



Jordan

The Atlas of Islamic World Science and Innovation
Country Case Study

Dr Sami Mahroum, Dr Jaber M. Al-Bdour, Elizabeth Scott, Suha Shouqar and
Eng. Abeer Arafat

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The views outlined in this report do not necessarily reflect the policy position of these partner organisations.



Each country report within the Atlas project importantly draws on in-country partners. In the case of Jordan, special thanks go to the Royal Scientific Society (the National Focal Point) and the Princess Sumaya University for Technology (the National Research Partner).



Cover image: Astrolabe from the workshop of Regiomontanus, the 15th century mathematician and astronomer. An astrolabe is a scientific instrument used to work out the time of day using the sun or the stars. It could also be used for astrological horoscopes and mathematical calculations. Astrolabes were first made around 150 BC in Greece. They were further developed by Islamic scholars and were often used for determining the exact direction of Mecca. (Description (c) BBC website. See bbc.co.uk/ahistoryoftheworld/objects)

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Foreword

Foreword from His Excellency Professor Dr Ekmeleddin İhsanoğlu, Secretary-General of the Organisation of the Islamic Conference

The completion of the Jordan Case Study marks another milestone in the Atlas of Islamic World Science and Innovation project. The study is an effort to analyze the status of Science, Technology and Innovation (STI), the related policy framework, governance structures, roles of various stakeholders and key science and innovation inputs and outputs.

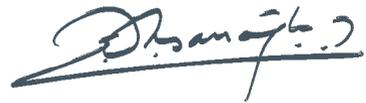
I would like to convey my appreciation for the keen personal interest and support of Her Royal Highness Princess Sumaya bint El Hassan in the preparation of the Jordan report which reaffirms Her Highness's strong patronage and commitment to supporting education and science and technology in Jordan.

I am pleased to note the recent steps by Jordan for the promotion of STI including programmes for strengthening R&D, scientific research funding, technology transfer and fostering industry-research collaboration. Efforts to develop the national education system at all levels from primary and secondary education to higher education are an important contribution towards building a knowledge-based economy in Jordan.

With its strong education system, well-educated young population, a rapidly developing ICT sector and well-established medical services industry, Jordan can make up for its deficiency in terms of natural resources.

I am hopeful that the recommendations contained in the report will be given due consideration by all the stakeholders in Jordan including scientists, researchers, policy makers, educators, industry and investors and will prove to be useful in terms of strengthening STI in Jordan.

I congratulate the project managers for their dedication and hard work for the finalization of the study. I thank all the partners in the Atlas project including the British Council, Qatar Foundation, COMSTECH, IDB, the International Development Research Centre of Canada, ISESCO, Nature, the Royal Society, and SESRIC for their contributions in the Atlas project.



Ekmeleddin İhsanoğlu

Introduction

“First, don’t give up. ... Don’t take ‘no’ for an answer. There are members of my society that when I say: ‘let’s do something’, or, ‘let’s move this sector of society’, say, ‘tsch, that’s never going to happen’, or, ‘tsch, we can’t find the money’. And I think the major challenge I have had over the past 10 years is not to be intimidated by the ‘tsch’ [attitude] that I get from society. We move forward. Sometimes you get knocked down. Sometimes you just have to dust yourself off and just keep trying.”

His Majesty King Abdullah II

Interview with Fareed Zachariya of CNN, Davos 2010

This was His Majesty King Abdullah II’s response to a question posed by Fareed Zachariya of CNN at Davos 2010, when asked what he believed to be the lessons he has learnt for creating growth in countries such as Jordan. It demonstrates the desire of Jordan’s leadership to drive forward its agenda for economic development while caught in the midst of a region challenged by political upheaval and military conflict.

The Hashemite Kingdom of Jordan is essentially a hard place, presenting many challenges for those mapping the path to its future economic development. From a dearth of natural resources, water scarcity and the aridity of much of its (nearly) landlocked geography, to its position in a historically turbulent geopolitical region, Jordan is a place where to survive and prosper requires considerable effort.

For over 60 years, this small country has received millions of refugees from Palestine, Kuwait, Iraq and most recently Syria. During the same period it has been either at war or surrounded by it. The consequent influx of refugees has exerted enormous pressures on the limited natural and physical resources of the country. With every wave of refugees, the demand for water, food, land, housing, schooling, transportation and energy has risen sharply, straining the country’s resources.

And yet, surprisingly, Jordan has emerged from these crises with expanded infrastructure, increased economic prosperity, improved education and expanded agricultural land. It is as if the ‘refugee influxes’ have constantly reminded the country of its shortcomings and weaknesses and kept those high on the political agenda. Today, while the country is relatively stable in the region, the same challenges remain: water, food and regional security.

While it could be argued that these represent the most constant and threatening challenges for Jordan, other pressing challenges also exist, namely tackling the issues of unemployment, poverty, demographic growth, brain drain and

economic development. Unlike many of its oil-rich neighbours, Jordan has limited natural resources. As a result, Jordan's future prosperity depends upon its ability to harness its human capital and relatively young population to support future economic growth. The development of a national ecosystem that stimulates science, technology and innovation (STI) offers Jordan an excellent vehicle to ensure future economic development and the welfare of its citizens.

STI and the national innovation system in Jordan

This report analyses the state of STI in Jordan, and provides an assessment of how effectively the existing national innovation system (NIS) develops and supports the country's innovative capabilities. Jordan's capacity to innovate in a large part reflects its ability to harness its human capital and knowledge resources in order to generate relevant scientific and technological research, and to convert the outputs of this research into commercial reality through higher value-added products and services. Jordan's innovative capabilities will, in turn, enable it to generate wealth, create jobs for its people, and thereby underpin the nation's capacity to achieve sustainable economic development going forward.

Chapter 1 of this report is a *mapping* exercise of the state of STI in Jordan. To provide context to the study, the chapter starts with a socio-economic overview of Jordan. This is followed by an analysis of STI and the framework of the NIS in Jordan. Key inputs and outputs of STI are then discussed, followed by a brief discussion of key STI hotspots driving growth in the Jordanian economy. Chapter 2 discusses the important role of *people*, or human capital, in Jordan, underpinned by its relatively young and well-educated population set against a scarcity of natural resources. Chapter 3 assesses *places* and the geographic spread of STI-related activities across Jordan. Chapter 4 addresses the *business* sector, and private sector investment in research and development (R&D), including the specific businesses and industry sectors most actively engaged in R&D, and the factors influencing these activities. Chapter 5 provides an overview of local *culture* and how this influences the local entrepreneurial environment. Existing and evolving networks for *collaboration* between stakeholders, including scientists, government and the private sector, both at the local, regional and international levels, are explored in Chapter 6. Examples of collaboration are also highlighted. Chapter 7 discusses issues of *sustainability* and the natural environment in the context of STI. Finally, Chapter 8 provides a *prognosis* for STI in Jordan, including an assessment of key strengths and weaknesses, and recommendations for ways in which STI can be enhanced going forward.

1 Day N & Muhammad A (2010). *Malaysia: The right recipe for innovation?* The Atlas of Islamic-World Science and Innovation, Country Case Study No.1. Royal Society: London.

2 See <http://www.demos.co.uk/projects/atlasofideas>.

This report has been modelled on similar studies conducted on Malaysia,¹ Brazil, China and South Korea.² It aims to provide an objective assessment of the state of STI, and the ecosystem for innovation in Jordan. Whereas consideration is given to the key sectors identified as being at the forefront of STI in Jordan, it is beyond the scope of this study to provide a detailed assessment of each sector. Moreover, this report focuses on the relationship between science and technology and innovation, rather than innovation in a broader context which might include, for example, business and social innovation.

The Atlas of Islamic-World Science and Innovation

This report forms part of a series of case studies which form part of *The Atlas of Islamic-World Science and Innovation*. The project is the work of partners from across the Islamic world, Europe and North America, with the full list of partners included on the inside cover. The Atlas project aims to map the changing landscape for science and innovation across a diverse selection of countries with large Muslim populations in the Middle East, Africa and Asia. Appendix 1 has further details of the project's aims, partners and methods.

