Strengths and Weaknesses of Science and Technology Institutions in Arab countries

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Acknowledgments

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Introduction

Strengths, Weaknesses, Opportunities and Challenges (SWOC) analysis of Arab countries innovation and research activities is a difficult exercise on various grounds. First, for most of the countries, science and innovation policy as such has still not been implemented. Nevertheless, but looking at each country individually, one can find an important activity that is dispersed over various policy agencies and ministries, performing institutions, and social and economic actors.

It has been historically the task of Ministries of research and higher education to be the first interested in promoting innovation. Ministries of industry, usually more prone to develop practical support schemes oriented to the industry have been the ones testing the measures for the promotion of innovation at the firm level and as part of the economic activities of the governments. These measures are usually direct grants and, more rarely, fiscal and economic incentives. Moreover, innovation has been usually thought of as an extension of research activities whereas most OECD countries try to implement demand-oriented innovation policies. Innovation has been usually extended toward a network paradigm, where the main focus was to forge linkages between research centres and productive units. This included promoting networking of individuals (engineers and scientists, professors and post-doc, doctoral students and enterprise personnel), of companies, of universities, of research centres; promotion of spin-offs and start-up companies; promotion of technology transfer units and intellectual property agencies. Training has usually been not included although it is known that vocational training, as well as combined degrees with companies and universities are excellent tools for the promotion of innovation. Technical centres that respond to the needs of specific industries are even more rare, with the very notable exception of Tunisia. Another very common instrument has been the promotion of technopoles, incubators, usually related to some large university campus. Finally, innovation policies should relate to the industrial policies, and this is more difficult to circumscribe to a specific national authority. Large industrial policies are usually sectoral and depend upon tariffs on imports and exports, taxes related to the ministry of budget or the economy, and local governments in regions. Localized industrial clusters (or agricultural and services clusters) have appeared as an effective tool and various experiences exist now in many countries (Saint Laurent, 2005).

On a whole, innovation policies, understood as this complex set of institutions and measures not as a unique form of intervention, have been developed and sustained quite firmly in the last few years by some governments, for example in Algeria, Egypt, Morocco and Tunisia. Other countries have also promoted specific schemes and measures for innovation in spite of the lack of proper financial resources for that (Jordan, Lebanon, and, to a lesser degree, Syria). Gulf countries have set-up also specific measures. It should be added that the European Union in the framework of the so-called "Barcelona process" (EU-Med cooperation) has also been suggesting more innovation-related actions for EU-Med cooperation in the hope of setting up a "Euro-Mediterranean Innovation Space" (EMIS) (Pasimeni *et alii*, 2006). Many international organisations, bilateral donors and NGOs have participated in the need of the countries to transform their development models from low-cost models into knowledge-based production: the EU, the OECD, UNESCO, UNIDO and

ALECSO are only a few examples to name. Finally, the World Bank has actively promoted the policies in favour of knowledge and innovation (Reiffers et al., 2002).

This policy shift from support to research toward innovation was basically done through measures promoting innovation in the public sector and contacts between the public sector and the productive companies in many forms: engineering networks, promotion of technology transfer units, fiscal measures, promotion of start-ups and venture-capital funding. Finally, to varying degrees, all the countries were profoundly affected by the EU policies, which served as an example by its own promotion of innovation and instruments set-up to measure it (such as the European Innovation Scoreboard).

In Western industrial countries and those with growing industrial economies, there is a positive correlation between the country's position on some 'innovation index' and the growth of their GDP. Arab countries, however, do not show such a positive correlation between GDP and innovation (Mouton and Waast, 2009). Despite the high GDP in oil-producing Arab countries, the ranking on the innovation and scientific research index of some of them remain low in comparison to other Arab countries with lower incomes (see the Innovation System Index for 17 Arab countries comparison between 1995 & 2008 in Source: (UNDP & Al Maktoum Foundation, 2009).

A first appraisal of the innovation policies in some Arab countries has concluded that measures to promote innovation cannot be evaluated properly because of lack of comparative standards (Arvanitis & M'henni, 2010). Direct measures to promote innovation through SME-oriented programmes, technoparks and incubators are easy to measure: however even this is not done, in particular because statistics on the productive sectors are not sufficient. What is also appearing after some more than 10 years of systematic efforts in various countries is that policies have usually been short-termed and success is expected to be easy and immediate. If this does not happen, the policy impact is very low. Long-term efforts are thus not encouraged. Examples like Berytech incubator in Beirut or the El-Ghazala pole of technology in Tunis are thus quite exceptional since they survived far beyond the usual short-term experiences. It is interesting to note that Berytech owes its extraordinary longevity and success to the fact that it is an autonomous management experience based on the permanent institutional support of Université Saint-Joseph; El-Ghazala, owes a great part of its longevity to the existence of the school of telecommunications, even though the companies that are inside the technopark do not have as strong linkages with the school as might be expected. In both cases, support is not in terms of money but rather in terms of creating an institutional background. These two examples, taking place in what can be probably considered the most contrary types of national research and innovation systems, the most decentralized and the most centralized systems of governance of science and technology, show that the question of the relations between the private and the public, the enterprises and the State, is not a simple matter of either promoting the public or the private sector. On the contrary, it is the policy mix that makes the difference and the ability to engage in combined policies. The major strengths thus would be in all countries to create these public and private linkages, that go far beyond financial support and relate to the creation of an ecosystem conductive to technological development.

The analysis in the following pages wants to advance in this direction and should be thought of as a first step toward establishing a list of strengths and weaknesses, taking into account the diverse innovation worlds in the various countries.

Methodology

In order to conduct this SWOC analysis we used mainly the following sources:

- Our report presented to ESCWA: "*The broken cycle between research, university and society in the Arab World: Proposals for change*" Feb. 2013 (hereby Hanafi & Arvanitis 2013)
- Answers of some countries to our questionnaire (see annex) (Jordan, Oman, Palestine, Yemen and Qatar)
- *The Global Innovation Index 2012: Stronger Innovation Linkages for Global Growth* which the result of a collaboration between INSEAD and the World Intellectual Property Organization (WIPO) as co-publishers, and their Knowledge Partners. (hereby Dutta 2013)
- Galal, Ahmed and Jean-Louis Reiffers (2012) *FEMISE report on the Euro-Mediterranean partnership*. 210 p.
  EraWatch (2011) *Country Reports for Algeria, Jordan, Egypt and Morocco*. http://erawatch.jrc.ec.europa.eu/
- Presentation of experts of some Arab countries in EXCWA Amman (April 30, 2013) on regional STI SWOT partnerships and the feedback from them.

Scopes and Limitations

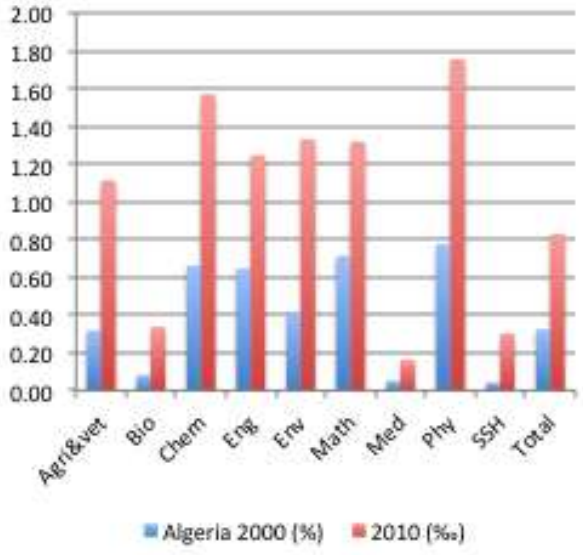
We have been focusing very much on university and public research as little information is available on private R&D. Therefore we limit the notion of innovation policy to some of its components that are usually on the "supply-side" that is a vision inherited from the old linear model and that is now changed to a generalized "networking model" (see Arvanitis and M'henni 2010 for a review of the innovation policies monitoring in some Arab countries). In a keynote speech given in Tunisia, Philippe Larédo (2011) presented this evolution that has taken place in Europe and OECD countries concerning innovation policies. He showed that the dominant paradigm is today that of the networked/distributed intellectual property rights, collaborations and alliances with users, with value-chain suppliers, and with knowledge providers. Manufacture-based and supply-based policies have been the main tools of action, and have evolved toward this network paradigm. Demand-driven policies have been difficult to come about. He showed that the innovation-related policy should not be understood as an extension of R&D policies, nor limited to technology transfer and 'valorisation' or the promotion of start-ups. Innovation policy will need to reconsider sector-based industrial policies by adding strong training, quality and innovation, and should apply not only to manufacturing sectors, but also to the service sectors. Further, cluster-based policies can be an important vector which can nurture innovation capabilities of firms in clusters, and some large firms can play the role of an anchor. These concepts are of particular relevance to the economies of the Arab countries which have promoted cluster-based economic activities. Also, we insist very much on the university sector although recent experience shows that in all countries universities have been rather weak at making technology transfer a reality. On

the contrary, specific and dedicated structures have been more effective. Finally, industrial and fiscal policy are rarely mobilized in Arab countries toward the promotion of innovation.

SWOC by country

Algeria

GDP (current prices)[1]: $210.5 billions
Population: 37.041 millions
Resources: Gas and oil
Key institutions in STI: National Plan, university of Alger.



Source: (Hanafi & Arvanitis 2013)

<u>High innovation indicators (GII)</u>

Indicator	Score	Rank
Ease of resolving insolvency	67.6	46
Current expenditure on education, % GNI	4.5	54
Graduates in science & engineering, %	28.0	15
General infrastructure	*39.2*	*54*
Gross capital formation, % GDP	41.2	2
Non-agricultural mkt access weighted tariff, %	0.0	17
PCT patent filings with foreign inventor, %	100.0	1
Knowledge absorption	*41.9*	*45*
Computer & comm. service imports, %	67.4	3
Knowledge diffusion	*30.1*	*54*
Computer & comm. service exports, %.	53.9	21
Paid-for dailies, circulation/th pop. 15–69	106.9	53
Creative services exports, %	8.3	22

Source: (Dutta 2013)

[1] The data for GDPs and population for all Arabic countries are from IMF for 2013, except Palestine and Syria.

Low innovation indicators (GII)

Indicator	Score	Rank
Innovation Output Sub-Index	15.8	134
Innovation Efficiency Index	0.5	136
Regulatory quality	22.6	135
Venture capital deals/tr PPP$ GDP	0.0	65
GMAT test takers/mn pop. 20–34	4.3	133
University/industry research collaboration	22.2	128
State of cluster development	20.3	131
PCT resident patent ap/bn PPP$ GDP	0.0	106
High-tech exports less re-exports, %	0.0	119
Creative outputs	11.7	136
Creative intangibles	*12.0*	*134*
Madrid resident trademark reg/bn PPP$ GDP	0.0	62
ICT & business model creation	18.7	133
Creative goods exports, %	0.0	131

Source: (Dutta 2013)

Strengths

- STI strategy: 2011 saw the enactment of two laws aimed at encouraging research activities and international collaborations. These measures aimed at attracting active participation of the Algerian scientific diaspora in national research programs, and sizable increase in salaries for researchers (through different mechanisms, specifically direct increase in base salaries and added incentive for participation in research projects). Several fiscal measures were taken with the aim to promote the emergence of a knowledge based economy and the encouragement of the development of R8D activities (within public and private entities). These measures can be summarised under two headers;
    - fiscal policy to promote R8D investment; embodied in exoneration from VAT and customs duties on necessary R8D equipment and IT infrastructure and fiscal decisions leading to improved socio-economic status of researchers and research professors.
    - Public research is undertaken in research centres and research units, the majority of which is under the supervision of MHESR: Nearly 6,000 employees are active in these research centres, of which, 2,000 are researchers. They work in fields as varied as hydrocarbons, iron and steel, electronics, chemistry, and food and agriculture. Some have “centres for research and development” while others have only simple units of research. They have had in most cases a quite difficult conversion to R&D (Khelfaoui, 2004: 80).
- Publications: The research strengths Algeria lies in chemistry; in fact when one looks at the production it is very much organic chemistry, chemical engineering and physic-chemical characterisations of specific materials (see above graph). Otherwise it still sticks to this engineering and material sciences dominant profile, a profile close to that of China.

- Universities: Many efforts are currently made by DGSRTD for a more active involvement of universities in research projects directed to the business sector. The

NFSRTD funds the creation of spinoffs and the commercialization of research results. (http://erawatch.jrc.ec.europa.eu/).

- R&D expenditures: Good investment in education in 2012 (8.215 billion Euros representing 20% of the national budget) and Higher Education and Scientific Research (2.771 billion Euros).
- Human resources: Good, but many of them went abroad during the civil war and have not come back
- Some large companies report R&D activities like Sonatrach or Cevital.

Weaknesses

- Algeria's participation in international research programs remains very low. Unlike Tunisia and Morocco, Algerian participation in the FP7 of the EU does not exceed 16 projects to 2012, with a budget of 43,6 million €.

Opportunities

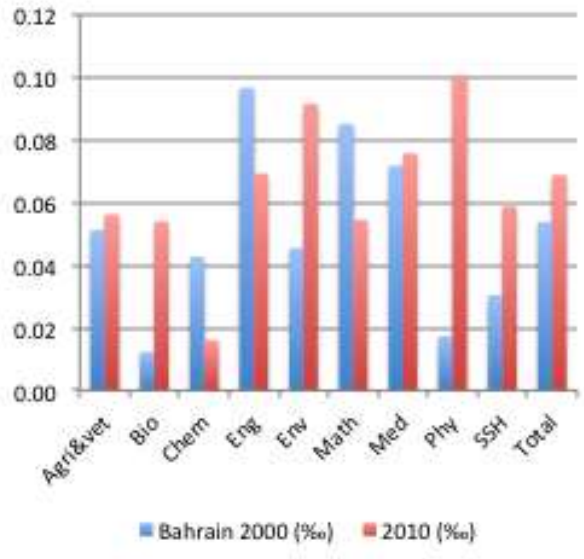
- Growth expected of the hydrocarbon sector.
- Good funding opportunities.
- Authorities also announced some initiatives for the support of the private sector. The Bourse d'Alger is going to become open to foreign capital in order to add liquidity to encourage more domestic firms to list.
- Plans to boost investment in tourism were announced, aspiring to attract 3.5 million tourists per year starting in 2015 (FEMISE).

