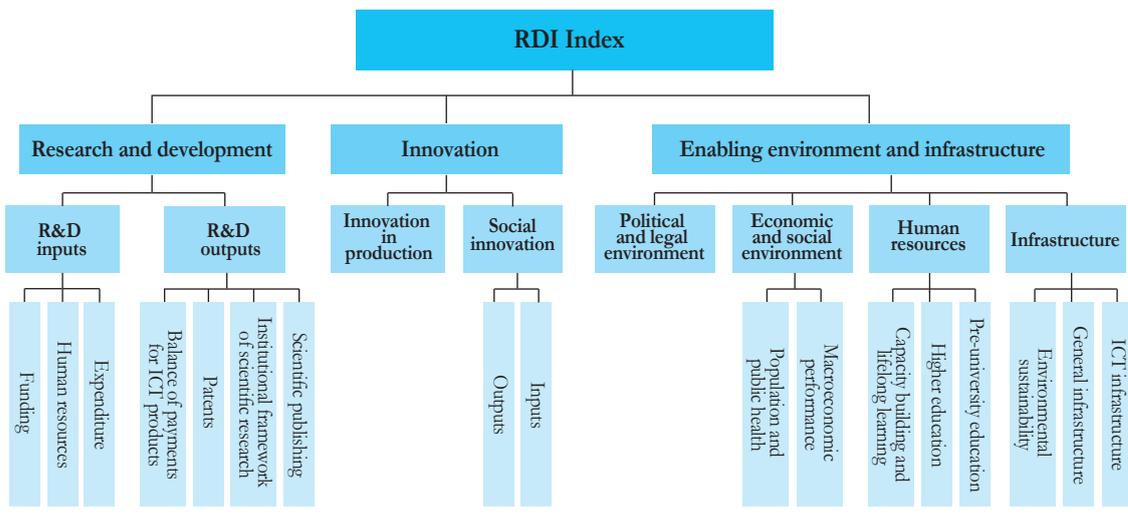
Figure 23 represents the structure of the RDI Index 2016.

Results

The results of the RDI Index reveal a general low performance by the Arab countries in this sector. Out of 22 countries, only seven (Bahrain, Kuwait, Lebanon, Qatar, Saudi Arabia, Tunisia and the United Arab Emirates) scored 50 and above. The highest score was that of the United Arab Emirates (68.53). For the remaining countries, the scores varied under 50, with Comoros, Iraq, Libya, and Somalia scoring the lowest.

Figure 23:

The revised structure of the RDI Index



Results on the pillars of the RDI Index show progress in 13 countries on the *enabling environment and infrastructure* pillar, with scores ranging from 19.76 to 71.16, followed by the *innovation* pillar, with scores in the range of 14.28–72.28, and the *research and development* pillar, with scores between 14.25 and 64.49. Qatar, Saudi Arabia and the United Arab Emirates were the only three countries that scored above 50 on all three pillars. Apart from these, five countries (Bahrain, Jordan, Lebanon, Morocco and Tunisia) scored above 50 on two pillars: *innovation* and *enabling environment and infrastructure*.

The results of the sub-pillars show some general trends with interesting exceptions. In general, the United Arab Emirates and Qatar achieved high scores on all sub-pillars except for that relating to *human resources*.

Figure 25 shows the results of Arab countries on the main pillars of the RDI Index.

- With regard to the two *research and development* sub-pillars, only five countries (Egypt, State of Palestine, Qatar, Tunisia and the United Arab Emirates) scored 50 and above on the *R&D inputs* sub-pillar. Likewise, only five countries (Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates) scored 50 and above on the *R&D outputs* sub-pillar. Comparing scores on both sub-pillars shows that for most countries where
- data was available for both, scores were higher on the outputs sub-pillar, with varied gaps between the two (reaching up to 63.67 points in the case of Saudi Arabia). Still, Egypt, Jordan, Morocco, State of Palestine and Tunisia scored higher on the inputs sub-pillar, with gaps ranging from 13.16 to 38.24 points. Correlation analysis revealed the absence of any statistically significant positive correlation between *R&D inputs* and *R&D outputs*, which indicates that the R&D system is not functioning well.
- Regarding the *innovation* pillar, which ideally consists of two sub-pillars (*innovation in production* and *social innovation*), no results could be calculated for the first sub-pillar due to lack of data. For the social innovation sub-pillar, nine countries (including most notably the United Arab Emirates and Saudi Arabia) scored 50 and above.
- In terms of the four sub-pillars of the *enabling environment and infrastructure* pillar, scores were relatively better on the *human resources* sub-pillar, with 13 countries scoring 50 and above. The six GCC states, Jordan, Morocco and Tunisia scored above 50 on all four sub-pillars. Correlation analysis indicated positive correlation with varying significance and the correlation coefficient ranged from 0.447 (between the *human resources* sub-pillar and the *economic and social environment* sub-pillar) to 0.885 (between the *economic and social environment* sub-pillar and