This report has been jointly authored by: the Lead Researcher, Dr Sami Mahroum, Director of INSEAD Innovation & Policy Initiative, at INSEAD's Abu Dhabi campus; the National Research Partner, Dr Jaber Al-Bdour, of The King Hussein School for Information Technology at the Princess Sumaya University of Science and Technology (PSUT) in Jordan; Suha Shouqar, of Jordan's Royal Scientific Society; and Elizabeth Scott, a research assistant to Dr Mahroum. Vitally important in conducting this study has been the information gathered through interviews with policy makers, academics, scientists, non-governmental organisations (NGOs), entrepreneurs and business leaders. These interviews were conducted in Jordan between October and December 2010. The project's National Focal Point, Eng. Abeer Arafat of Jordan's Royal Scientific Society, facilitated this process, arranging in excess of 60 interviews over this period (including some conducted by email and questionnaire due to the availability of interviewees). A full list of individuals interviewed as part of this project is provided in Appendix 2.

1 Mapping

Visitors to Jordan will notice the juxtaposition of an ancient land and civilisations steeped in history in a country guided by Islamic principles, set alongside a young, progressive and IT-savvy population seeking rapid technological development and integration into the modern world. Jordan must be encouraged and developed to ensure it reaches its full potential as a leader in STI in the region.

Jordan's innovative capabilities can be defined as its ability to develop new areas of competitive advantage through the generation of new or superior products, services and/or processes. These are generated through the R&D activities it undertakes, most typically—although not exclusively—in the fields of science and technology (S&T), which is the focal point of this report. Jordan's innovative capacity also reflects its ability to successfully commercialise new ideas and technologies, and in so doing create sustainable economic growth and employment opportunities for its citizens. The development of a strong system of innovation is therefore essential if Jordan is to establish its competitive advantage and compete effectively in global markets. All stakeholders in Jordan's NIS—including scientists, researchers, policy makers, educators, industrialists, entrepreneurs and investors—play a vital role in ensuring Jordan realises its full innovative capacity and achieves its maximum potential.

This chapter provides a brief overview of the socio-economic development of Jordan, and the environment for STI. This is followed by a discussion of the development of a NIS framework in Jordan, including key stakeholders and existing policies and governance structures. Key inputs and outputs of science and innovation are discussed, followed by an overview of the emerging STI hotspots shaping Jordan's future economic development.

1.1 Economic overview of Jordan

Jordan became an independent state in 1946 after the ending of the British Mandate that had been in place since the end of World War I. A small country in terms of area and population, Jordan is also relatively poor in natural resources, perhaps most notably in oil and natural gas which are found abundantly in some neighbouring countries. Those natural resources Jordan does have are primarily comprised of phosphates and potash. Water scarcity, a problem compounded by population growth and drought, presents an ongoing challenge for Jordan, together with energy, food and regional security. Despite obvious disadvantages, Jordan is ranked in the upper-middle level of developing countries based on GDP *per capita*.³

3 Source: <http://data.worldbank.org/country/jordan>.

During the 1950s, Jordan was classified as an agricultural country. Nevertheless, several large industries including cement, petroleum refining and the cigarette industry were established during this period. The 1960s through to the early 1990s saw Jordan develop into a semi-industrialised economy. This was aided in the 1960s by the introduction of an import substitution policy, including trade barriers, aimed at promoting economic growth and development. More recently, Jordan has established a network of free trade agreements (FTAs), including signing an FTA with the United States—its main export market—and with Turkey. In 2010 Jordan was one of the three countries forming the Levant Business forum.⁴

During the 1970s, resources were directed into developing the medical and healthcare sectors in Jordan, initially to support the country's large military sector. Medical services provided Jordan with an opportunity to develop new industries in the face of limited natural resources, while at the same time utilising its human resources and providing employment for the graduates of the University of Jordan's newly established Medical School. The 1980s saw the private medical sector flourish, with medical tourism becoming an important source of income as Jordan established itself as a regional centre of excellence.

Since the early 1990s, Jordan has sought to focus the future economic development of its service sectors. By 2017 it is estimated that approximately two-thirds of Jordan's GDP will be attributed to the services sector. Jordan has also implemented a policy of privatisation, moving to private ownership in the transportation, communication, water, electricity, education and healthcare sectors. By 2010, government ownership in the education and health sectors stood at approximately 60%.

One of the more significant policy initiatives that have influenced the path of economic development in Jordan occurred in the 1990s when Jordan's telecommunications sector was liberalised and the private sector was allowed to invest in telecommunication projects. This was subsequently reinforced when Jordan became a full member of the World Trade Organization (WTO) in 2000, resulting in the provision of licences for fixed and mobile telephone services to private companies from 2004 onwards.⁵ The consequent growth in the telecommunications sector paved the way for the emergence of a broader information and communications technology (ICT) sector in Jordan. Many private universities were also established over this period, and took advantage of the opportunity to train and supply IT graduates required by the growing demand of the emerging ICT sector.

4 Domrose W & zu Kocker G (2009). *Study on the national innovation system in Jordan*. Final report (draft). VDI/VDE Innovation + Technik GmbH, Germany, October, p 9. See also <http://harrisschool.uchicago.edu/Blogs/DIC/?p=846>.

5 *A Chronology of the Telecommunication Sector Development 1921–2008*. Telecommunications Regulatory Commission, Jordan. See http://www.trc.gov.jo/index.php?option=com_content&task=view&id=337&Itemid=507&lang=english.



Royal Scientific Society / food testing lab

The global financial crises that began to unfold during 2008 saw real GDP growth in Jordan decline from 7.8% in 2008 to 2.8% in 2009. This compares to a global decline in the real GDP from 2.7% in 2008 to -0.7% in 2009.⁶ Over the same period, as economic growth slowed but remained positive in Jordan, the unemployment rate increased only slightly from 12.7% to 12.9%. As well as putting economic growth into a world context, economic growth should also be viewed against an average annual population growth rate in Jordan of 2.2% between 2005 and 2010.⁷

The *2010–2011 Global competitiveness report* (GCR) published by the World Economic Forum (WEF), ranked Jordan 65th out of 135 countries. This positioned Jordan in front of its neighbouring countries of Lebanon (74), Egypt (68) and Syria (115), but well behind Israel (11), Saudi Arabia (26) and the United Arab Emirates (UAE) (27). This 65th position ranking also marked a drop of 15 positions from the previous report, reflecting a decline in a wide range of factors that together determine a country's overall competitive positioning. In terms of innovation, the 2010–2011 GCR ranked Jordan in 68th position, with the availability of scientists and engineers, followed by government procurement of advanced technological products, listed as the strongest factors driving innovation, while company spending on R&D was rated comparatively poorly. Israel ranked highest for innovation in the region (6). This is potentially an important driver of FDI, including

6 *The world factbook*. CIA: Washington, DC. See <https://www.cia.gov/library/publications/the-world-factbook/geos/jo.html>.

7 *Jordan in figures*. Nations Online. See <http://www.nationsonline.org/oneworld/Country-Stats/Jordan-statistics.htm>.

8 Laying the foundations, A new era for R&D in the Middle East. See http://www.managementthinking.eiu.com/sites/default/files/downloads/EIU-ATIC_Report1_Web.pdf

R&D-related FDI, for the country, as is evidenced by, among others, an Economist Intelligence Unit (EIU) survey of R&D investments in the Middle East, where the attraction of tapping local S&T talent ranked second to access to local markets (EIU, 2011)⁹. See Table 1.1 for a summary of the economic and social data for Jordan.