Challenges

- Elevated unemployment among young in particular young graduates.
- Algeria is a high-risk market for multinational drugmakers because of the combination of regional uncertainty and state interference in its business environment.
- There are no venture capital schemes despite some attempts in the past.
- Diaspora remains in foreign countries.
- Administrative and bureaucratic burdens are very high.

Bahrain

GDP (current prices): $28.1 billions
Population: 1.174 millions
Resources: Gas and oil
Key institutions in STI: BCSR



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)[2]	Rank
Cost of redundancy dismissal, salary weeks	8.0	1
Tertiary education	*74.1*	*2*
Tertiary inbound mobility, %	24.1	6
Gross tertiary outbound enrolment, %	8.0	5
Government's online service	86.3	9
General infrastructure	*63.5*	*7*
Electricity output, kWh/cap	11,603.5	10
Electricity consumption, kWh/cap	13,624.5	10
Trade & competition	*78.9*	*5*
Exports of goods & services, % GDP	96.8	6
Innovation linkages	*65.9*	*5*
JV–strategic alliance deals/tr PPP$ GDP	339.5	1
PCT patent filings with foreign inventor, %	100.0	1
ICT & organizational model creation†	73.1	6

Source: (Dutta 2013)

[2] Hard data series (62 indicators) are drawn from a variety of public and private sources such as United Nations agencies (the United Nations Educational, Scientific and Cultural Organization, the World Intellectual Property Organization), the World Bank, Thomson Reuters, and Standard & Poor's.

Low innovation indicators (GII)

Indicator	Score	Rank
Innovation Efficiency Index	0.6	125
Political environment	*40.8*	*115*
Press freedom	8.8	137
Current expenditure on education, % GNI	3.0	106
Ecological sustainability	*7.8*	*126*
GDP/unit of energy use, 2000 PPP$/kg oil eq	1.9	117
Ease of getting credit	21.1	104
GMAT mean score	415.8	122
Computer & comm. service imports, %	11.5	120
PCT resident patent ap/bn PPP$ GDP	0.0	98
High-tech exports less re-exports, %	0.0	117
Domestic resident trademark reg/bn PPP$ GDP	2.0	83

Source: (Dutta 2013)

Strengths

- Bahrain is good generally speaking in tertiary education
- General business-friendly policy and partnerships in innovation between private and public R&D.

Weaknesses

- Bahrain is weak in scientific production, although there is a breakthrough in physics during the last 10 years (see the above graph)
- Bahrain is weak in terms of many indicators related to innovation efficiency and productive industry and especially high-tech.
- Research centers or consultative agencies outside of universities play a primary role in social science research (UNDP, 2009: 202).

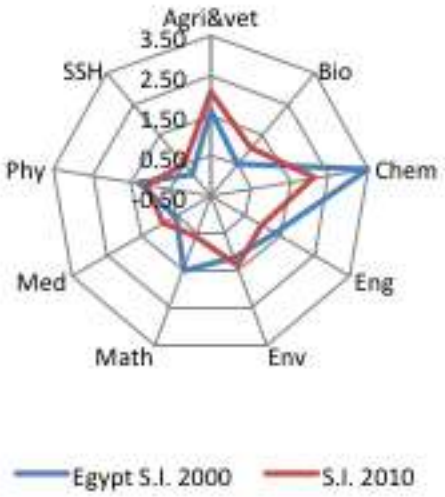
Opportunities

Bahrain is good generally speaking in business environment.

Challenges

weak in terms of many indicators related to political stability.

Egypt
GDP (current prices): $264.7 billions
Population: 84.1 millions
Resources: Tourism, industry, Gas
Key institutions in STI: STDF fund and RDI office at the Ministry of research and higher education; Academy of Scientific Research and Technology (ASRT).



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Ease of starting a business	88.4	17
Current expenditure on education, % GNI	4.4	58
Information & communication technologies (ICT)	*45.3*	*49*
Government's online service	60.1	42
E-participation	68.4	15
Total value of stocks traded, % GDP	17.0	39
Venture capital deals/tr PPP$ GDP	3.9	58
Knowledge-intensive employment, %	30.3	41

Scientific & technical articles/bn PPP$ GDP	4.8	58
Royalty & license fees receipts/th GDP	0.9	33
Creative goods exports, %	4.3	17

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Political environment	*33.5*	*130*
Press freedom	27.4	132
Cost of redundancy dismissal, salary weeks	36.8	131
Regulatory environment	*44.5*	*126*
Gross tertiary outbound enrolment, %	0.1	136
General infrastructure	*25.7*	*122*
Trade & competition	*50.6*	*121*
Imports of goods & services, % GDP	26.1	122
Exports of goods & services, % GDP	21.3	122
University/industry research collaboration†	26.6	122
Knowledge absorption	*26.2*	*119*
New businesses/th pop. 15–64..	0.1	93
Madrid resident trademark reg/bn PPP$	0.1	55
Country-code TLDs/th pop. 15–69	1.5	120

Source: (Dutta 2013)

Strengths

- A strong institutional change in the policy toward research funding seems to be triggering a real shift in production (creation of STDF fund and RDI office at the Ministry of research and higher education). More money distributed through competitive projects, international collaborative projects, and recognition of the research activities seems to be a key feature.
- Institutional structure: Over the past four decades, Egypt's Academy of Scientific Research and Technology (ASRT) has been largely responsible for shaping the country's science and innovation system. Royal Scientific Society well established and mature infrastructure for scientific testing and consulting services. Egypt was setting up Mubarak Science Park which changed name after the Egypt Revolution. However, this park does function as a research center but not as a technology park or as a hub of contacts with its environment (Chalony & Moisseron, 2010).
- Egypt has good current expenditure on education, % GNI which is reflected in the number Scientific & technical articles/bn PPP$ GDP (4.8).

- In the recent years, Egyptian universities indeed collaborated with scholars from Europe, Japan, Australia and US. (Bond et al. 2012) However collaboration is also in region level. Egyptian researchers co-author on average 10 papers a year with collaborators in UAE, Kuwait, Lebanon, Qatar, Jordan, Oman and Libya.
- The new Egypt-Japan University of Science and Technology (E-JUST) near Alexandria is considered a model of international cooperation in education and industry-orientated research. (Bond et al. 2012: 119).
- Egypt has a large pool of researchers and science students that harbours great talent, as well as a powerful and active diaspora.
- Recently Egypt moved from being specialized in fundamental science (Math, physics and Chemistry) toward agriculture and medicine and biology which most probably bio-technology (see the above graph). Egypt now well placed to lead the way in future regional collaborations in renewable energy, nanotechnology, biotechnology, agriculture, water resources and pharmaceuticals (Bond et al. 2012)..
- Alexandria University came 147th in the Times Higher Education World Universities Rankings 2010 – the first time an Egyptian university had made the top 200 – largely on account of the quality of its research in mathematics and theoretical physics.
- Mobtakron Initiative that targets Grassroots Innovation of Communities "TOK-TOK"; STEM School Innovation "FAB-LAB"; University Student Innovation "AICE " "GP" "ASMP"; University and R.C Research Innovation "TICO"; Enterprises Innovation "IRA'
-

Weaknesses

- Between 2004 and 2010 governmental R&D expenditure averaged around 0.25% of GDP.
- State does not incentives to encourage businesses to invest in R&D in areas. Egypt is very weak in University/industry research collaboration and *Knowledge absorption* and in education.
- Research centers or consultative agencies outside of universities play a primary role in social science research (UNDP, 2009: 202)
- Egypt has an exceptionally low figure of co-publications.
- Average number of citations is 0.6, which is very low even compared to the Arab region. However, Egypt has much higher H-index than in other Arab countries. This is due to a high production in the biomedical fields and reflects a real engagement in internationally recognized research.

Opportunities

- Egypt advanced in the last year to provide conducive environment for attracting foreign investment and many indicators related to ICT.
- The emergence of the Ahmad Zowil university and Science City: pole of excellence

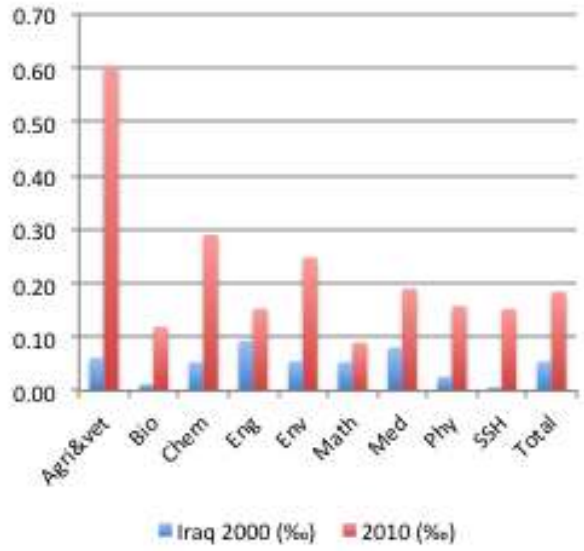
Challenges

- The general infrastructure for innovation is still a big problem
- the political stability.

- public appetite for science appears diminished.
- With restricted water supplies, a growing population, a land mass dominated by desert and myriad threats from climate change already beginning to bite, Egypt faces a huge challenge in agricultural development in the coming (Bond et al. 2012)..
- Brain drain: 12500 Egyptians scientists and engineers living in the USA (Mouton and Waast 2009).
- Egypt's rapid population growth has proved an enormous challenge for its education system. In addition, Egyptian universities and their rigid academic culture holds back creativity and innovation (Bond et al. 2012)
- Ahmad Zowil University and Science City: pole hijacking the excellent researchers from Egyptian national universities and weakening them. There is no cooperation between this City and them.

Iraq

GDP (current prices): $233.2 billions
Population: 34.7 millions
Resources: Gasand oil
Key institutions in STI: National plan



Source: (Hanafi & Arvanitis 2013)

Strengths

- Recent effort in R&D to regain its former shine research situation.
- New focus of research in agriculture and veterinary research.
- 204 local scientific journals published 9651 articles (2012), three time and half more than in 2005 (٢٦٩٦ articles). (Shihab, forthcoming)

Weaknesses

- R&D: there is no item in the general budget about the R&D; expenditure in 2012 is 4.55 million (Shihab, forthcoming)

- Public research centres are burdened with scientific services required by public utilities, or are under the pressure of teaching.
- Universities have a limited research record.
- Contribution to the production of original research and patents are inexistent and they do not include all scientific specializations.
- Lacking a proper university system (which in fact had a quite famous educational system before wars raged the country).
- Low quality of local scientific production.
- No incubators

Opportunities

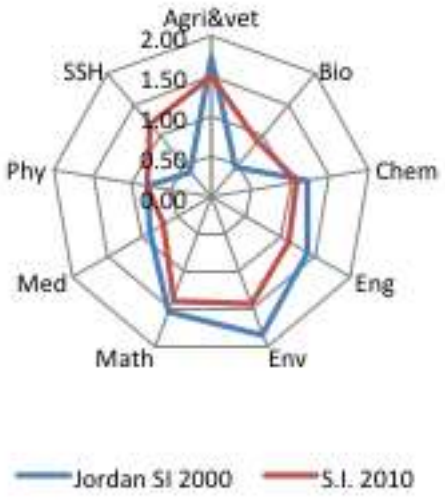
- Economy recovery of Iraq
- Oil economy
- Wide diaspora

Challenges

- High-risk political and social environment.
- Bureaucracy
- Little involvement of the diaspora to S&T in Iraq

Jordan

GDP (current prices): $ 34.076 billions
Population: 6.5 millions
Resources: Agriculture and service
Key institutions in STI: HCST, National Center for Agricultural Research



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Innovation Efficiency Index	**0.9**	**21**

Cost of redundancy dismissal, salary weeks.	8.0	1
Ease of paying taxes	88.4	17
Current expenditure on education, % GNI	5.6	26
Tertiary education	*45.9*	*31*
Tertiary inbound mobility, %	10.4	15
Market capitalization, % GDP	111.9	14
Imports of goods & services, % GDP.	65.9	27
FDI net inflows, % GDP	6.2	31
ISO 9001 quality certificates/bn PPP$ GDP	17.6	28
Creative outputs	45.1	24
Creative intangibles	*68.8*	*5*
Domestic res trademark reg/bn PPP$ GDP	211.7	1
Creative goods exports, %	2.8	29

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Gross capital formation, % GDP	15.3	128
Environmental performance	42.2	112
Ease of getting credit	15.3	112
Non-agricultural mkt access weighted tariff, %	4.6	132
University/industry research collaboration	34.5	110
PCT patent filings with foreign inventor, %	14.3	87
High-tech imports less re-imports, %	5.1	101
Computer & comm. service imports, %	10.3	125
Growth rate of PPP$ GDP/worker, %.	0.7	98
Computer & comm. service exports, %	11.7	115

Source: (Dutta 2013)

Strength

- Jordan has a good education system (Soumitra, 2013).
- Many science and technology community colleges (technical-oriented schools that provide vocational training) (Erawatch, 2011c).