Figure 24:

Results of Arab countries on the RDI Index

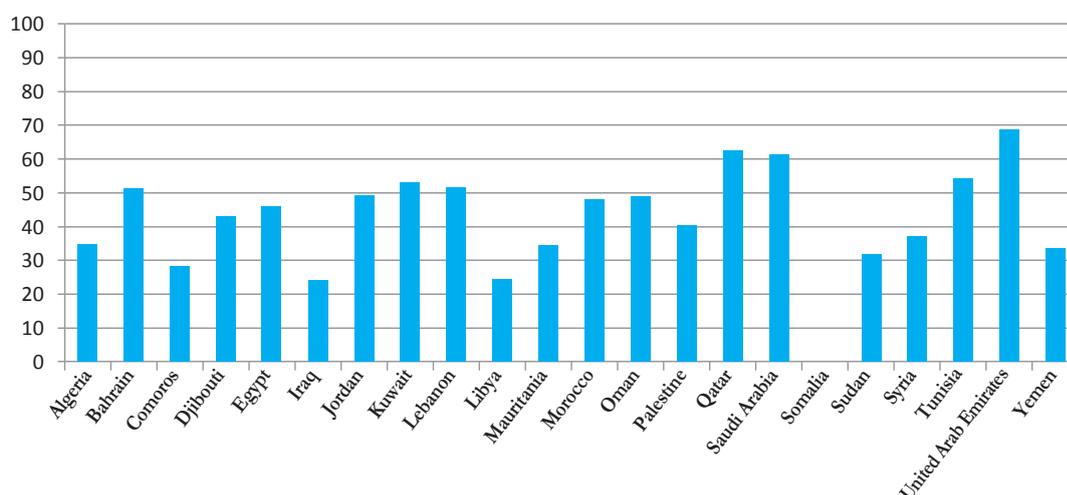
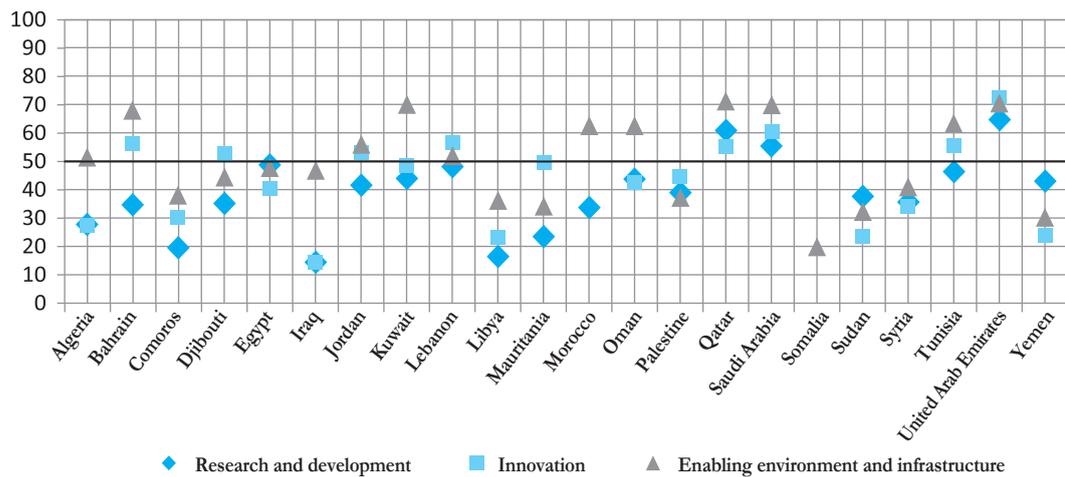


Figure 25:

Results of Arab countries on the main pillars of the RDI Index



the *enabling environment and infrastructure* sub-pillar).

Overall, these results indicate that the performance of Arab countries in terms of RDI is still far below global levels. In addition, there is lack of researchers in the region compared to more advanced regions. This suggests that Arab states need to exert more efforts to provide the necessary financial support to enhance human capabilities and improve the various components of the RDI sector.

This overall low performance should not obscure the successes in the region, particularly in certain GCC countries which have begun to compete for top global positions. Furthermore, one cannot discuss the overall performance of the Arab region without considering that a group of Arab countries are currently experiencing unstable political, economic, social and security conditions which inevitably affect their research output and innovation capability.

Endnotes

- ¹ Hargreaves and Shaw, 2006.
- ² OECD, 2015.
- ³ UNDP and MBRF 2015.
- ⁴ Cornell University et al., 2015.
- ⁵ OECD, 2005.
- ⁶ UNDP and MBRF, 2015.
- ⁷ Khorshid, 2015 (in Arabic).