Table 1.1. Summary of economic and social data in Jordan

Indicator	2006	2007	2008	2009 or latest year available	Source
Real GDP growth	7.9%	8.5%	7.6%	3.1% (2010)	Central Bank of Jordan
GDP <i>per capita</i> PPP (constant 2005 international \$)	4,587	4,876	5,137	5,160	World Bank
GDP <i>per capita</i> Jordanian Dinars (JD) constant prices, 1994=100)	1,853	2,107	2,574	2,720	Central Bank of Jordan
FDI, net inflows (BoP, \$US)	3.54 billion	2.62 billion	2.83 billion	2.38 billion	World Bank
FDI, net inflows (% of GDP)	23.9%	15.4%	13.3%	10.5%	World Bank
Inflation rate (2006=100)	6.2%	4.7%	13.9%	-0.7%	Department of Statistics (DOS)
Population (million)	5.60	5.72	5.85	6.249 (2011)	DOS
Population aged under 15 years	37.3%	37.3%	37.3%	37.3% (2011)	DOS
Unemployment	13.9%	13.1%	12.7%	12.9% (2011)	DOS
Poverty gap	2.8%	n.a.	2.6%	n.a.	DOS ⁹
Internet users (per 1,000)	770	1,163	1,500	2,324 (2010)	Telecommunication Regulatory Commission (TRC) ¹⁰
Mobile phone subscribers (per 1,000)	4,343	4,772	5,314	6,620 (2010)	TRC
Literacy rate (% population aged 15+)	91.1%	92.1%	92.3%	92.8%	DOS/Ministry of Education

9 The poverty gap is equivalent to the total cash gap size necessary to elevate a household that is below the poverty line to a position at or above it. For the purposes of comparison, this gap is calculated as a percentage of the total value of expenditure for the entire population when

their expenditure is equal to the poverty line. The equation of poverty gap is as follows:

$$PG = \sum q (z - y_i) / NZ * 100$$
 where:
 PG=relative poverty gap;
 Z=poverty line;

N=total population;
 Y=level of expenditure or income of the poor individual;
 q=number of poor population

10 Source: http://www.trc.gov.jo/index.php?option=com_content&task=view&id=2018&lang=english.

1.2 The imperative of developing STI in Jordan

Since achieving independence in 1946, a moderate and pragmatic foreign policy has enabled Jordan to remain relatively stable despite the turbulence experienced elsewhere in the region.¹¹ Palestine and Israel border Jordan from the west, Syria from the north, Iraq from the east and Saudi Arabia from the south. Nevertheless, Jordan is widely considered as one of the most politically stable and peaceful countries in the Arab region. Even during the major regional turmoil of the so-called 'Arab Spring' in 2011, when Jordan did witness a number of demonstrations calling for political reforms, the demands for change centred on reforms within the established political system (particularly amendments to the electoral law) rather than on regime change.

Jordan also enjoys close ties both within the region and globally. Regionally, Jordan enjoys strong family and tribal links with its bordered neighbouring countries. The active role played by the Jordanian royal family, which engages in frequent overseas visits to promote both Jordan and the region, has also contributed to Jordan's close international ties. These ties have been further strengthened by Jordan's large, well-educated and successful diaspora. Collectively, Jordan has used such links as channels for developing business links, increasing the flow of remittances and investment, and fostering knowledge transfer.

Moreover, in the face of scarce natural resources, Jordan's economic prosperity has always depended upon its ability to effectively develop and utilise its human capital. Accordingly, Jordan is pinning much of its future hopes on developing the country's service economy, including ICT, tourism, medical services, pharmaceuticals and biotechnology, and the renewable energy sector. STI provide the key to the successful development of these industry sectors. Therefore, recognising the valuable asset provided by its relatively young population (35% under the age of 15 years in 2009),¹² Jordan has established education (especially higher education), scientific research and the development of a culture of innovation and entrepreneurship as priorities within its 2006–2015 National Policy Agenda.¹³

Autonomy and stability in a turbulent region, however, come at a high price. Jordan ranks fifth highest in the world in terms of military expenditure when measured as a percentage of GDP. The diversion of such a large amount of national income towards military expenditure comes at the cost of funding programmes that could be otherwise be directed towards achieving the country's economic development objectives.¹⁴

11 See the BBC's country profile of Jordan for more information <http://www.bbc.co.uk/news/world-middle-east-14631981>, accessed 16 April 2013. See also Omari R (2010). *Jordan's strength lies in its diplomacy*. The Jordan Times, 2 December 2010.

12 Jordan in figures. Nations Online. See <http://www.nationsonline.org/oneworld/Country-Stats/Jordan-statistics.htm>.

13 National Agenda: The Jordan We Strive For: 2006–2015. National Agenda Steering Committee: Amman, Jordan, pp 30–33.

14 UNESCO (2010). The current status of science around the world. Science Report, November. ISBN: 978–92–3–104132–7, p 253. However, as Jordan strives towards developing the nation's innovative capacity, it must

also be cognizant of the need to compete with other developing countries also seeking to develop knowledge-based economies. Regional examples include the KSA, Qatar and the UAE, all with young populations but which, unlike Jordan, benefit from the cash flows provided by large oil and natural gas reserves that are being directed towards achieving economic development goals.

Thus, since its independence from Britain, the Jordanian economic development strategy has rested on three pillars: an economically oriented foreign policy, a socio-developmentally centred education policy and a stability-focused security policy. Over the last decade, the government began to realise that Jordan could and should enjoy higher levels of economic performance, given its geographic location, political and social stability, the quality of its workforce and population, as well as its burgeoning international relations. The government consequently decided to develop a stronger STI base in order to help Jordanian businesses achieve higher levels of productivity. It is also hoped that developing a strong national STI system will help Jordan achieve its objectives of attaining secure supplies of food, water and energy resources.

1.3 The NIS in Jordan

Since the 1960s, various institutional arrangements have been tested to support education and S&T endeavours and to strengthen national innovation capabilities. In 1961 the Scientific Research Council was established. The Council's mandate was to promote, plan and fund scientific R&D, identify national R&D priorities and enhance international cooperation in S&T. The Council was subsequently replaced in 1977 by the Directorate of Science and Technology at the Ministry of Planning.¹⁵

Jordan's first public university, the University of Jordan (UoJ), was established in 1962. The establishment of the UoJ reflected the government's growing awareness of the important role education plays in Jordan's economic development. The opening of the UoJ has subsequently been followed by the establishment of 29 public and private universities across Jordan.

In 1970 the Royal Scientific Society (RSS), Jordan's main industrial research institution, was established as a national, not-for-profit, non-governmental, applied research institution designed to support the socio-economic development of Jordan. Its activities vary from R&D, quality assurance, testing, certification and calibration. New organisations have been established under the RSS to support areas in entrepreneurship development, innovation, technology transfer and commercialisation. These include: the Queen Rania Center for Entrepreneurship (QREC), El Hassan Business Park (EHBP) and the Intellectual Property Commercialisation Office (IPCO).

In 1978 Jordan's Science and Technology Policy Conference was held in Jordan, during which a recommendation was made to establish a national umbrella organisation to take responsibility for planning, coordinating, financing and promoting S&T activities at a national level. This recommendation eventually led to the creation of the Higher Council for Science and Technology (HCST) in 1987.

¹⁵ Tweissi A (2009). *Who observes science and technology in Jordan?* HCST: Amman, Jordan.

The HCST was given the mandate to build a national S&T base in Jordan for the purpose of achieving national economic, social and cultural development objectives.^{16,17,18} The HCST and its affiliated centres seek to fulfil this mandate through the provision of support and finance to institutions and projects involved in S&T activities, including R&D, training and innovation, and through the development of a national S&T strategy. It is interesting to note, however, that the HCST did not develop its first national S&T strategy until 1995.

The government provides the HCST with an independent budget to support R&D projects and programmes. The HCST is presided over by HRH Prince El Hassan Bin Talal, who has played an ongoing role in developing STI in Jordan, highlighting the strong support to STI and the development of the NIS provided by the royal family.

Although there has been no specific innovation policy in Jordan, elements of programmes dealing with enterprise transformation, human resource development and other newly formed initiatives—many of which are discussed later in this report—encourage innovation and have contributed to the overall goal of developing an innovative society.¹⁹ Moreover, the government has introduced a system of awards not only for excellence in industry, but also for transparency and good governance in public administration.²⁰ National innovation policies are also implicit in national policies for industrial transformation, SME²¹ development, administrative reform, education and research.²²

1.3.1 Jordanian NIS today: key stakeholders

The government has created a NIS by putting in place a range of stakeholders and enabling platforms to promote S&T research and to support successful entrepreneurship. The *ERAWATCH research inventory report for Jordan*,²³ published in 2010, provides a summarised overview of the governance structure of the NIS in Jordan, as shown in Figure 1.1.