- Strong institutional change in the policy toward research funding. More money distributed through competitive projects, international collaborative projects, and recognition of the research activities seems to be a key feature. Jordan has a stronger emphasis in engineering and environment and –surprisingly –social sciences.
- Clinical medicine is a research strengths for Jordan as well. Jordan is moving toward a specialization pattern oriented to life sciences (biomedical and medicine), although it emerged out of a typical engineering-dominated landscape of research. It is now evolving toward producing more research which will be based on a recognized medical capability. Nonetheless, still the dominant disciplines in Jordan remain engineering-related areas of specialization.
- Institutional infrastructure: Royal Scientific Society well established and mature infrastructure for scientific testing and consulting services. In 2009, Jordan launched El-Hassan Science Park as part of a major science project in Amman.
- The Higher council for science and technology was established the National Policy and strategy for science, technology and innovation 2013-2017. It uses the methodology of Winds of change. The result was identifying eight priorities that are by order: water, energy, poverty, food, demographics, climate change, urbanization and finally waste.
- In addition, there are intellectual Property Commercialization Office (iPCO), National Center for Agricultural Research and Extension and pharmaceutical Innovation System.
- High levels of co-authorship with foreign partners in a rapidly expanding scientific activity.
- Some new research centers: the Balka research centre in Jordan grew out of an international (mainly British) funding on environmental sciences; Prince Faisal Centre for Dead Sea, Environment and Energy Research; Energy and Oil Shale Research Center Tafila University
- Good initiatives: "A professor in every factory" (promoted in 2003) which focuses on sending an academic into factories during summer vacations. Another recent initiative, funded by a common EU-Jordan fund has been the SRTD programme (a 4 million Euros programme) that funds innovation-related actions in enterprises. Most of these programmes have been directed to SMEs. (The Arab Knowledge Report, 2010)
- A decent level of R&D spending in the private sector was noticed: 30% of R&D expenditures as compared to the 70% of the public sector (this figure appears as the highest in ESCWA countries).
- There is an incubator (Oasis) of 500 with a proven record of transforming entrepreneurial ventures into viable businesses (SWOT analysis of Jordan Science System, ESCWA).
- Relationship between universities and private sector: eleven branch TT offices at universities, research centres and business organisations (Erawatch, 2011c).

Weaknesses

- Most research centers have a very low budget (Total budget is below $50 million) and the total budget of research centers is typically spent as follows: salaries represent around 75%, R&D 7%, laboratory equipment 10%, and others 8%.
- Critical future technology research (Nano based) needs infrastructure and support.
- Jordanian science journals are not internationally accredited and suffer from fundamental problems such as irregular publishing, lack of objective peer review of the articles accepted for publication, and the unedited publication of the proceedings of conferences and seminars. Additionally, some of these periodicals are not regarded as credible for academic promotion purposes, which makes many researchers and academics prefer to publish in international, peer reviewed journals (UNDP, 2009:200).
- In social science, university production is weak. There is a diversity in the statuses of research organizations, but more importantly, we find the sweeping majority of the organizations outside the premises of universities.

Opportunities

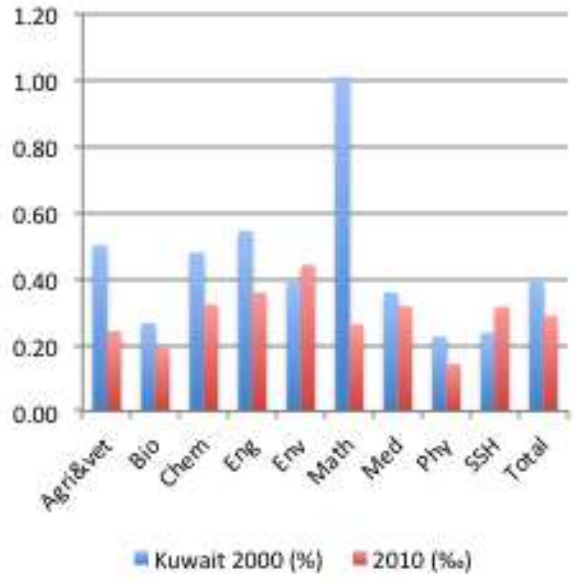
- Good human resources for the National Network for Advanced Materials and Nano-Technology (NNAMNT).
- Relatively high number of university students in science majors (around 90k)
- Regional and international coalitions.
- Jordan Badia Research and Development Program, mature community experience.
- Jordanian scientist Diaspora.

Challenges

- Jordan created its observatory but its activities were halted.
- Brain drain: 4 000 Jordanians scientists and engineers living in the USA (Mouton and Waast 2009).
- Poor resources and industrial input (Soumitra 2013)
- Bureaucracy and poor cooperation among the local organizations and institutes.
- Acceleration of technological development and international competition.
- Lack of confidence in the Jordanian Science Technology and Innovation outcomes.
- Limited market size and undeveloped commercialization system.
- Limited Infrastructure and a lack of advanced equipment.

Kuwait

GDP (current prices): $ 173.438 billions
Population: 3.89 millions
Resources: Gas and oil
Key institutions in STI: KFAS, Scientific Center of Kuwait.



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Ease of paying taxes	92.0	12
Pupil-teacher ratio, secondary	8.0	10
Gross tertiary outbound enrolment, %	5.8	12
Electricity output, kWh/ca	15,270.0	6
Electricity consumption, kWh/cap	16,673.0	5
GMAT test takers/mn pop. 20–34	547.7	9
PCT patent filings with foreign inventor, %	100.0	1
Knowledge diffusion	*72.5*	*3*
Computer & comm. service exports, %	64.1	9
FDI net outflows, % GDP	7.9	6
Paid-for dailies, circulation/th pop. 15–69	505.7	4

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Cost of redundancy dismissal,	28.1	122

salary weeks		
Gross capital formation, % GDP	13.9	133
Ecological sustainability	*15.9*	*120*
GDP/unit of energy use, 2000 PPP$/kg oil eq	2.4	108
Environmental performance	35.5	118
Venture capital deals/tr PPP$ GDP	0.0	65
R&D financed by business, %.	2.3	83
GMAT mean score	391.4	134
R&D financed by abroad, %	1.2	80
Computer & comm. service imports, %	11.2	122
Knowledge impact	*18.4*	*125*
Growth rate of PPP$ GDP/worker, %	1.5	111

Source: (Dutta 2013)

Strength

- Pursuing strategy to support the university and research system.
- Scientific Center of Kuwait that serves as a center for environmental education of the gulf region in which the largest aquarium in the Arab world, holding over 100 different species of animals.
- General business-friendly policy and partnerships in innovation between private and public R&D.
- Clinical medicine is the research strengths for Kuwait.

Weaknesses

- Weak R&D expenditure.
- Research centers or consultative agencies outside of universities play a primary role in social science research (UNDP, 2009: 202).

Opportunities

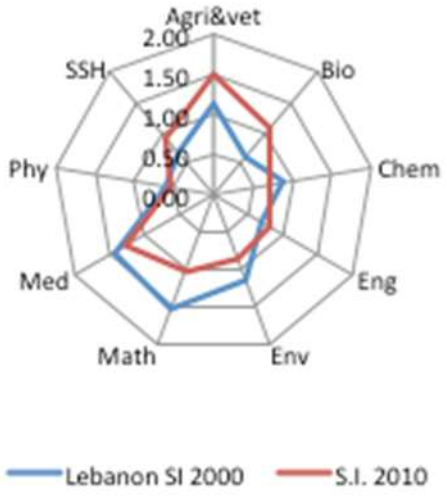
- Good business environment

Challenges

- Bureaucracy
- Lack of cooperation with the Arab countries that have good human resources

Lebanon

GDP (current prices): $43.842 billions
Population: 4.062 millions
Resources: tourism
Key institutions in STI: The National Council for scientific research (CNRS), American University of Beirut, Saint Josef University.



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Pupil-teacher ratio, secondary	8.9	16
Tertiary inbound mobility, %	15.0	11
Gross capital formation, % GDP	32.7	16
Non-agricultural mkt access weighted tariff, %.	0.0	1
GMAT test takers/mn pop. 20–34	1,178.6	4
PCT patent filings with foreign inventor, %	100.0	1
Computer & comm. service imports, %	55.9	10
FDI net inflows, % GDP	12.7	11
Computer & comm. service exports, %.	55.5	18
Creative goods exports, %.	5.4	10

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Political stability	28.4	131
Current expenditure on education, % GNI	1.6	132
Public expenditure/pupil, % GDP/cap	6.2	116
Quality of scientific research institutions	23.6	121
Venture capital deals/tr PPP$ GDP	0.0	65
Exports of goods & services, % GDP	20.9	124
Royalty & license fees payments/th GDP	0.3	99
High-tech imports less re-imports, %.	4.0	117
Creative intangibles	*27.0*	*122*
ICT & business model creation	34.6	124
ICT & organizational model creation	19.3	132

Source: (Dutta 2013)

Strength

- The National Council for scientific research (CNRS) has launched the Lebanese Observatory on Research, Development and Innovation (LORDI).
- CNRS mainly functioned as an agency distributing research grants on the basis of competitive calls for offer. It has also four institutes of its own, but these are small in size.
- Increasing growth of research production especially in terms of agriculture and biology.
- High levels of co-publication that increased from 22% in 1987 to 55% in 2006, but also it has been progressively re-orienting itself toward more collaborations with European partners. EU is the major region of cooperation, thanks to its funding system, but also USA.
- Active pursuit of scientific research and consolidate the evaluation systems inside their universities.
- Strong medical research core of two large hospitals (Medical Center of AUB formerly known as AUH, and Hotel Dieu de France) which are both attached to two important universities (AUB and USJ). However, there is also a growing number of publications from Lebanese University and Balamand University which both have well regarded university hospitals, but most of the production of Lebanon in this area is related to AUB and its Medical Center.
- AUB has deployed a strong effort in promoting the scientific production of its personnel and this translates to its overall production figures.
- Since 2007, the Nature Conservation Center (Ibdaa- AUB) holds an annual event, the International Biodiversity Day at AUB, providing an opportunity for undergraduate and graduate students to participate in a full-fledged poster forum.

- The average number of citations is 0.99, the highest in the Arab region.
- Berytech: The first technological pole in Lebanon and the region to provide a conducive environment for the creation and development of start-ups, hence taking part in the economic revival of the country, participating in wealth and job creation, and retaining graduates and hi-level skills in Lebanon. It has emerged as a private initiative of the school of engineering of the Saint-Joseph University

Weaknesses

- Low government investment in education (Current expenditure on education [% GNI] and public expenditure/pupil, % GDP/cap).
- Weaknesses in ICT system.
- There is no post-doctorate system for the graduates.

Opportunities

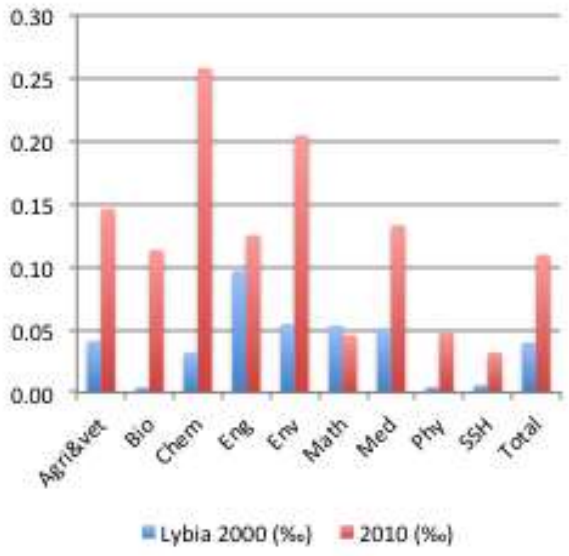
- Attempting to reverse the brain drain of medical doctors. Based on a 2009 survey in US among Lebanese doctors practicing in USA,[3] out of 286 doctors surveyed, 61% were willing to relocate to Lebanon but only a third were willing to relocate to the Arab gulf.
- A little more than half of them were willing to relocate to Lebanon as a base for clinical missions to the gulf. These findings suggest that there is a possibility of making Lebanon a regional 'academic hub' by recruiting Lebanese medical graduates practicing abroad is feasible (Akl et al. 2012).

Challenges

- Lack of political stability and the impact of the Syrian uprising on Lebanon
- Brain drain: 11500 Lebanese scientists and engineers living in the USA (Mouton and Waast 2009).

Libya

GDP (current prices): $ 96.367 billions
Population: 6.529 millions
Resources: Gas and oil.
Key institutions in STI: Al-Fatah University at Tripoli, University of Garyounis at Banghazi, Bright Star University of Technology at Marsa al-Brega and Sebha University.



ıtact, 286 participated in the survey.

Source: (Hanafi & Arvanitis 2013)

Strength

- Has many universities with good faculties of science, engineering, agriculture (Al-Fatah University at Tripoli, University of Garyounis at Banghazi, Bright Star University of Technology at Marsa al-Brega and Sebha University)
- Wind and solar projects, including solar desalination: increasing in the publication in chemistry and environment research.

Weaknesses

- Very small share in the scientific production.
- Lack a proper university system.
- In social science university production is weak. There is a diversity in the statuses of research organizations, but more importantly, we find the sweeping majority of the organizations outside the premises of universities.

Opportunities

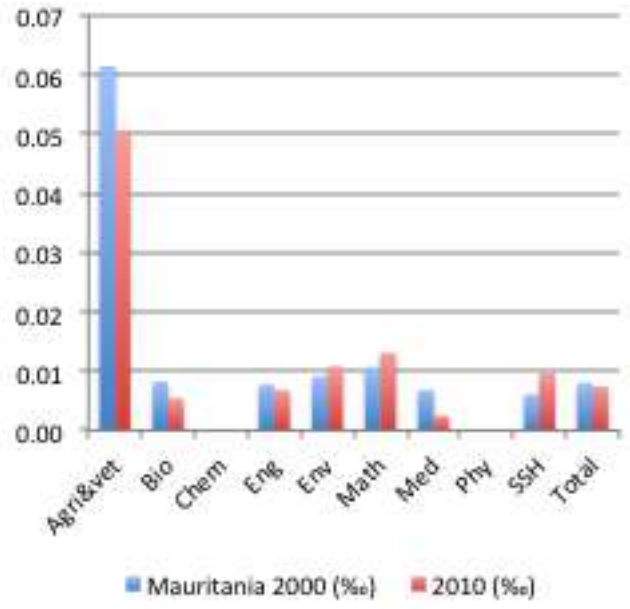
Gas and oil production

Challenges

Political instability

Mauritania

GDP (current prices): $ 4.547 billions
Population: 3.715 millions
Resources: agriculture, mining
Key institutions in STI: the national mining company, SNIM



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score	Rank
Ease of starting a business	92.0	12
Ease of paying taxes	94.2	9
Gross tertiary outbound enrolment, %	7.4	6
Ease of protecting investors	90.6	12
Trade & competition	*75.1*	*15*
Applied tariff rate, weighted mean, %	1.1	7
Non-agricultural mkt access weighted tariff, %	0.0	9
PCT patent filings with foreign inventor, %	100.0	1
New businesses/th pop. 15–64	7.3	12
Creative goods & services	*42.5*	*15*
National feature films/mn pop. 15–69	20.1	1
Creative goods exports, %	4.7	13

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score	Rank
Public expenditure/pupil, % GDP/cap	12.6	97
Tertiary inbound mobility, %	0.0	90
Infrastructure	23.5	112
E-participation	7.9	98
Ecological sustainability	*2.0*	*130*
Venture capital deals/tr PPP$ GDP	0.0	65
Knowledge-intensive employment, %	15.8	85
High-tech imports less re-imports, %	6.0	91
Knowledge creation	*2.1*	*134*
Domestic resident patent ap/bn PPP$ GDP.	0.1	104
Scientific & technical articles/bn PPP$ GDP	1.2	106
High-tech exports less re-exports, %	0.4	91
Creative services exports, %	0.6	84

Source: (Dutta 2013)

Strength

- In mining, national STI capabilities through the national mining company, SNIM, and in the public sector, are relatively well developed given the long history of iron ore extraction and the strong support provided for the public sector management and regulatory sides of the industry backed by external financing, notably from the World Bank. (UNCTAD, 2009)
- SNIM can be seen as a centre of excellence and professionalism for the country.
- The only relatively significant research publication is in agriculture and animal science, but co-authorship is extremely high.
- Oil industry: Oil transnational corporations (TNCs) have been contributing to the buildup of domestic skills in the industry through financial contributions for training, but adequate training of local personnel to man the industry is proving a challenge and knowledge flows to date have accordingly been limited.
-

Weakness

- The national system of innovation and knowledge systems suffer from extensive systems failure.
- no clear STI strategy
- very weak linkages among the different actors in the system (in particular between research institutes, universities, the private sector and Government)
- Labour productivity is generally low, and most enterprises do not have the technological innovation capabilities, and are not upgrading their production technologies, to allow them to become internationally competitive.
- the maintenance of the public sector capabilities in mining, in the form of a strong skills base is in part dependent upon continued external financial support. Even the skills base of the national mining company is in need of replenishment to replace experienced technical staff who will eventually retire.
- In the oil industry, national capabilities in engineering and in management (regulation of the industry, financial management of the national oil fund, negotiation of contracts and marketing of oil) require substantial improvement, which is natural in light of the recent nature of oil production (which started in 2006).
- The knowledge and skills base of both regulators and the national oil company is improving but is at a relatively early stage of development and needs to progress faster. Deficiencies in education and training in oil-related disciplines in the universities
- Very small share in the scientific production.

Opportunities

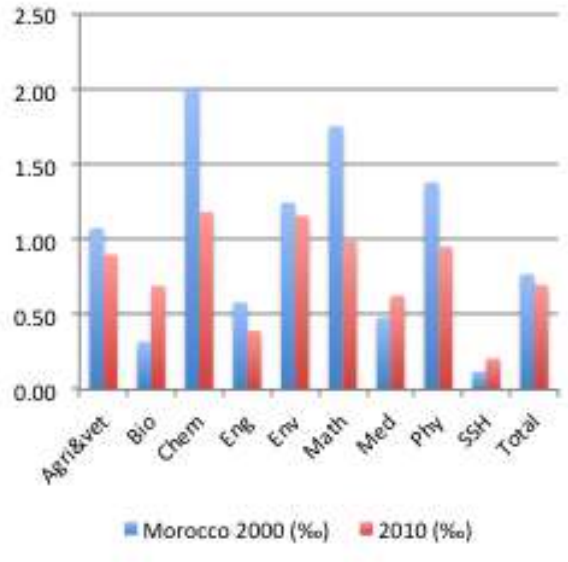
- Growth in agriculture.
- Ease of starting a business.

Challenges

- Low economic resources.
- Political instability.
- Weak e-participation
- Lack of Infrastructure: capital accumulation through high investment rates is needed to overcome persistently severe infrastructure bottlenecks to production, transport and trade.
- Lack of financial sector development : it human capital development is needed to strengthen the skills base, particularly in technical subjects such as science, engineering and other technical disciplines, and in entrepreneurship and management.
- Lack of technology diffusion and improved absorptive capacity are both needed to stimulate a stronger and more broadly based technological upgrading and improved innovation performance. (UNCTAD, 2009)
- heavy reliance of the country on natural resource activities: mining, fisheries and more recently oil.

Morocco

GDP (current prices): $ 107.111 billions
Population: 32.853 millions
Resources: tourism,
Key institutions in STI: OCP in Morocco (one of the largest phosphate producers in the world); Fondation Abdulaziz library and database in the social sciences



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Current expenditure on education, % GNI	5.2	36
Public expenditure/pupil, % GDP/cap	24.1	32
Tertiary education	*41.8*	*46*
Graduates in science & engineering, %	34.9	5
Gross capital formation, % GDP	35.1	8
Ecological sustainability	*39.8*	*41*
GDP/unit of energy use, 2000 PPP$/kg oil eq.	11.6	5
Domestic credit to private sector, % GDP	68.8	49
Market capitalization, % GDP	75.8	28
Venture capital deals/tr PPP$ GDP	12.3	42
State of cluster development	47.1	44
Domestic res trademark reg/bn PPP$ GDP.	95.7	11

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Press freedom	50.5	112
Ease of paying taxes	18.7	113
School life expectancy, years	10.4	115
Government's online service	24.8	126
E-participation	0.0	127
Environmental performance	45.8	100
Ease of protecting investors	7.1	123
Business sophistication	29.5	124
Knowledge workers	*29.6*	*115*
Knowledge-intensive employment, %	6.8	100
Innovation linkages	*27.2*	*113*
Royalty & license fees payments/th GDP	0.3	97
Creative goods & services	*7.2*	*116*
Recreation & culture consumption, %	1.2	93

Source: (Dutta 2013)

Strength

- OCP in Morocco (one of the largest phosphate producers in the world) invests 1% of its sales into R&D (sales were estimated around 7 bln USD per year). A large part of

that investment is not related to internal R&D but to the so-called "open innovation" which consists in contracting and out-sourcing research.

- EU-Morocco joint "Twinning" project and French bilateral cooperation with Morocco
- high levels of co-authorship: although international cooperation represents 3% of total expenditure in R&D, it represents an important source for investment in equipment, travel and other expenses. International cooperation was vital for the emergence of Moroccan research and has a real scientific impact since almost 70% of the articles published recently are co-authored with foreign researchers (mainly from Europe with France and Spain playing a leading role in this respect).
- Fondation Abdulaziz library and database in the social sciences.
- Important funds were allocated within the framework of the "Emergency Programme" linked to clear objectives in terms of publications, PhD theses, patents, research labs accreditation (Erawatch, 2011d).
- Creation of 4 technological clusters.
- The private sector represented 22% of R&D expenditure in 2010 (12% in 2005). According to the national survey on R&D and innovation carried out by the Association R&D Maroc in 2005, The proportion of companies that have R&D and innovation in the sample is 41% (in a sample of 1001 companies),
- The Moroccan Industrial and Commercial Property Office received 1007 applications in 2010 against 929 applications in 2009. 151 were nationals and 856 were foreigners. 11 Moroccan universities applied for 40 patents in the same year. There is no evidence with regard to the socio-economic impacts of university patents. EPO and USPTO patenting is marginal.
- Technology Business Incubators: Al Akhawayn University Incubator (Ifrane) and Casablanca Technology Park.
- Business Incubators: Morocco Incubation and Spin-off Network (RMIE), Casa Pioneers (Casablanca), iNSANE! (Casablanca).

- Set up ICT clusters : Morocco Microelectronics Cluster (www.microelectronics.ma/) and Maroc Numeric Cluster (www.marocnumericcluster.org/) aimed at helping with the creation of innovative and high-added value projects in the following four niches of excellence (Mobile services; Electrobanking / management of digital copyrights/ security; Web design/ computer graphics / Multimedia; Domestic developped softwares to meet the needs of government and enterprises).

- Political will to make the SNRI (National System of Research and Innovation) a lever of development: Enactment of new legislation (Law 01-00 on the organization of higher education and the 08-00 law relating to the creation of GIPs ''Groups of Public Interest'') and National policy of programming (2000-2004 plan, PARS, PROTARS, calls for proposals for projects funded, competence poles), and valorization (IMIST; MARWAN network UATRS; RTD RMIE; GIR) (IMIST; MARWAN network, UATRS; RTD, RMIE; RGI)

Weaknesses

- Universities have a limited research record.
- 15 technology transfer units have been created in universities but only one or two have been active.

- very weak linkages among the different actors in the system (in particular between research institutes, universities, the private sector and Government)
- Emergency Programme developed several indicators to monitor the progress towards set objectives. But an Evaluation system for the whole research system is yet to be developed for more evidence based policies in the future. (Erewatch, 2011d)
- Moroccan science journals suffer from fundamental problems such as irregular publishing, lack of objective peer review of the articles accepted for publication, and the unedited publication of the proceedings of conferences and seminars. Additionally, some of these periodicals are not regarded as credible for academic promotion purposes, which makes many researchers and academics prefer to publish in international, peer reviewed journals (UNDP, 2009:200).

Opportunities

- New emerging democracy.
- Stratégie nationale pour le développement de la recherche scientifique à l'horizon 2025 :

  Implemented since 2006, it constitutes the "road map" for the development of multiannual and annual action plans for the promotion and valorization of National System of Research and Innovation (SNRI). Their major orientations are:

- Governance and performance of the SNRI ((control, organization, structuring, coordination, evaluation, valorization, communication and information, relation with the socio-economic world);
- Promotion, motivation and mobilization of human resources
- Diversification of funding sources, and improving the financial management of research activities
- The improvement of scientific infrastructure, of R & D and innovation
- International cooperation (policy, capitalization, expansion: Africa and the Arab World, joint research programs, scientific exchanges)

  Actions to be taken:

- Increase in the share of GDP devoted to research and innovation to reach 3%;
- Increase from 3 to 10 % the share of international cooperation in research funding;
- Incentives to promote technology transfer
- Instruments to support creation of innovative enterprises and promotion of R & D activities in companies (Programmes Innov'act, MEDIBTIKAR …)
    - Foundation MASCIR recruited several tens of researchers from the Moroccan Diaspora as well as foreigners which is quite uncommon in Morocco. (Erawatch, 2010d).
- Moroccan researchers living abroad are estimated to be more than 15000. To limit the effects of brain drain, the Moroccan Government launched the **FINCOME** programme targeting highly skilled diaspora that brings together several stakeholders to propose practical programmes and actions. The FINCOME call for proposal launched jointly by CNRST and association "R&D Maroc" support financially short

term visits (transportation fees & per diems) of eminent Moroccan experts to transfer their knowledge and skills to their Moroccan counterparts mainly in academic and research institutions. So far more than 230 Moroccan experts (mainly professors, researchers and engineers) participated in the programme with more than 100% increase in 2010.

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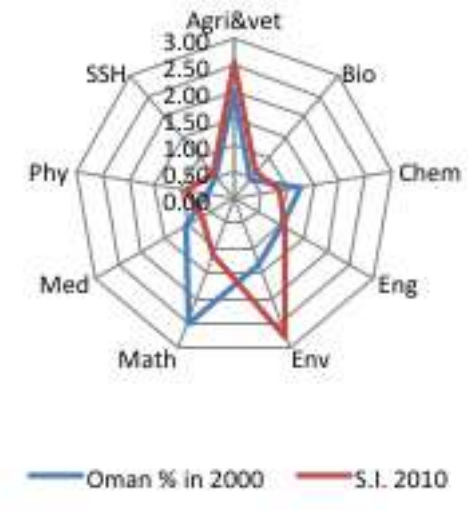
Challenges

- difficulty to professionalize the technology transfer activities inside the universities
- Problems related to bureaucracy and inadequate legal framework, human resources management and promotion system are still persistent (Erewatch, 2011)

Oman

GDP (current prices): $ 78.788 billions
Population: 3.186 millions
Resources: Gas and oil
Key institutions in STI: the Research Council; Long term objectives of Vision 2020; Information Technology Authority (ITA) - ICT / eGovt Initiative.