16 DG Joint Research Centre (2010). *ERAWATCH research inventory report: Jordan*. European Commission, p 15.

17 An explanatory bulletin to the Higher Council for Science and Technology, its general secretariat and the centres affiliated to it (2010). HCST, p 7.

18 Elshuraydeh K, Mustafa I, Al Majali M, Al Assaf M, Sarraf F & Hamarneh O (2006). *Science & technology and innovation profile of Jordan*, October. ESTIME, HCST: Amman, Jordan.

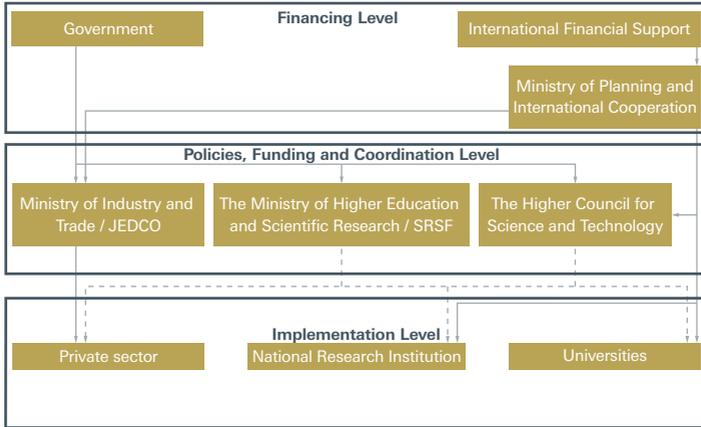
19 For example, initiatives that encourage the development of an environment conducive to STI include the recent establishment of the STI Observatory and ESCWA Technology Centre (ETC) in Jordan, as well as other facilities including El Hassan Science City (EHSC) and the Queen Rania Centre for Entrepreneurship (QRCE).

20 Source: Medibtkar Program website.

21 Small and medium-sized enterprises (SMEs).

22 Source: *Annual Innovation policy trends report for the MED-zone countries* (2005).

23 See <http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=619&parentID=44&countryCode=JO>.

Figure 1.1. Governance structure of the Jordanian NIS

Source: ERAWATCH research inventory report for Jordan (2010), European Commission.

A wide range of stakeholders currently have an interest in Jordan's NIS. A list of key stakeholders, while not exhaustive, is provided listed below:

- Higher Council for Science and Technology (HCST) (see Box 1.1);
- Royal Scientific Society (RSS);
- Ministry of Planning and International Cooperation (MoPIC);
- Ministry of Higher Education and Scientific Research (MHESR) through the Scientific Research Support Fund (SRSF);
- Numerous other ministries (see Box 1.2);
- Universities;
- Technical advisory centres (university based);
- El Hassan Science City (EHSC)—incorporating PSUT, RSS and EHBP;
- Incubators and business parks: eg. Al Urdonia Lil Ebda, Oasis 500, iPark, Agro Industry Business Incubator/JIC University of Jordan;
- Donar organisations: eg. USAID, Japan International Cooperation Agency (JICA);
- Support to Research and Technology Development (STRD), an EU-funded programme;
- Industry and professional associations (see Box 1.3);
- Companies;
- Entrepreneurs and start-ups;
- Contract research organisations (CROs);
- Development Zones and Free Zones Commission (DFZC).

Box 1.1.

Relevant bodies within the HCST include:

- National Fund for Enterprise Support (NAFES). Note: this organisation is independently managed and funded;
- Industrial Research and Development Fund (IRDF);
- iPark.

HCST-affiliated research centres include:

- National Center for Human Resources Development (NCHRD);
- National Center for Research and Development;
- National Center for Diabetes, Endocrine and Inherited Diseases (NCDID).

Box 1.2.

Beyond MoPIC and MHESR, other ministries with a stakeholder interest in the NIS include:

- Ministry of Education (MoE);
- Ministry of Information and Communication Technology (MICT);
- Ministry of Energy and Mineral Resources (including Renewable Energy Fund) (MEMR);
- Ministry of Health;
- Ministry of Environment;
- Ministry of Finance;
- Ministry of Industry and Trade;
- Ministry of Agriculture (including National Center for Agricultural Research and Extension; NCARE).

Box 1.3.

Industry and professional associations with a stakeholder interest in the NIS include:

- Jordan Chamber of Commerce;
- Jordan Chamber of Industry;
- Information Technology Association of Jordan (Int@j);
- Jordan Engineers Association (JEA);
- Jordan Medical Association.

However, interviews with companies and entrepreneurs indicated that the large number of stakeholders sometimes leads to confusion among those seeking support for R&D and innovation activities. Indeed some interviewees indicated that it was easier to 'go it alone' than to navigate their way through the complex network of organisations, institutions and programmes offering differing forms of assistance and support. Other stakeholders expressed their frustration with an apparent lack of coordination and communication between the many stakeholders making up Jordan's NIS. This problem is not unique to Jordan, with governments around the world finding it increasingly necessary to consolidate and streamline various support schemes. However, in the case of Jordan, a developing economy, the greater dependency on donor organisations might cause a further challenge to streamlining and consolidating support programmes, with many schemes being donor driven rather than user led.

The National Agenda 2006–2015, published by the National Agenda Steering Committee in 2005, supports this view, stating that scientific research and innovation 'suffers from fragmented administration, unclear channels and linkages, limited cooperation and coordination, and inefficient financial management'. Our findings suggest little has been done to redress this situation since the National Agenda was published in 2005.

Therefore, there is a growing call for the need to streamline the current NIS by removing overlapping or duplicated programmes and initiatives, reducing the number of organisations involved in the NIS. It is believed that a more streamlined NIS would also contribute to improved communication and coordination between stakeholders. Further to this, the establishment of a stronger, overarching umbrella organisation with the authority and responsibility to coordinate the entire NIS could also strengthen its capacity to promote STI in Jordan.²⁴ This could potentially take the form of a strong HCST, or require that one ministry take leadership over the NIS. As the Rapid Innovation Action Learning (RIAL) team that reviewed Jordan's innovation policy in early 2010 indicated, 'there is currently no central cockpit, let alone a pilot, for innovation policy in Jordan'.²⁵

1.3.2 S&T governance and strategy

Within the current NIS, three government bodies are involved in formulating R&D policy in Jordan:

- Ministry of Planning—the department's main input into the STI system is through the funding of the Industrial Research and Development Fund (IRDF) and National Fund for Enterprise Support (NAFES);
- Ministry of Industry and Trade (MIT);
- Ministry of Higher Education and Scientific Research (MHESR)—through the funding and administration of the SRSF;

24 Tee D (2006). *A practical guide to wealth creation: proposals for an innovation policy for Jordan*. EJADA & EC, April, p 40.

25 Chung S, Kim JS, Rischard JF & White J (2010). A candid review of Jordan's innovation policy. World Bank/Korea RIAL Team for Jordan, April, p 7.

- The HCST, on behalf of the government, develops national S&T strategies for five-year periods. The 2005–2010 S&T strategy—to be replaced by the 2012–2016 strategy—states that it will review and amend ongoing national S&T policy every five years;
- The HCST's S&T strategy for 2005–2010 aimed to build the S&T base in Jordan and promote an ecosystem that converts S&T ideas and R&D results into tangible economic assets, and to create sustainable jobs opportunities for Jordanian citizens. More specifically, during 2005–2010, the strategy aimed to focus R&D activities on: ICT, biotechnology, and advanced materials and nanotechnology (eg. the Robotics and Intelligent Automation Innovation Centre of Excellence (RIAIC) at the Jordan University of Science and Technology (JUST)).

However, the findings of the *Study on the Innovation System in Jordan* by VDI/VDE Innovation + Technik GmbH (October 2009) indicated that some experts interviewed expressed concerns about HCST's S&T strategies not always being reflected in Jordan's research and innovation policies. A greater involvement by innovation experts as well as stakeholders from outside government in the formulation of future S&T strategies is seen as necessary to ensure that national research strategies are coherent, practice-orientated and enjoy greater acceptance at all levels within the NIS.²⁶

1.3.3 Systemic benchmarking and foresight exercises informing the strategy

Nevertheless, to address the need for systematic intelligence gathering to promote STI efforts in Jordan, the HCST has undertaken a number of 'National S&T requirements and potential surveys'. The first study was undertaken in 1996–1998, with a subsequent study conducted in 2003–2004. In 2003 the HCST also completed a three-year project called 'Jordanian scenarios 2020'. This project involved:

- *Stage 1.* Conducting a SWOT analysis of five main areas in Jordan: natural resources, human resources, the economy, social sciences and culture. Population forecasting for 2000–2020 was also conducted;
- *Stage 2.* Formulation of three scenarios: 'reference' scenario, 'developmental' scenario and 'innovative' scenario. The scenarios each reflected certain assumptions concerning different domestic and international forces expected to influence Jordan going forward.