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Institutions	71.9	33
Political stability	81.9	32
Regulatory environment	*82.5*	*32*
Cost of redundancy dismissal, salary weeks	8.0	1
Business environment	*68.3*	*33*
Ease of paying taxes	95.6	7
Human capital & research	48.1	36
Tertiary education	*49.0*	*21*
Graduates in science & engineering, %	38.9	2
Research & development (R&D)	*45.9*	*26*
Government's online service	66.7	35
General infrastructure	*47.0*	*30*
Gross capital formation, % GDP	29.6	20
Innovation linkages	*66.0*	*4*
State of cluster development	51.8	32
JV–strategic alliance deals/tr PPP$ GDP	191.0	1
PCT patent filings with foreign inventor, %..	100.0	1
Creative intangibles	*64.4*	*8*
ICT & organizational model creation	70.1	0

Source: (Dutta 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Environmental performance	44.0	105
Ease of getting credit	15.3	112
Venture capital deals/tr PPP$ GDP	0.0	65
Knowledge workers	*29.3*	*116*
Firms offering formal training, % firms	20.9	89
GMAT mean score	406.6	125
High-tech imports less re-imports, %	4.9	105
PCT resident patent ap/bn PPP$ GDP	0.1	89
High-tech exports less re-exports, %	0.1	114
Creative goods & services	*7.4*	*115*
National feature films/mn pop. 15–69	0.0	100
Country-code TLDs/th pop. 15–69	0.3	132

Source: (Dutta 2013)

Strength

- General business-friendly policy and partnerships in innovation between private and public R&D.
- Institutional setting and its driver: the Research Council; Long term objectives of Vision 2020; Information Technology Authority (ITA) - ICT / eGovt Initiative ; TRC mandate established by a Royal Decree; Government initiatives to enable sustainable job creation.
- Entrepreneurship initiatives in favour of innovation: ICT Industrial- by Information Technology Authority (ITA); A study on "Entrepreneurial Academic Institutions in Oman" to identify actions & models for academic institutions to spur innovation driven entrepreneurship was carried out by TRC last year ; National SME Symposium held recently in Bahla ; Introduction of curriculum of entrepreneurship in universities
- Specific sectors deploying innovation strategies: National Innovation Policy under development by The Research Council: Several innovation initiatives of TRC including: innovation Hub; Industrial Innovation Assistance Programme ; Education Innovation Assistance Programme ; Academic Innovation Assistance Program; Community & Individual Innovation Assistance Programme
- Productive sector: Enhanced Oil Recovery and Research initiatives in agro-technologies, fisheries.
- Strategies to promote research and innovation: Gamut of initiatives of The Research Council, which started with the development of the National Research Strategy and also includes several more projects in the pipeline including the Animal and Plant

Genetic Resource Centre, Science Park, Venture Funding Agency and National Innovation Policy Development.

- In terms of Research: there are many initiative: open Research Grant, strategic Research Grant, Road Safety Research Program, Dubas Bug Program, Social Observatory Research Program, Nanotechnology for water desalination, Faculty Mentored Undergraduate Research Award Program –Recently Launched, Eco-house Design Competition.
- In terms of innovation: Innovation Hub – A pilot initiative, Industrial Innovation Assistance Programme Operating since 3 years, Education Innovation Assistance Programme,
- Community Innovation Assistance Programme
- ICT Incubation Hub
- In terms of scientific production: shift in the last 10 years from the math and chemistry to environmental science and agriculture and animal science (including fisheries)

Weakness

- Obstacles of the Institutional setting : Lack of understanding about innovation ; Fragmented innovation eco-system ; Minimal private, public, academia collaborations; Dependence on skilled foreign workforce
- For the productive sector:
    - Lack of commercial focus in government funded research
    - Lack of Dedicated research centres with trained workforce
    - Minimal participation of private companies, as most are trade based
    - Dependence on foreign workforce
- For the private and NGOs sector: Private research, except in the oil & gas sector is practically non-existent due to trade based nature of business. Critical factors include:
    - Dependence on skilled foreign workforce
    - High training costs
    - Inefficiencies

Opportunities

- Excellent infrastructure, fast developing new infrastructure projects, ports, free zones
- Self- reliance in fossil fuel
- Huge solar energy potential and renewable energy projects initiated
- Huge demographic advantage

For the productive sector:

- Enhanced Oil Recovery technologies.
- Export of processed food especially for regional market.
- Downstream products of oil & gas.
- Academic Innovation Assistance Program: Pilot phase with SQU to be launched soon

Challenges

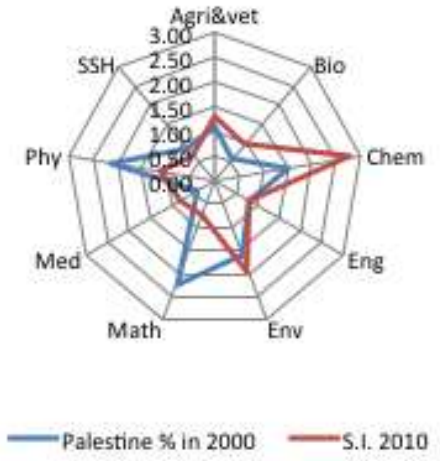
- High unemployment
- SMEs are trade based and dominated by hidden trade
- Lack of SME technological capabilities to attract high-tech FDIs
- Lack of proper IP infrastructure and governing policies
- Poor productivity
- Lack of cooperation with the Arab countries that have good human resources

For the productive sector:

- Research Excellence in the above sectors
- Desalination Technologies
- Understanding of technology transfer mechanisms to build local capacities

Palestine

GDP (current prices): $10 billions
Population: 3.927 millions (2011)
Resources: industry
Key institutions in STI: University of Birzeit and ICT Centers of Excellences.



Source: (Hanafi & Arvanitis 2013)

Strength

- Public sector is not taking a leading role in driving innovation in Palestine. The NGOs and Educational institutions are driving the sector.
- **Targeting students and fresh graduates**: there are many such programs more than 50, almost in all universities, PICTI, Leaders, IYF, etc;

- In terms of scientific production: shift in the last 10 years from the math and physics to chemistry and agriculture and animal science
- Many research centers affiliated to universities but not in social science
- ICT Centers of Excellences
  - Friends of Fawzi Kawash Information Technology Center of Excellence (FFKITCE), Palestine Polytechnic University.
  - Hassib Sabbagh IT Center of Excellence (HSITCE), Arab American University-Jenin.
  - Said Khoury IT Center of Excellence, Al Quds University.
  - Intel Information Technology Center of Excellence, Islamic University of Gaza.
  - Najjad Zeenni Center of Excellence in Information Technology, Birzeit University.
- Development of some incubators
- **Targeting existing business (**Sadara ventures, Palestinian Investment Fund, Abraaj Capital, Siraj): Large investment fund; Good business knowledge (in some domains); Long term strategy to support companies; Large network locally and globally
- **Software: Large number of graduates; Low number of turn-over; English language; Close to Israel**
- **Universities:** Good network with European and American universities; Summer school – bringing Palestinian Diaspora to teach in summer

Weaknesses

- Research centers or consultative agencies outside of universities play a primary role in social science research (UNDP, 2009: 202)
- Weak linkages among the different actors in the system (in particular between research institutes, universities, the private sector and Government).
- **Targeting students and fresh graduates** : They lack exit strategy for entrepreneurs; Funding provided to entrepreneurs is not enough to start a business; People managing those program are not entrepreneurs; Most programs are concentrated in major cities; Lack of coordination between those programs
- **Targeting existing business :** Pipeline of mature businesses is very weak; Regulatory framework in the country is major obstacle
- Software: Small market and demand is very low; International network is very weak; Image of Palestine; R&D at universities is missing; No specialization and expertise in specific areas
- Universities: Lack of research culture; Lack of policies to promote research; Difficulty in attracting high quality researchers; Weaknesses of the private industry; Lack of research culture; Lack of policies to promote research; Difficulty in attracting high quality researchers; Weaknesses of the private industry
-

Opportunities

- Excellent ICT capability

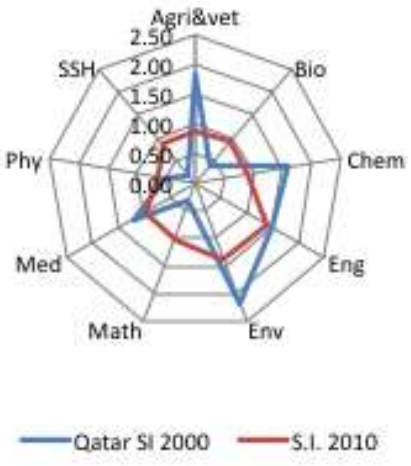
- Return of local experts from the diaspora even for short period (through TOKTEN program)

Challenges

- Israeli occupation
- Economy under heavy Israeli control
- Restricted mobility of the Palestinian scientists
- Brain drain: 2 500 Palestinians scientists and engineers living in the USA (Mouton and Waast 2009).
- Lack of knowledge about the palestinian diaspora as the internet-based network called PALESTA (Palestinian Scientists and Technologists Abroad) was stopped.

Qatar

GDP (current prices): $ 188.812 billions
Population: 1.912 millions
Resources: Gas and oil.
Key institutions in STI: Qatar Foundation for Science and Technology; Qatar educational Park, Technology Innovation and Entrepreneurship Program.



Source: (Hanafi & Arvanitis 2013)

<u>High innovation indicators (GII)</u>

Indicator	Score (0–100) or value (hard data)	Rank
Ease of paying taxes	100.0	1
Tertiary inbound mobility, %	38.9	3
Research & development (R&D)	*80.5*	*2*
Quality of scientific research institutions	80.5	6
General infrastructure	*67.4*	*3*

Electricity output, kWh/cap	15,128.7	7
Electricity consumption, kWh/cap	16,352.7	7
Gross capital formation, % GDP	38.9	5
Intensity of local competition	81.4	4
Innovation linkages	*67.8*	*3*
Knowledge absorption	*64.6*	*5*
Knowledge impact	*74.2*	*1*
Growth rate of PPP$ GDP/worker, %	14.8	1
Creative intangibles	*76.2*	*1*
ICT & business model creation	73.8	6
ICT & organizational model creation	78.6	2

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Current expenditure on education, % GN	1.8	129
PISA scales in reading, maths, & science	373.1	66
Tertiary enrolment, % gross	10.0	107
Ecological sustainability	*18.2*	*117*
GDP/unit of energy use, 2000 PPP$/kg oil eq	1.5	122
Ease of getting credit	15.3	112
Venture capital deals/tr PPP$ GDP	0.0	65
Knowledge creation	*1.5*	*139*
Knowledge diffusion	*0.0*	*139*
Creative goods exports, %	0.1	120
Country-code TLDs/th pop. 15–69	1.4	121

Source: (Dutta 2013)

Strength

- *Key public institutions driving innovation:*
  - Qatar Foundation and science and research organizations under it:
    - Qatar Science and Technology Park as a "national agency charged with executing applied research and delivering commercialized technologies in four themed areas: Energy, Environment, Health Sciences, and Information and Communication Technologies. QSTP has access to the resources of Educational City's cluster of leading international research universities".

- Qatar National Research Fund as a prime enabler for research in the country, playing a catalytic role in Qatar's development by encouraging and supporting high-quality basic and applied research serving national needs and interests, and also contributing to the visibility of the country's investments in research and education, and technology development and innovation.
- Good universities in Qatar (Qatar University, Carnegie Melon University in Qatar, Texas A&M – University at Qatar, Georgetown University School of Foreign Service, Northwestern University in Qatar, Qatar Faculty of Islamic Studies)
- R&D Directorate that has developed a national strategic plan, the Qatar National Research Strategy (QNRS) that identified four pillars for R&D that span energy & environment, biomedical and healthcare, ICT, and social science, arts & humanities, and embracing the development of the following centers of excellence associated with the above research pillars:
  - Qatar Energy & Environment Research Institute
  - Qatar Computing Research Institute
  - Qatar Biomedical Research Institute
- Strong support at high level to research and innovation (recognized by government at strategic level).
- Qatar set the bar high by calling for the allocation of 2.8 per cent of the general budget to support scientific research in mid of 2008.
- In terms of scientific production: shift in the last 10 years from the agriculture and animal science, chemistry and environmental science to physics to biology and math

Entrepreneurship initiatives in favor of innovation:

- Technology Innovation and Entrepreneurship Program (under QSTP);
- Digital Incubation Center (under ictQATAR), Bedaya Center.
- iHorizons –"a Qatari software company, with offices throughout the region, specializing in the development of e-business applications and software solutions".
- The Qatar Mobility Innovations Center (QMIC) - "the first regional independent innovations institution that focuses on using emerging mobility and wireless technologies to deliver locally-engineered innovations to the market. These innovations address the needs of a number of important market segments like Transportation, Environment, Utilities, and Sports".
- Gulf Organization for Research & Development (GORD): "a 100% government Qatari organization leading the fight to transform the way buildings are designed, built and operated by promoting healthy, energy- and resource-efficient building practices".

Specific sectors in favor of innovation:

- The Energy and Industry sector and air transportation (investing in biofuels and clean energy R&D)
- ICT applications, and social media
- Healthcare and medical (Bio Bank; HMC embracing robotic surgery techniques where training is provided by QSTP)
- The built environment through green buildings codes
- Education (the WISE Initiative in education); Sports (use of electronic 'jockeys' in camel racing!).

- *Drivers of the entrepreneurship initiatives:* Strong support at high level (government will in place) Establishment of Qatar National Research Fund.
- *Strategic sectors for deploying innovation in Qatar*: Health and healthcare, Energy and Environment, Computer Sciences and IT, Social Sciences, Arts and Humanities.
- Driver of these strategic sectors: government support.

- The critical factors of research inside universities or public research institutes:

- Qatar has recently developed a good R&D academic base (through international universities from which the industrial sector could benefit.
- Deployment of modern innovation building concepts (open innovation).

Weakness

- Limited human resource base.
- Pursuing "branding" strategies for their universities.
- *Obstacles the entrepreneurship initiatives:* Low diversification of domestic industry with; dominance of Oil and Gas industry;
- *obstacles of the strategic sectors*: limited scientific base; reliance on imported technology and human resources.

- The critical factors of research inside universities or public research institutes:

- Gap between innovation inputs/outputs: still short on knowledge, technology and creative outputs

Opportunities

- Oil and gas economy
- Qatar National Vision 2030[4]
- Qatar's National Research Strategy 2012 and Strategic Plan for Implementation.[5]

Challenges

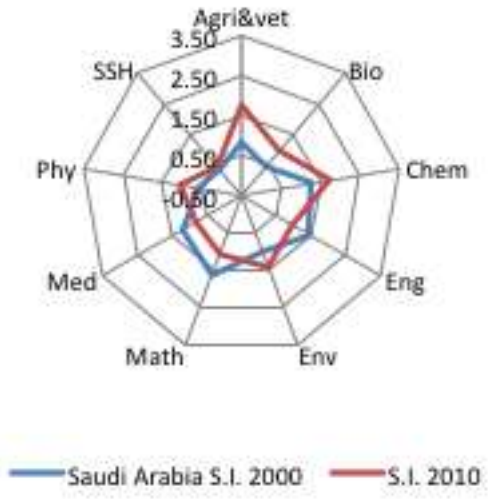
- Lack of enough human resources
- Lack of cooperation with the Arab countries that have good human resources
- Parachuted universities' branches that do not contribute in a research which is necessarily relevant to Qatari society or to Arab societies.

[4] http://www.gsdp.gov.qa/portal/page/portal/gsdp_en/qatar_national_vision/qnv_2030_document/QNV2030_English_v2.pdf

[5] http://dwaa80npcw0ml.cloudfront.net/app/media/346.

Saudi Arabia

GDP (current prices): $ 745.617 billions
Population: 29.632 millions
Resources: Gas and oil
Key institutions in STI: National Science, Technology, and Innovation Plan; King Abdulaziz City for Science and Technology (KACST)



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Business environment	*80.8*	*15*
Ease of starting a business	90.6	14
Ease of paying taxes	94.9	8
Education	*65.5*	*15*
Current expenditure on education, % GN	7.2	9
Graduates in science & engineering, %	35.8	4
Government's online service	79.7	19
Ease of protecting investors	87.0	16
Intensity of local competition	77.2	16
Innovation linkages	*61.4*	*6*
State of cluster development	62.7	11
JV–strategic alliance deals/tr PPP$ GDP	79.0	17
Creative intangibles	*72.4*	*3*
ICT & business model creation	69.3	17
ICT & organizational model creation	75.5	5

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Innovation Efficiency Index	0.6	127
Press freedom	37.0	127
Researchers, headcounts/mn pop	47.4	115
Gross expenditure on R&D, % GDP	0.1	100
GDP/unit of energy use, 2000 PPP$/kg oil eq	2.4	111
Venture capital deals/tr PPP$ GDP	0.0	65
GMAT mean score	349.5	139
Knowledge & technology outputs	15.3	130
Knowledge creation	*2.7*	*132*
Growth rate of PPP$ GDP/worker, %	0.7	97
High-tech exports less re-exports, %	0.1	111
Computer & comm. service exports, %	2.8	132
Recreation & culture consumption, %	1.5	90

Source: (Dutta 2013)

Strength

- National Science, Technology, and Innovation Plan
- Steep rise in publication output and patenting activity: Saudi Arabia produced less than 2% of world output in 2000, but by 2011 this had risen to over 5% which is more than double in relative share despite growth in output from other nations over the same period. (Thomson Reuters 2012)
- 6 Scientific Journals with Springer
- General business-friendly policy and partnerships in innovation between private and public R&D.
- In terms of scientific production: a dramatic growth of the publication in the last 10 years and shift from math to the agriculture and animal science, biology and chemistry. (see above graph) In fact when one looks at the production it is very much organic chemistry, chemical engineering and physio-chemical characterisations of specific materials. In terms of topic, the research focuses are in the Red Sea and Clinical medicine.
- High co-authoring.

- King Abdulaziz City for Science and Technology (KACST) is host to both the Saudi Arabian national science agency and its national laboratories. The science agency function involves science and technology policymaking, data collection, funding of external research, and services such as the patent office. KACST is a real "science

city" (or technopole) with three components: research, innovation and service for the public and private sectors. In term of research it has 15 research teams in different disciplines. In terms of innovation, KACST has three programmes concerning industrial property, an incubator and innovation centers, plus a grant system to "Encourage Excellence and Innovation". KACST has a 2011 giant budget of around half billion US$ ($491,713,692), offering research grants for 64 researchers/ research teams with ($16 m). It is interesting that only 23% of budget is in basic science while the remaining is in applied science (31% in medicine, 27% in engineering and 16% in agriculture) (KACST, 2012: 105).

- KACST understood that it is very important to provide an outlet for research output by subsidizing open access to academic referee journals. KACST partnered with Springer to publish eight international journals to foster the development of key applied technologies, providing a forum for the dissemination of research advances and successes from the Kingdom of Saudi Arabia and the world. Their open access journals are: Applied Water Science, Journal of Petroleum Exploration and Production Technology, Applied Petrochemical Research, Applied Nanoscience, Biotech, Materials for Renewable and Sustainable Energy. All these journals have two chief editors: one Westerner and other Saudi.

- Saudi authorities opted for encouraging a model that is driven by local expertise, with the help of regional and international expatriates, and contrary to what is happened in UAE and Qatar (parachuting foreign branches).
- Both MIST and KAUST have also developed unique "technology parks" that offer innovators and entrepreneurs mentoring support for product development and for deployment of the tens of patents that the schools have already acquired.
- Technology Business Incubators (BADIR-ICT Technology Incubator, Badir for Advanced Manufacturing, BADIR for Biotechnology, Riyadh)

Weaknesses

- Research centers or consultative agencies outside of universities play a primary role in social science research (UNDP, 2009: 202)
- Weak social science production and has very functionalist nature.
- The citation impact of most of the SA universities is below world average

Opportunities

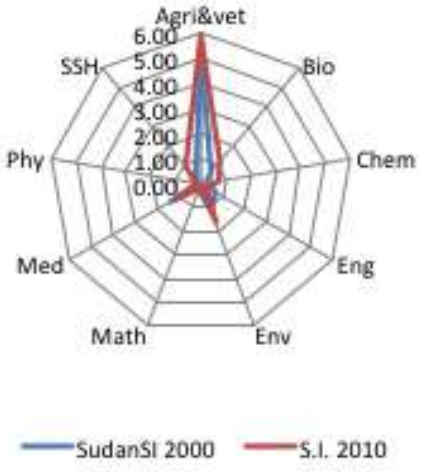
- Oil and gas economy
- Newly local HR
- Good Business environment
- Excellent ICT system
- Private sector funding for the R&D

Challenges

- Low Innovation Efficiency Index.
- Lack of cooperation with the Arab countries that have good human resources

The Sudan

GDP (current prices): $ 50.593 billions
Population: 34.382 millions
Resources: Agriculture
Key institutions in STI: The Council of Higher Education and Scientific Research; Agricultural Research Corporation (ARC)



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Ease of resolving insolvency	46.7	75
Ease of paying taxes	48.2	73
Gross tertiary outbound enrolment, %	1.0	73
Gross capital formation, % GDP	23.3	59
GDP/unit of energy use, 2000 PPP$/kg oil eq	5.7	59
Non-agricultural mkt access weighted tariff, %.	0.0	14
Innovation linkages	*54.9*	*10*
JV–strategic alliance deals/tr PPP$ GDP	16.4	71
PCT patent filings with foreign inventor, %	100.0	1
High-tech imports less re-imports, %	8.3	67
FDI net inflows, % GDP	4.7	40

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Global Innovation Index 2012 (out of 141	**16.8**	**141**
Innovation Output Sub-Index	10.3	141
Innovation Input Sub-Index	23.3	141
Innovation Efficiency Index	0.4	141
Political environment	*10.1*	*141*
Political stability	0.1	140
Government effectiveness	5.0	139
Rule of law	12.8	138
Current expenditure on education, % GNI	0.9	137
Research & development (R&D)	*4.2*	*136*
ISO 14001 environmental certificates/bn PPP$ GDP	0.0	133
Market sophistication	16.4	140
Credit	*1.5*	*141*
Venture capital deals/tr PPP$ GDP	0.0	65
Knowledge absorption	*19.9*	*140*
Computer & comm. service imports, %.	1.6	134
Domestic resident patent ap/bn PPP$ GDP	0.0	108
Creative outputs	2.4	141
Creative intangibles	*2.7*	*136*
Madrid resident trademark reg/bn PPP$ GDP	0.0	61
Creative goods exports, %	0.0	132
Online creativity	*2.2*	*139*
Video uploads on YouTube/pop. 15–69	8.6	136

Strength

- The Council of Higher Education and Scientific Research was established in 1991 as a governmental body responsible for formulating policies and plans and coordinating national efforts in this respect.
- The Ministry of science and technology includes some specialized research institutes and centers including Agricultural Research Corporation (ARC); Animal Resources Research Corporation (ARRC); National Centre for Research (NCR); Industrial Research and Consultancy Centre (IRCC); Sudan Atomic Energy Corporation (SAEC); Sudanese Metrology Authority (SMA); Central Laboratories (CL); Sudan Academy of Sciences (SAS); Social and Economic Research Bureau (SERB).

- Research publication is almost in agriculture.
- Az-Zubair Prize for Innovation and Scientific Excellence.
- The Future University (FU) considered a prime producer of skilled computer scientists and information technologists. It has many centers (Kush Institute for Space Technology (KIST), UNESCO Cousteau Echo-Technie Chair (UCEC), International Computer Driving License Center (ICDL), Centre for E-learning and Software Development (CESD), Training and Research Center, Innovation Development Environment Application Sudan Center (IDEAS), Center for Technological Services (CTS), ISTIC - Africa Hub)

Weaknesses

- Sudan lags behind the world's developed and leading developing countries in terms of the same input and output indicators.
- Very small share in the scientific production: the number of publications per researcher per year which is 0.03 in average compared to the international rate of 2 papers for each researcher. (Nour 2010)
- low contribution to education
- the worst country in terms of Global Innovation Index 2012 (141 out of 141)
- UNDP-Human Development Indicators (2007) and (2009) which indicate that Sudan has scored medium in human development in the last few years, it is classified amongst the bottom of developing countries in terms of HDI, as it ranked 147 and 150 out of 177 developing countries in 2007 and 2009 respectively. (Nour 2010)

Opportunities

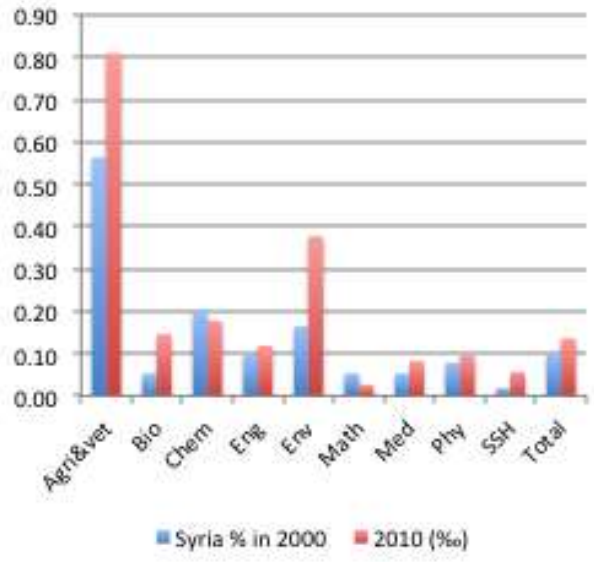
- great natural resources

Challenges

- political turmoil
- Sudan is still lacking both basic and high technology infrastructure

Syria

GDP (current prices): $ 31.2 billions (2010)
Population: 26 millions (2010)
Resources: Oil, agro-food industries
Key institutions in STI: Syrian Center for Scientific Research; ISSAT



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Regulatory environment	*64.7*	*76*
Cost of redundancy dismissal, salary weeks	8.7	23
Pupil-teacher ratio, secondary	7.2	5
Research & development (R&D)	*27.0*	*51*
ICT access	39.6	75
Trade & competition	*65.5*	*61*
Non-agricultural mkt access weighted tariff, %	0.0	12
Exports of goods & services, % GDP	35.3	77
Intensity of local competition	69.5	42
Firms offering formal training, % firms	38.3	45
FDI net inflows, % GDP	2.3	70
Creative goods exports, %	1.6	52
Creative services exports, %	2.0	61

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Political environment	*24.1*	*136*
Press freedom	0.0	140
Credit	*2.5*	*139*
Ease of getting credit	1.4	137

Venture capital deals/tr PPP$ GDP	0.0	65
Business sophistication	25.4	134
University/industry research collaboration	23.4	126
JV–strategic alliance deals/tr PPP$ GDP	0.0	114
Knowledge absorption	*16.6*	*141*
High-tech imports less re-imports, %	2.4	121
Computer & comm. service imports, %	6.1	130
Knowledge diffusion	*2.3*	*136*
Computer & comm. service exports, %	5.7	128
Creative intangibles	*23.8*	*129*
ICT & business model creation	28.7	128
Country-code TLDs/th pop. 15–69	0.0	140

Source: (Dutta 2013)

Strength

- There is the Higher Commission for Scientific Research (Damacus-Syria) that is responsible for national STI plan development. (http://www.hcsr.gov.sy/?d=288&id=384)
- The total number of scientific publications for universities and other institutes related to Ministry of Higher Education (National and International) in 2009 is 2916 publications. (HCSR 2010)
- The total number of R&D projects for 2009 was 1506, out of which 1276 projects for Agriculture. (HCSR 2010) Agriculture seems to be the most advanced areas. Specific Research Center for Agriculture is well established (http://www.gcsar.gov.sy/gcsarAR/).
- The international agricultural centre ICARDA (HQ was based in Aleppo) belonging to the CGIAR network[6] have played an important role in structuring the research in this field in the region. It is specialized on plant and animal sciences.
- Some research also is in environment
- 46 registered patents in 2009. (HCSR 2010)
- $75 million of scientific research spending in 2009. (HCSR 2010)
- Good ICT access
- Several incubators for ICT, business and technology (examples: SCS incubators http://www.idisc.net/en/Incubator.105.html)

[6] The Consultative Group on International Agricultural Research is based in Washington and groups fifteen international research centers. www.cgiar.org/ ICARDA is the only one center based in the region.