Unfortunately, the output of this project is reported to have had no direct impact on the formulation of S&T or R&D policy.²⁷

In May 2010 a further foresight exercise known as 'The National Campaign for Public Awareness of the Drivers of Change Initiative' was launched in Jordan

26 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in Jordan*. VDI/VDE Innovation + Technik GmbH: Berlin, pp 22–24.

27 Mustafa I (2015). *Country report, Jordan*. SCOPE/Foresight.

under the patronage of HM King Abdullah II and initiated by HRH Princess Sumaya bint El Hassan, President of EHSC. The campaign builds on work developed by ARUP to identify the top 25 key drivers of change that will shape the future of Jordan. It is intended to be used as a platform for national dialogue, engaging Jordanians from all walks of life in local communities, public and private sectors, and NGOs, in a conversation about those drivers of change that will shape the future of Jordan. Moreover, it is envisaged that the knowledge created will be used to help local communities help themselves, to highlight the importance of 'change and opportunity', and to inform government policy makers on national issues.

1.3.4 S&T strategy is the de facto national innovation policy

While research indicates that there is a clear awareness within government regarding the need for a national innovation policy, no such policy has been produced to date.²⁸ The nearest thing Jordan currently has to a national innovation policy is the HCST's five-year S&T strategy. Nevertheless, this S&T strategy is very sector orientated rather than being focused on creating an environment conducive to innovation in a broader context (eg. innovation in business practices, in the services sector or addressing social innovation). This is typical of the innovation policies adopted in developing countries which typically do not focus on innovation beyond the fields of S&T. The tendency for ministers to change regularly, thereby weakening long-term commitment to innovation initiatives, has also been cited as a reason contributing to the absence of a national innovation policy in Jordan to date.

Nevertheless, it is hoped that the recent establishment of an innovation committee by the HSCT will contribute to the future development of a coherent national innovation policy. The HCST, being a non-political public entity, provides a more stable platform for innovation policy and hence it is a good home for the innovation committee. This committee has been mandated to develop STI policy in Jordan for the years 2012–2016. Five subcommittees have been formed for the purpose of establishing policies addressing:

- Institutional framework, policies and legislation;
- Infrastructure and human resources;
- Government financing of higher education and scientific research institutions;
- Productivity and competitiveness of the national economy and private sector participation;
- The national innovation system.

A possible explanation for the lack of a national innovation policy in Jordan until now is provided in the ESTIME study *Towards science and technology*

28 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in Jordan*. VDI/VDE Innovation + Technik GmbH: Berlin, pp 22–24.

evaluation in the Mediterranean Countries (2007). This study analysed the S&T capabilities of Morocco, Tunisia, Algeria, Egypt, Lebanon, Syria, Jordan and the Palestinian Territories.²⁹ The findings of the study indicated that many high-ranking government officers in these countries come from S&T domains and hence tend to think of innovation as synonymous with S&T activities. The study recommended that specific training programmes be created to educate high-level bureaucrats and thereby promote an improved awareness and understanding of research, policy design, knowledge creation and dissemination, and the use of research as a tool for national development.³⁰

1.3.5 National cluster policy

Jordan also lacks a national cluster policy that could be used to support the development of key sectors, or as part of regional economic development plans within the Jordanian economy, that demonstrate strong potential for innovation and growth. But despite the lack of a national cluster policy, in the early 2000s a pharmaceutical industry cluster was established to support growth of this historically important sector of the Jordanian economy. An informal ICT cluster was also formed more recently to support growth of this relatively young but successful sector. These clusters have been established in a bottom-up approach driven by industry players rather than by any specific government initiatives.³¹

A fertiliser chemical cluster has also been established within the Aqaba Special Economic Zone (ASEZ) in the south of Jordan. With an already established fertiliser operation located in the ASEZ, the cluster is seeking to attract both upstream and downstream industries (eg. chemical industries) that can benefit from the proximity of a potential customer to their product, as well as the proximity to raw materials.³²

The establishment of EHSC in 2007 represents another cluster in which a scientific and technological base is being developed. The vision of EHSC is to create 'a world class academic and research zone with the aim of transferring knowledge to application by partnering with science and technology based enterprises that will be attracted to locate in the campus and to support young entrepreneurs to launch and grow their technology-focused start-ups'.³³ EHSC encompasses the RSS, PSUT and HCST in an effort to bring together a state-of-the-art science city that will build on the advancements and successes of its member institutions.

Further to this, the USAID Jordan Development Program is currently developing an 'innovation clusters' initiative. This initiative aims to introduce the concept of clustering in six economic sectors: ICT, medical services, clean technology, pharmaceuticals, architecture and engineering, and local economic development.

29 ESTIME (2007). *Towards science and technology evaluation in the Mediterranean countries—final report*. ESTIME, p 12.

30 ESTIME (2007). *Towards science and technology evaluation in the Mediterranean countries—final report*. ESTIME, p 12.

31 ESTIME (2007). *Towards science and technology evaluation in the Mediterranean countries—final report*. ESTIME, pp 26–29.

32 Source: <http://www.jordaninvestment.com/BusinessandInvestment/Wheretoinvest/>

AqabaSpecialEconomicZone ASEZ/tabid/268/language/en-US/Default.aspx.

33 El Hassan Science City: summary brochure.

1.3.6 Institutional and programme support for innovation

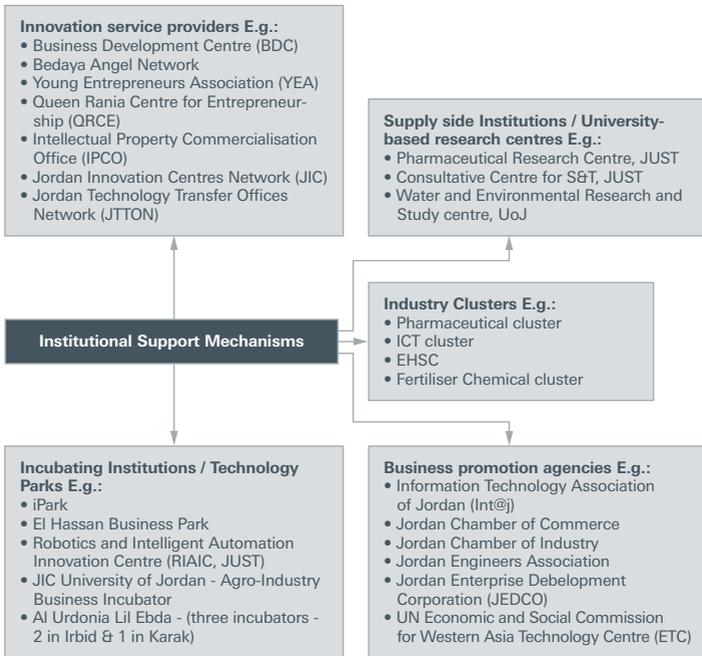
There are a number of institutional and programme support mechanisms to promote innovation in Jordan.³⁴ These organisations within a NIS assist firms/ stakeholders to develop their innovation capabilities and competitiveness. This is done through mechanisms including training, consultation and mentoring, and by conducting applied R&D.

Fieldwork indicated that institutional support in Jordan is provided through a variety of stakeholders, including:

- Supply-side institutions, such as university-based research centres;
- Incubating institutions/technology parks;
- Industry clusters;
- Business promotion agencies;
- Innovation service providers.

Examples of organisations involved in providing institutional support within the NIS are shown in Figure 1.2.