Weaknesses

- Public research centres are burdened with scientific services required by public utilities, or are under the pressure of teaching.
- lack of incentives for faculty to conduct research. Universities have thus a limited research record
- Limited number of scientists and engineers who work in research and development. (UNESCO, 2010)
- Contribution to the production of original research and patents are inexistent and they do not include all scientific specializations.
- Lacking a proper university system
- Research centers or consultative agencies outside of universities play a primary role in social science research (UNDP, 2009: 202).
- Industrial sector: generally the results of scientific researches are still bot very significant, and non-existent effect on the competitive performance in Syria. The competitive industrial performance in Syria is low because the Syrian industry depended on the workers who have low level of education and used rapid technologies.

Opportunities

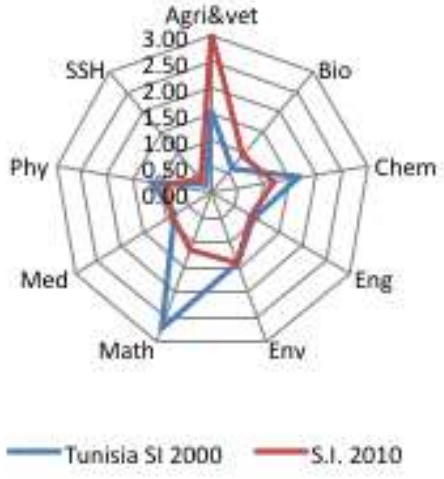
- Oil economy

Challenges

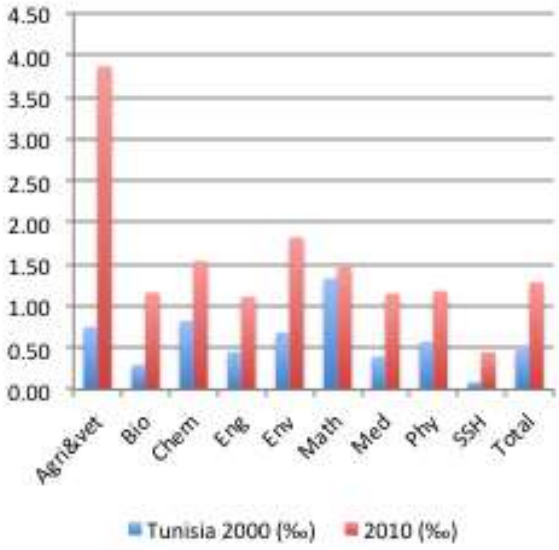
- Syria political upheaval.
- Very low FDI.
- The good social scientists were either in prison, exiled or assassinated
- Brain drain: 5 000 Syrians scientists and engineers living in the USA (Mouton and Waast 2009).

Tunisia

GDP (current prices): $ 49.489 billions
Population: 10.918 millions
Resources: tourism, garment and agro-food industries
Key institutions in STI: National research evaluation system (called CNEARS); PASRI: Projet d'Appui au Système de Recherche et Innovation ; Industrial clustering ; University of Tunis.



Source: (Hanafi & Arvanitis 2013)



Source: (Hanafi & Arvanitis 2013)

<u>High innovation indicators (GII)</u>

Indicators	Score (0–100) or value (hard data)	Rank
Researchers, headcounts/mn pop	3,239.8	31
Business environment	*72.1*	*28*
Ease of resolving insolvency	76.9	33
Current expenditure on education, % GNI	6.7	13
Researchers, headcounts/mn pop	3,239.8	31
Gross capital formation, % GDP	26.4	30
GDP/unit of energy use, 2000 PPP$/kg oil eq	9.8	13

Non-agricultural mkt access weighted tariff, %.	0.2	31
R&D financed by abroad, %	14.9	20
PCT patent filings with foreign inventor, %	100.0	1
Scientific & technical articles/bn PPP$ GDP	10.7	34
Creative intangibles	*60.0*	*11*
ICT & organizational model creation	60.3	23

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicators	Score (0–100) or value (hard data)	Rank
Press freedom	52.5	108
PISA scales in reading, maths, & science	391.9	61
Tertiary inbound mobility, %	0.7	82
Environmental performance	46.7	94
Venture capital deals/tr PPP$ GDP	0.0	65
Trade & competition	*56.4*	*107*
Applied tariff rate, weighted mean, %	16.0	139
GMAT test takers/mn pop. 20–34	24.8	109
Knowledge absorption	*27.3*	*109*
Royalty & license fees payments/th GDP	0.3	96
National feature films/mn pop. 15–69	0.1	97
Creative services exports, %	0.3	90

Source: (Dutta 2013)

Strengths

- Tunisia research system is among the best structured in the Arab World with a system of nationally recognized label for research laboratories and research units. Evaluation done by a national committee of research.
- Dedicated national budget for research.
- National research evaluation system (called CNEARS)
- Creation of a national programme to support innovation (PASRI: Projet d'Appui au Système de Recherche et Innovation) co-funded by EU and Tunisian Ministry
- Structured system of interventions in support of innovation: support to investment in R&D, technology transfer and to a more limited scale venture capital.
- Research specialization on agriculture and veterinary research, biological sciences and bio-medical sciences, and environmental sciences.
- Strong biotechnological research.
- Important collaboration with France.
- Specific research centers for applied science in Industry (textiles, mechanical and electrical engineering, packaging, agrofood, chemical industry, construction materials, wood and furniture, leather and shoes).
- Reputable engineering schools modeled after the French system of Grandes Ecoles
- National system of technopoles..

- Business–government relations have enhanced industrial upgrading and promoted industry clusters. (HDR, 2013). Tunisia has pioneering an upgrading programme for SMEs with Eu funding that has been quite successful in the early 2000 years.
- systematic policy to promote technoparks that function as nurseries and incubators as well as technopoles: El Ghazala technopole in Tunis, mainly oriented toward ITC is the strongest and oldest of these technopoles and it was structured around the national telecommunication engineering school.
- Tunisia has quadrupled its publication (from 540 in 2000 to 2026 in 2008) and its world share reached 2.05
- Industrial cluster are known in Tunisia : textile and clothing industry in Ksar-Hellal, lether industry in El-Jem, carpets in Kairouan, construction bricks in Moknine, ceramics in Nabeul, mechanics, metal work, shoes in Sfax,…
- Based on a sample of 543 manufacturing firms, taken from the Tunisian Survey of Technological Innovation conducted in 2005 by the Tunisian Ministry of Scientific Research, Technology and Skills Development, the results indicate that the firm's technological competences, derived from in-house R&D effort and cooperation are the main determinants of innovation performance of Tunisian firms. (El Elj 2010)

Weakness

- Dispersion of technopoles and projects that do not seem to be compatible with local capabilities
- Few contact between academics and production
- Difficult relations with EU concerning science policy (a feature that is changing mainly due to political change in Tunisia)

Opportunities

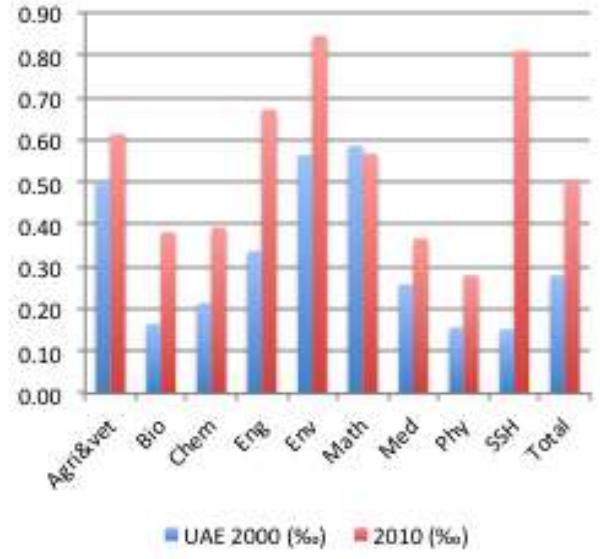
- Democratic transition
- A flourishing of garment industry
- Good ICT & organizational model creation

Challenges

- Bureaucracy

The United Arab Emirates

GDP (current prices): $ 369.364 billions
Population: 5.702 millions
Resources: Gas and oil
Key institutions in STI: National Research Foundation; Masadar Institute of Science and Technology (MIST)



Source: (Hanafi & Arvanitis 2013)

<u>High innovation indicators (GII)</u>

Indicator	Score (0–100) or value (hard data)	Rank
Cost of redundancy dismissal, salary weeks	8.0	1
Ease of paying taxes	97.1	5
Tertiary education	*56.9*	*8*
Tertiary inbound mobility, %	39.2	2
Government's online service	86.3	9
E-participation	73.7	11
General infrastructure	*69.3*	*2*
Electricity output, kWh/cap	17,878.6	3
Electricity consumption, kWh/cap	17,295.9	1
Innovation linkages	*68.7*	*2*
JV–strategic alliance deals/tr PPP$ GDP	147.8	7
PCT patent filings with foreign inventor, %	100.0	1
Creative intangibles	*70.8*	*4*
ICT & organizational model creation	72.9	7

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Innovation Efficiency Index	0.6	121
Ease of resolving insolvency	6.4	131
Public expenditure/pupil, % GDP/cap	8.3	112
GDP/unit of energy use, 2000 PPP$/kg oil eq	2.0	116
Ease of protecting investors	22.3	100
Non-agricultural mkt access weighted tariff, %	2.4	121
Knowledge & technology outputs	18.7	110
Scientific & technical articles/bn PPP$ GDP	1.1	109
Growth rate of PPP$ GDP/worker, %	1.4	110
Computer software spending, % GDP	0.1	62
Knowledge diffusion	*0.3*	*138*
High-tech exports less re-exports, %	0.1	108
Recreation & culture consumption, %	2.2	79

Strength

- National Research Foundation was established a strategic plan for 2011-2013 and vision plan for 2020.
- In the last 10 years there are great growth of scientific publication, especially in agriculture, engineering and SSH.
- Relatively high H-index as the Emirates has engaged into what seems to be the progress towards internationally recognized research. This might be also the result of growing numbers of expatriates in UAE.
- Masadar Institute of Science and Technology (MIST) that has been established in Abu Dhabi in collaboration with M.I.T., as a graduate and research institution to focus primarily on alternative energy and green technology.
- Annual UAE Innovation and Entrepreneurship Forum, since 2007. In 2013, forum was hosted by the Masdar Institute and more than 200 private and public stakeholders in innovation and entrepreneurship are set to gather at the event to discuss innovation and entrepreneurship ecosystem in the UAE.
- Grants to connect university researchers with the local industry
- Virtual Business Incubator: ADU Enterprise (Abu Dhabi)

Weaknesses

- Research centers or consultative agencies outside of universities play a primary role in social science research (UNDP, 2009: 202).
- Pursuing active "branding" strategies for their universities.

Opportunities

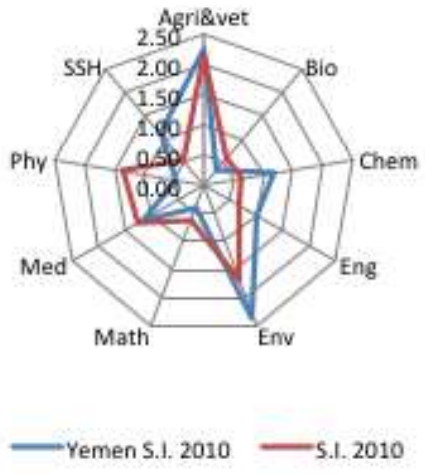
- Very good Tertiary education

Challenges

- Bureaucracy
- Lack of cooperation with the Arab countries that have good human resources

Yemen

GDP (current prices): $ 38.952 billions
Population: 26.66 millions
Resources: agriculture
Key institutions in STI: Supreme Council for Scientific Research



Source: (Hanafi & Arvanitis 2013)

High innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Ease of starting a business	69.7	43
Education	*58.2*	*46*
Public expenditure/pupil, % GDP/cap	42.9	3
Pupil-teacher ratio, secondary	11.7	42
Tertiary inbound mobility, %	2.7	47
Gross capital formation, %	24.4	49

GDP		
Trade & competition	*66.6*	*53*
Non-agricultural mkt access weighted tariff, %	0.1	27
Imports of goods & services, % GDP	41.4	68
Computer & comm. service imports, %.	34.7	59
Knowledge impact	*33.7*	*68*
Growth rate of PPP$ GDP/worker, %	4.2	29
Royalty & license fees receipts/th GDP	1.3	27

Source: (Dutta 2013)

Low innovation indicators (GII)

Indicator	Score (0–100) or value (hard data)	Rank
Global Innovation Index 2012 (out of 141	**19.2**	**139**
Political environment	*16.8*	*140*
Political stability	11.6	139
Quality of scientific research institutions	11.3	132
E-participation	0.0	127
ISO 14001 environmental certificates/bn PPP$ GDP	0.0	134
Domestic credit to private sector, % GDP	7.4	140
Venture capital deals/tr PPP$ GDP	0.0	65
Business sophistication	18.7	141
GMAT mean score	367.0	138
Innovation linkages	*12.5*	*139*
University/industry research collaboration	8.4	133
Knowledge creation	*1.2*	*140*
High-tech exports less re-exports, %	0.0	120
ICT & organizational model creation	16.4	133
Recreation & culture consumption, %.	0.3	100

Source: (Dutta 2013)

Strength

Public institutions driving towards innovation and research:

- National Information Center.

- Supreme Council for Scientific Research.

- Board of Trustees President's Award for Scientific Research.

- Ministry of Higher Education and Scientific Research.

- The Ministry of Industry and Trade.

- The Central Authority for Scientific Research.

- Public Authority for Agricultural Research.

- Yemeni Center for Social Studies and Research.

- Center for Research and Educational Development.

- Yemeni Research and Studies Center..

- Technology Business Incubators: Aden ICT Incubator

- Research Centers at Yemeni Universities (28 Centres).

- Government's keenness to support and encourage scientific research: Encourage scientific research through the establishment of incentives and awards to researchers.