Figure 1.2. Organisations providing institutional support within the NIS



34 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in*

Network offices within the Jordan Technology Transfer Offices Network:

- King Abdullah II Design and Development Bureau (KADDB)
- Jordan Enterprise Development Corporation (JEDCO)
- Yarmouk University
- Jarash Private University
- Mu'tah University
- Jordan Industrial Estates Corporation
- Amman Chamber of Industry
- Al Urdinia Lil Ebda
- National Center for Agricultural Research and Extension, and
- University of Jordan – E.g. Hamdi Mango Center for Scientific Research (HMCSR)

Recent initiatives aimed at providing support mechanisms for innovation include the establishment of the Jordan Technology Transfer Offices Network (JTTON) in January 2010. The JTTON was established with the support of the Support to Research & Technological Development (SRTD) at HCST with the objective of facilitating the movement of novel Jordanian technologies from their original academic sources to the general public. The network comprises 11 members from both academia and industrial institutions. The IPCO at EHBP acts as the central office for the network, and is in charge of coordination between offices within the network (network offices are indicated in the text box, to the left).

Since its establishment in 2009, IPCO's goal has been to stimulate researchers and inventors in Jordanian universities and research centres to invest in their ideas by turning them into commercial projects that will ultimately benefit the national economy. To date, IPCO has received 75 research ideas and has transformed 15 into registered patents. The office has provided technical assistance in IP consultation, patent drafting and technology licensing to different organisations. In one example, IPCO assisted the RSS to increase its level of registered patents from 11 to 23 in 2010. This was achieved through an IP audit of existing RSS work that was patentable by the IPCO, ongoing capacity building and learning exercises, and through the promotion of a greater level of awareness of patenting methodologies.

In a more recent development aimed at supporting innovation in the region, the United Nation's Economic and Social Commission for Western Asia (ESCWA)³⁵ established the ESCWA Technology Centre (ETC) in Amman. The ETC's mandate is to:

- Identify systematic issues that obstruct national and regional economic development;
- Provide insight and assistance to member countries on effective mechanisms of technology acquisition and accumulation;
- Make available through out-sourcing the technological capabilities currently lacking in existing national industries;

35 Established in 1973, the member states of ESCWA are: Bahrain, Egypt, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syria, UAE and Yemen.

-
- Propose mechanisms for the more effective utilisation of national infrastructures and human capital available to the region;
 - Provide assistance in the strengthening of national STI policies, including facilitating access to information and disseminating information concerning best practice methodologies;
 - Provide assistance to member countries in achieving the Millennium Development Goals.

Institutional support mechanisms appeared to be reasonably well developed in Jordan. Nevertheless, research conducted for this report suggests that service providers generally suffer from a lack of committed funding, and would benefit from funding that was embedded within a programmatic framework. And while better coordination across different service providers is also recommended, the recent establishment of the JTTON should work towards redressing this situation.

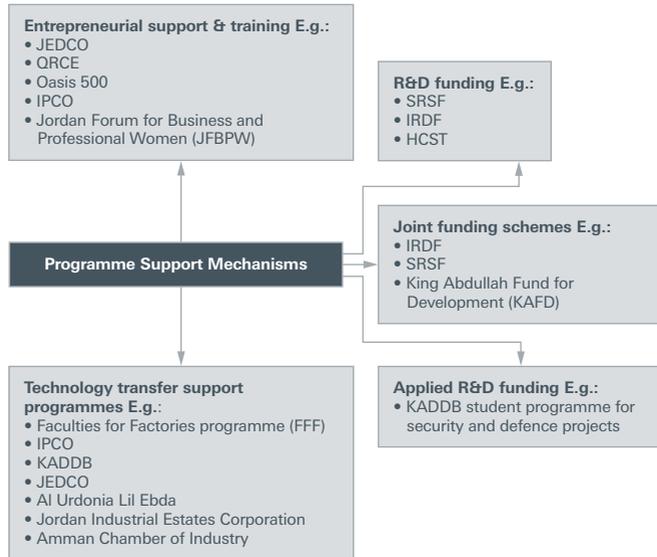
Programme support mechanisms in Jordan include:

- Technology transfer support programmes between researchers and industry;
- R&D funding;
- Applied R&D funding;
- Joint funding schemes³⁶;
- Entrepreneurial support and training.

Examples of established programme support mechanisms currently operating in Jordan are provided in Figure 1.3.

36 Such as: IJERA (<http://www.ijera.jo/content/about-us>); the JEWEL project (a twinning programme between the Jordan University of Science and Technology (JUST) and the Aristotle University of

Thessaloniki, Greece); and JoRIEW (a project promoting closer scientific collaboration between Jordanian and European Research Area-located research centres).

Figure 1.3. Established programme support mechanisms

The VDI/VDE/IT study determined that most programme-based forms of support were in a developing phase. Entrepreneurial support was seen as the strongest area, including initiatives to provide entrepreneurial training and coaching. And while the study found that mechanisms for technology transfer were weak and relationships between researchers and industry need to be better developed, it is anticipated that the recent establishment of the JTTON will improve this situation. Further to this, the Faculty for Factory (FFF) programme has assisted in connecting academia with industry. Nevertheless, the FFF's main focus is to bring faculty and industry together to work on specific problems—thereby raising the level of awareness of the needs for applied research and cooperation—rather than on focusing on promoting innovation *per se*.

Research indicates that another reason behind the limited number of joint projects between industry and academia in the area of applied R&D is the limited incentive provided to faculty to work with the private sector on joint research projects. Not only are faculty researchers unable to gain financial advantage by taking part in joint research projects, but academic advancement is based upon publication in academic journals. As a result, academic research is often focused on basic rather than applied research aimed at theoretical publications. Heavy teaching loads are also cited as a reason behind the lack of applied research and collaboration between academia and industry. As a result, ways to encourage greater university–industry cooperation are needed.

To date, public funding programmes for R&D remain a relatively new concept in Jordan, and are primarily directed through the SRSF by means of competitive funding. In order to better promote S&T-driven innovation going forward, it is recommended that the application and administration processes of the SRSF be refined and linked to the S&T strategy of the HCST. Moreover, the appropriateness of current levels of public R&D funding directed through the SRSF should be reviewed.

1.3.7 Innovation capacity

Interviews with a broad cross-section of stakeholders in the NIS indicated that there is considerable existing and emerging innovative capacity in Jordan that is yet to be fully exploited. While traditional elements of Jordanian society – based on a culture of trade and commerce rather than scientific and technological endeavour – have to some extent hindered the development of Jordan’s innovation capacity in the past, the country’s young and well-educated population is now driving the country’s innovation capacity. Examples of existing and emerging pockets of innovation in Jordan are discussed later in this chapter. Issues of culture are discussed later in the report.

Data on R&D activities in developing nations, including Jordan, are limited. The 2010 UNESCO science report provides an estimate of Jordan’s R&D for the year 2002. At this time, R&D expenditures reached 0.34% of GDP, or the equivalent of US\$59.7 million. By comparison, the world’s overall level of R&D expenditure per economic output stood at 1.7% in both 2002 and 2007, the most recent year reported by UNESCO.

Jordan does not currently maintain nor publish an ongoing comprehensive database of R&D activity by universities or the private sector. However, the HCST in collaboration with the ESCWA has recently established the ‘Science, technology and innovation observatory’. The STI observatory is based at the HCST and, once operations commence, will develop a monitoring and evaluation system based on quantitative indicators of the national research and innovation system. As a result, in the future Jordan will develop a method for systematically recording levels of R&D activity by both the public and private sectors which should assist in R&D planning, decision-making processes and S&T and innovation policy development. In the meantime, no complete list of R&D grants going to universities in Jordan exists. However, there are snapshot surveys of R&D activity available on an *ad hoc* basis, and internal lists of grants from specific government funding programmes and university-funded research projects.³⁷

37 Source: UNESCO (2010). *The current status of science around the world*. Science Report, November.

The VDI/VDE/IT study assessed the innovation capacity in Jordan and drew the following conclusions³⁸:

- Jordan has a long tradition of entrepreneurial culture and entrepreneurs are accepted at all levels in society;
- Incubators are well-recognised facilities for the improvement of entrepreneurship and technology transfer;
- Strengthening the existing incubators could improve the framework conditions of entrepreneurs;
- There is a lot of potential for innovation and new ideas in Jordan;
- The landscape of universities in Jordan is sufficiently developed with a growing number of private universities;
- Universities focus on theoretical teaching, and cover most relevant technological domains; the quality of teaching is considered relatively high although many graduates leave Jordan for work in nearby countries;
- Research activities play a minor role in universities; those which are undertaken are directed towards theoretical publications; few incentives exist to encourage collaboration between universities and industry;
- Universities could play a stronger role in innovation issues if they adapted the existing curricula according to industrial needs;
- Private R&D institutions are almost non-existent;
- Support for innovators is needed;
- Small and medium-sized enterprises (SMEs) are facing a lack of innovative products and services. This reflects the fact that the innovation capability of the management of SMEs is generally underdeveloped. The Jordanian economy is primarily based on micro-enterprises, with only a few being capable of competing on an international basis. Hence, SMEs are not seen as being the main drivers of innovation as is generally the case in more developed economies.

1.4 Key inputs to the STI system

The most tangible and readily measured inputs into any STI system comprise human capital, in terms of R&D personnel, and 'funding', as measured by public and private sector expenditure on R&D and innovation activities. Other inputs that also contribute to the STI system, such as the time, effort, resources and goodwill invested in developing and promoting a national STI system by government and business leaders, politicians and the wider community are less easily measured, but should not be ignored.

38 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in Jordan*. VDI/VDE Innovation + Technik GmbH: Berlin, p 12.

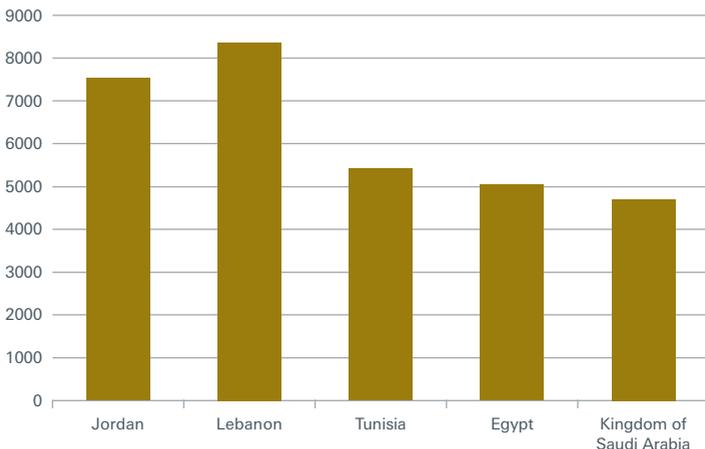
1.4.1 Human capital

Education

Jordan's education indicators are among the highest in the region. School enrolments stand at 95% at primary level and 66% at secondary level. However, vocational training offered within secondary level education (grades 11 and 12) has declined in recent years due to the low employability of graduates and a persistent cultural stigma that vocational education leads to limited career opportunities. Vocational education graduates encounter difficulties in securing jobs as skills taught often fail to meet market demand and the quality of training is considered to be of a poor standard. Vocational education is also seen as less prestigious than an academic education.³⁹

In the *2010–2011 World competitiveness report*, Jordan ranked 57th out of 139 countries in terms of higher education and training. This represented a decline in ranking compared to the 2008–2009 report in which Jordan was ranked in the 42nd position. UNESCO data put Jordan second only to Lebanon among its Arab neighbours in terms of percentage of tertiary graduates in the population (see chart, overleaf). Like Lebanon, however, it must be noted that demand for university education is driven by the prospect of overseas employment, where both the prospect of employment and the rate of return on investment in education are higher.

Figure 1.4. Total tertiary graduates per million people (Latest values - 2007 or 2009, UNESCO)



³⁹ The MoE is the main provider of secondary education (academic and vocational). Private schools do not provide vocational training at the secondary level.



Farah Hospital, Amman, Jordan

MHESR data indicate that just over 52,918 students graduated from universities with undergraduate degrees in Jordan in 2010–2011, a slight increase over previous years. In addition to undergraduate degrees, 3,962 students graduated with masters degrees and 473 with postdoctoral degrees.⁴⁰ There is an obvious large discrepancy between the number of graduates and those pursuing advanced degrees at the masters and PhD levels, signalling perhaps less emphasis on specific career tracks (ie. specialisation) and more on employment (ie. generic skills). While the number of students graduating with engineering degrees increased by 23% over the period 2005–2009, the number of science graduates declined by 2%, and the number of mathematics and computer science graduates fell by almost 14%.

The latter figure is rather interesting given the relative strength of the IT sector in Jordan, but perhaps it can best be understood in light of the small size of this market in Jordan, and the greater competition from Indian IT workers globally. Engineering skills, however, remain in strong supply, given the high demand for Jordanian and Arab engineers in the Gulf region.

40 Source: *The annual statistical report on higher education in Jordan 2010–2011*. Ministry of Higher Education & Scientific Research.

S&T employment

The HCST's 2005 S&T Potential Study provides the most recent data available, measuring the number of people employed in S&T activities in both the public and private sectors in Jordan.⁴¹ As indicated in Table 1.2, just over 42,000 people were recorded as being employed in S&T activities in Jordan in 2003–2004. These are divided into four categories: scientists, technicians, technical staff, and management staff.⁴²

Table 1.2. Human capital employed in S&T activities in Jordan, 2003-2004.

Human resources category	No.	% of total
Scientists & engineers	15,799	37.6
Technicians	6,352	15.1
Technical staff	12,970	30.8
Management	6,940	16.5
TOTAL	42,601	100.0

Source: HCST's S&T potential study (2005), as reported in Elshuraydeh K, Mustafa I, Al Majali M, Al Assaf M, Sarraf F & Hamarneh O (2006). *Science & technology and innovation profile of Jordan*, October. ESTIME, HCST: Amman, Jordan.

Data provided by the *ERAWATCH research inventory report*⁴³ indicate that the total number of people working in S&T-related activities in Jordan quadrupled between 1986 and 1996, and then doubled between 1996 and 2003. However, it should be cautioned that some of the data in this report could not be verified. The Jordan Department of Statistics (DOS) estimates that approximately 11% of the employed workforce worked as 'technicians', which is a very broad definition that does not necessarily reflect the core R&D workforce of the country.

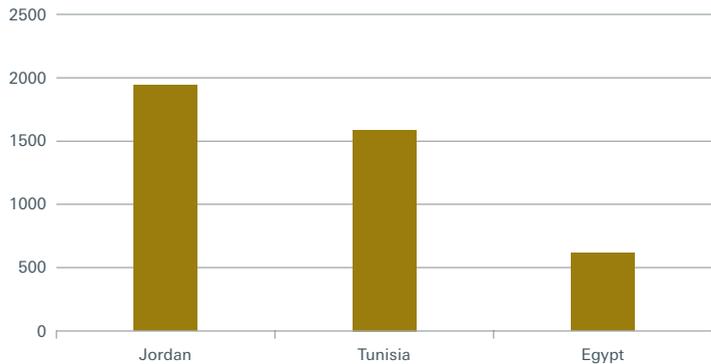
Other data sources, particularly from the World Bank, estimate that in 2006–2007 Jordan had around 12,687 R&D researchers, yielding a rate of around 1,951 researchers per million inhabitants, or 1.9 researchers per 1,000 people. The following chart shows comparative figures available for selected neighbouring Arab countries:

41 Elshuraydeh K, Mustafa I, Al Majali M, Al Assaf M, Sarraf F & Hamarneh O (2006). *Science & technology and innovation profile of Jordan*, October. ESTIME, HCST: Amman, Jordan, pp 48–57.

42 In Jordan 'technicians' refers to personnel with high-school qualifications in vocational areas, or three-year diplomas from vocational training institutions. 'Technical' staff refers to personnel with a community college or equivalent degree in any field of knowledge.

43 DG Joint Research Centre (2010). *ERAWATCH research inventory report: Jordan*. European Commission. See <http://cordis.europa.eu/erawatch/>.