- initiatives: Aden University Award for Scientific Research and Saeed Foundation Initiative for Science and Culture

- The most important sectors in support of innovation: Agriculture, Education, Culture, Industry, Social Affairs

- Small amount of the scientific publication but with high co-authoring rate...

Universities and public research centers: Support the political leadership for scientific research and researchers as stipulated in the relevant laws; Provide a nucleus for a limited infrastructure for research and development activities in some areas, represented by a number of government research centers; The presence of the nucleus of a human base of researchers and technicians with good scientific and technical levels; There are some incentives and awards for researchers in a number of disciplines.

- Productive enterprises: Provides a nucleus of specialized research centers to productive sectors; Presence of specialized cadre of researchers; Provide funding to

do some specialized research in these institutions; The presence of institutions that sponsor, support and encourage researchers; Publishing and printing some research – which to some extent - creates an incentive for others.

- The private sector and non-governmental organizations: Provide incentives for researchers; The presence of institutions that sponsor, support and encourage researchers; Work to support the printing and dissemination of research.

Weaknesses

- Absence of policies and general strategies for scientific research and poor coordination between institutions.
- Some research centers and bodies lack the existence of programs and plans linked to development plans.
- Universities and Research institutions: lack research facilities and supplies (laboratories, equipment, materials, and libraries containing with sophisticated periodicals and references; Poor levels of communication and relationships between scientific research institutions and the beneficiaries of the outputs of the research activities; Limited databases for researchers and scientific research institutions; University libraries lack modern sources and references and scientific periodicals in addition to advanced techniques which serve scientific research.
- Lack of budget review, especially scientific research general state budget. Non-observation of national budget especially for scientific research in the general state budget for 2013
- Productive enterprises: Poor levels of communication and relationships between scientific research institutions and the beneficiaries of the outputs of the research activities; Lack of incentives to encourage competition for scientific research; No participation in specialized scientific conferences, which limits the knowledge and experiences of researchers ; Low interest rehabilitation researchers to develop their scientific and practical skills; Not keeping pace with scientific developments in equipping research laboratories; Lack of awareness among the productive and service sectors of the importance of scientific research in the development of services and industry.

The private sector and non-governmental organizations: Focus on research related to the human and social aspects; Shortage of books, studies, periodicals and research; The predominance of library research over research based teams.

- Scarcity of research laboratories for conducting and applying scientific research to innovation.
- Poor coordination with Arab and global research centers to learn and benefit from their experience
- Poor coordination between government institutions and research centers, which increases the difficulty of completing research.

Opportunities
Good education system indicators (Public expenditure/pupil, % GDP/cap and Pupil-teacher ratio, secondary)

Challenges
- The Yemeni economy is traditional

Institutions working in the field focus on industrial re-manufacturing or assembly and lack productivity in the manufacturing process, which reduces opportunities to develop their innovation.

- The weak size of the economy and the low level of value added, which limits the size of the support for scientific research and innovation.

- There is no strategy in Yemen for scientific research, this being one of the most important factors that hinder scientific research in Yemen since there is no framework for the organization of scientific research.

- In the bottom of the **Global Innovation Index 2012 (139 out of 141)**

Conclusion

There are some regional and subregional trends we may identify in this study.

Regional trends

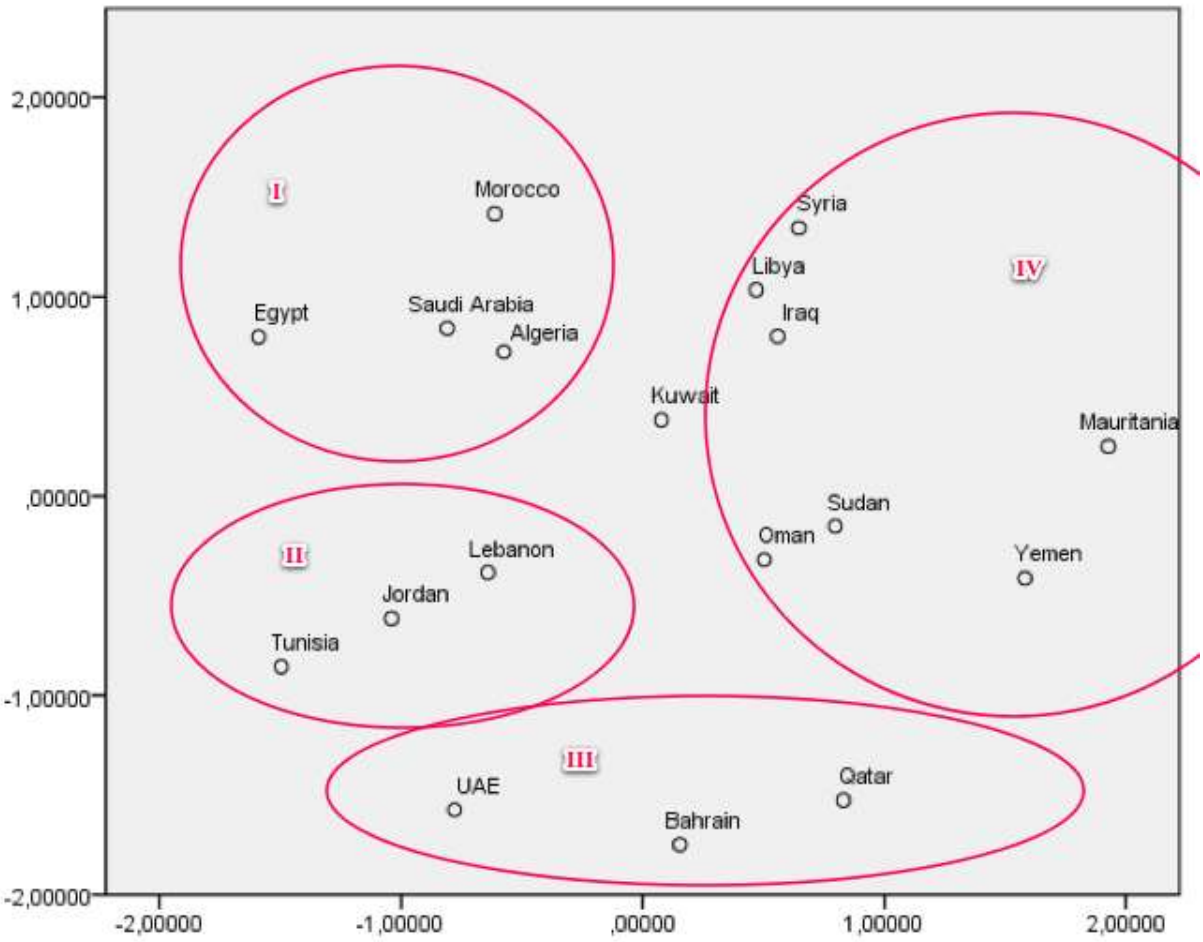
1- For most of the countries, innovation policy as such has still not been implemented. However, looking at each country individually, one can find an important activity that is dispersed over various policy agencies and ministries, performing institutions, and social and economic actors.
2- Due to the low level of human capital and the vulnerability of infrastructure, the in-house innovation and R&D activities are very limited
3- Regional commonality: there is no significant transnational R&D. According to (UNCTAD 2005), the transnational R&D in the emerging countries has increased from 2% in 1996 to reach 18% in 2002 with a concentration in Asia, particularly in China and India. However, for South Mediterranean countries, the only country that hosted the transnational R&D is Israel with 4.4 % of actual investments. Recently, the Maghreb has become a destination for the transnational firms that intend to invest in R&D in modern and emerging sectors1 besides the strategic sectors (Petroleum, agriculture.). (El Elj 2010)
4- despite the existence of policy and tools to enhance private R&D activities in Tunisia,
5- R&D is carried out mainly by public sectors.
6- Another source of innovation is the acquisition of external technological capabilities by purchasing new machinery or licensing agreement with foreign innovative companies; ie. appropriation and assimilation of foreign technologies and adaptation

of the production processes so as to efficiently utilize these technologies with local resources (labor, raw materials, etc.). But, it is obvious that catching up will not take place automatically. It requires a strong technological capability within the company to facilitate the adoption and assimilation of new technologies. (El Elj 2010)

Sub-regional trends

We conducted a factor analysis to correlate between different statistical characteristics of science, technology and innovation.[7] The Figure below represents countries on this same space formed by the first two axis, where variables representing size (and thus, larger countries) are on the left and the smaller ones on the right, while dynamic variables are pulling on the lower part of axis one, whereas the size of the university system is on the upper part of this space.

Figure: Countries Represented in the space of two main factors



[7] For more details about this factor analysis see (Hanafi and Arvanitis, 2013).

In effect, we see the larger and dynamic countries on the upper left part, the small and dynamic countries on the lower part, and the less dynamic countries on the right part of the diagram (the scale is not exactly the same for variables and for countries: countries vary on a wider scale than variables). Kuwait has always occupied a more central position with relative figures in all variables being in middle grounds.

Thus we have **four groups** of countries:

- Group I: **Large research systems with slower growth,** relative to other Arab countries. **Egypt, Morocco, Saudi Arabia** and **Algeria**. Rather "rich" or comparatively large countries. Egypt is a case by itself, in this group (or any other) and its lack of natural resources (compared to the other three) sets it apart. But the group is basically aggregating larger research systems, which also tend to have certain inertia, growing rather slowly, consolidating their international collaborations. Morocco has a particularity of having a recently sluggish growth of production after a period of very rapid growth (explained by the rapidly growing academic population in the late nineties, mostly because of Moroccan returnees). It is the more diversified system in the sample. As we will see later, Egypt and Algeria share a very similar profile of disciplinary specialization.
- Group II: **Small, dynamic and integrated**. **Tunisia, Jordan** and **Lebanon**: small and very dynamic research systems by all standards. These are the countries having the highest records in publications and growth of production. They are also small by any standard but have proportionally high figures of researchers and of scientific production. Although they have low scores in overall innovation, these countries tend to have niches of innovative activities. Curiously, Tunisia has a very centralized science policy system, whereas Jordan and Lebanon do not. Had we had indicators to measure this centralization we would probably have had different results but we know from recent work that **Tunisia**, **Jordan**, and **Lebanon** are engaged in an active pursuit of scientific research and consolidate the evaluation systems inside their universities. **Kuwait**, which stands in between group I and II, could for analytical purposes be integrated in group II, because of its older strategy to support the university and research system. Only its small size makes it different. Jordan finally is the country that has changed most recently which translates to a surge in its scientific production.
- Group III. **Very small and rapidly expanding**. **UAE**, **Bahrain** and **Qatar**, very small and rich Gulf countries, with an active policy in developing technologies and universities, pursuing active "branding" strategies for their universities, and trying to make the most out of their high-level resources.

- Group IV. **All other countries**. It is quite difficult to differentiate between them. They are rather small and less integrated research systems. Some universities seem to be developed but figures are low on many grounds. Iraq stands in this group since it still has not engaged in the reconstruction of its once well-known university system.

Table 1: Four intuitive institutional models in Arab countries

Type	Countries	Main features
The Gulf model	Gulf countries	Decentralized trade-oriented governance Public universities open to foreign teachers/researchers Research based on international collaborations Foundations for research
The Middle East model	Syria Egypt Iraq	Centralized type of governance Research in large public research centers and universities Large public universities
The Machreq model	Lebanon Jordan	Decentralized governance Research concentrated in private universities
The Maghreb model	Algeria Morocco Tunisia	Centralized governance Large public universities Research mainly in universities and public research institutes

Source: ESTIME - own presentation.

Finally we may summarize the situation of science and technology in the Arab countries as following (1 weak; 2 average; 3 strong).

country	STI strategy	R&D expenditures	Universities	Publications	International collaboration	Incubation	private sector innovation	Human resources	involved diaspora
Algeria	2	2	2	2	2	1	1	2	2
Bahrain	2	2	1	1	1	1	2	2	1
Egypt	3	1	1	2	2	1	2	2	1
Iraq	2	1	1	1	1	1	1	2	1
Jordan	3	2	2	2	2	2	1	2	1
Kuwait	2	2	2	2	1	2	1	1	1

Lebanon	2	1	3	3	3	2	1	3	2
Libya	1	1	1	1	1	1	1	1	1
Mauritania	1	1	1	1	1	1	1	1	1
Morocco	2	2	2	2	3	2	2	2	2
Oman	3	2	2	1	1	1	1	1	1
Palestine	2	1	2	2	2	2	1	2	2
Qatar	3	3	3	2	2	2	2	1	1
Saudi Arabia	2	2	3	2	1	3	3	2	1
The Sudan	1	1	1	1	1	1	1	1	1
Syria	2	1	1	1	1	1	1	1	1
Tunisia	3	3	3	2	3	1	2	3	1
The United Arab Emirates	3	2	2	2	2	1	1	1	1
Yemen	1	1	1	1	1	1	1	1	1

Appendix

Questionnaire

ESCWA Technology center contracted us to conduct a SWOC analysis (Strengths, Weaknesses, Opportunities and Challenges) of Science and Technology Institutions in each ESCWA member country. For that, we would be grateful if you give us your opinion/data about the following questions **with specific examples**.

1. Can you mention the specific public institutions that drive innovation in your country or reluctant to do it? Organize your data in terms SWOC and highlight the reasons.
2. Can you mention entrepreneurship initiatives in favor of innovation in your country? Organize your data in terms SWOC and highlight the reasons.
3. Can you mention specific sectors (industrial, agriculture, services, etc.) in favor of innovation in your country? Organize your data in terms SWOC and highlight the reasons.
4. What are the characteristics of your economy that promote or hinder research and innovation?
5. In the domain(s) that you know of, can you mention the SWOC of research inside universities or public research institutes?
6. In the domain(s) that you know of, can you mention the SWOC of research inside public companies?
7. What are the SWOC of research in your country in private and NGOs sectors?

8. In a nutshell, what are the top 3 strategies to promote research and innovation in your country?

Please send us your reply before Dec. 29, 2012 to Ms Safa Salih salih11@un.org

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