**Figure 1.5. Researchers in R&D per million people
(Latest available values - 2006 or 2007, World Bank)**



In order to put the Jordanian data into a global context, UNESCO estimates that in 2007 Japan had 5.7 researchers per 1,000 inhabitants, and the US and UK had 4.7 and 4.2, respectively.⁴⁴ In another comparison provided in the OIC Outlook (2010), OIC member countries were recorded as having on average 0.6 researchers per 1,000 inhabitants, compared to a global average of 2.5. Nevertheless, Jordan was one of only two OIC member countries reported to be above the world average, the other country being Tunisia.⁴⁵

Strong engineering workforce

S&T-based employment in Jordan is spread across a range of industry sectors. The Jordan Engineers Association (JEA) estimates that there are approximately 94,000 licensed engineers registered in Jordan as at the end of 2011,⁴⁶ specialising in a range of areas including electrical, civil and mechanical engineering. However, it is unclear what percentage of engineers is actively engaged in research, or in generating innovative products, services or processes. The JEA indicates that it encourages engineers to increase their skills and innovative capacity by providing, *inter alia*, training programmes, collaborating with universities, sponsoring conferences and providing financial assistance to professors to participate in overseas conferences. The JEA also works with incubators (eg. Al Hassan Industrial Centre in Irbid) to encourage the participation of engineers, to build engineering capacity, and to encourage creativity and innovation. The JEA indicates that over the past five years, and especially since the global financial crisis, Jordan has experienced an increasing level of unemployment among engineers across many fields. Approximately 25,000 Jordanian engineers are estimated to be currently working in the Gulf and internationally.

44 UNESCO (2010). *Human resources in R&D*. UNESCO Institute for Statistics, October.

45 OIC (2010). *Research & scientific development in OIC countries*. Statistical, Economic & Social Research & Training Centre for Islamic Countries, p 1.

46 Source: Engineering Syndicate.

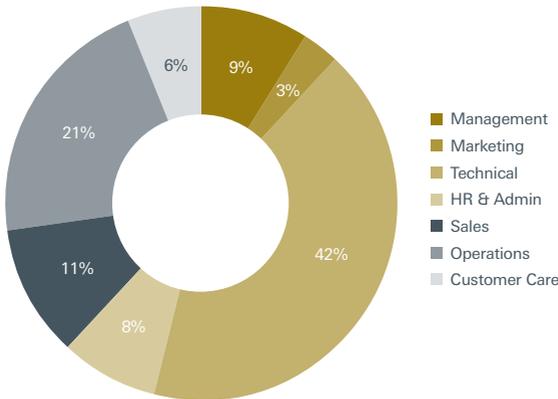
IT employment

A 2009 report assessing the economic impact of the Jordanian ICT industry estimated that approximately 16,650 people were directly employed in the ICT sector, of whom approximately two-thirds were classified as ‘technical’ staff. A further 51,600 people were estimated to be employed indirectly by the industry.⁴⁷

The pie chart below identifies ICT employment by function for the year 2010. It can be seen that more than one-third of employees in the ICT sector were engaged in ‘technical’ activities:

The National ICT strategy of Jordan for the years 2007 to 2011 indicated that the Jordanian ICT industry, academia and government do not invest in R&D at a level consistent with a mature, innovation-driven and internationally competitive industry.⁴⁸ *The Global information technology report 2009–2010* published by INSEAD for the WEF reported that Jordan ranked 44th out of 133 countries based in terms of its networked readiness index for IT development, the same as in the previous year.

Figure 1.6. Employment by function

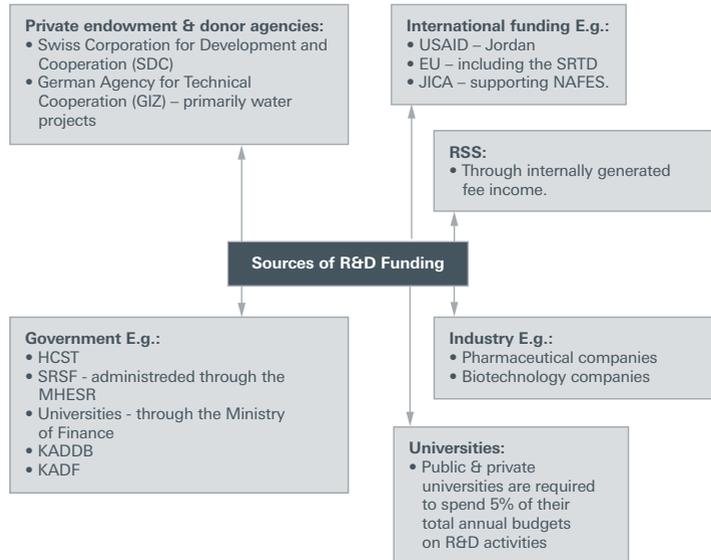


1.4.2 Funding innovation

R&D funding in Jordan is sourced through a range of different sources and programmes, as illustrated in the diagram below. The SRSF and HCST represent the two main government-sponsored funding programmes supporting scientific R&D in Jordan.

47 Ministry of Information and Communications Technology (2009). *Assessment of the economic impacts of ICT in the Hashemite Kingdom of Jordan project: final report*. MOICT, 30 December, pp 17–18.

48 Int@j (2007). Key challenges. *National ICT strategy of Jordan, 2007–2001*. Information and Technology Association of Jordan, 22 July, p 3.

Figure 1.7. Sources of R&D funding in Jordan

The SRSF focuses on funding academic R&D across a range of sectors including engineering, ICT, new and renewable energies, and medicine. It provides grants ranging in size (in Jordan Dinars, JD) from 10,000 to 500,000, with 100,000 being the average grant size. The SRSF estimates that it has spent on average JD5 million (UD\$7.1 million)⁴⁹ each year since 2008. Interviews conducted for this report with members of the Jordan Competitiveness Team within the Ministry of Planning and International Cooperation (MOPIC) indicate that a high proportion of projects supported by the SRSF have focused on existing product development rather than new product innovations or the exploration of new possibilities.

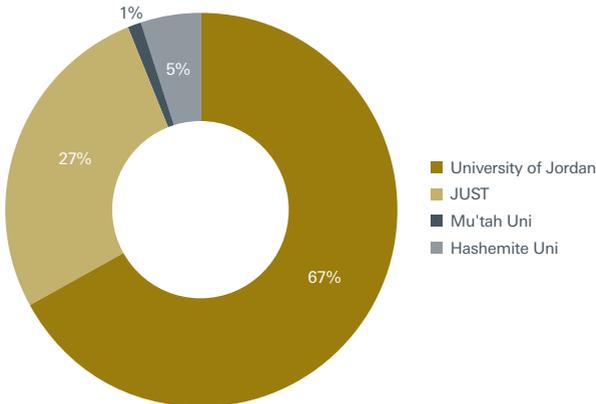
Dr Nasri Rabadi, Director General of the SRSF, wants commercialisation to be the key evaluation criterion for funding. Until early 2010, the SRSF received funding from a 1% levy on the profits of publicly listed companies. This arrangement has subsequently been changed and funding is now provided from consolidated government revenue. At the time of writing, the impact on the SRSF resulting from this change in funding arrangements was unclear.

49 Assuming exchange rate of 1 JD = 1.41 US\$.

The IRDF, administered by the HCST, funds scientific R&D projects that assist industry in solving technical problems and adopting competitive technologies. In some cases these projects are undertaken by way of collaboration between the RSS and industry, thereby facilitating the transfer of technology and knowledge between the scientific research community and industry. The IRDF also funds projects conducted by universities (eg. UoJ, JUST, Yarmouk University and Hashemite University), as well as R&D institutes (eg. the National Centre for Agricultural Research and Extension). It could be argued that the IRDF provides a vehicle for the Jordanian government to assume an entrepreneurial role in Jordan's NIS by providing funding to S&T-related R&D, in the hope that successful activities would become self-funding and 'spin-off' in time through the commercialisation of R&D outputs.

It is estimated that in 2008 Jordan's public universities spent 2.5% of their budgets on R&D, while the private universities spent 1.9%. However, universities are not required to report on the results of R&D activities, suggesting a lack of monitoring of R&D outcomes. Out of the 29 universities currently operating in Jordan, UoJ, JUST, Mu'tah University and the Hashemite University undertake the most significant levels of R&D activities, with the UoJ being the biggest spender on R&D among them all. The following chart illustrates the distribution of a total R&D expenditure of US\$3.5 million across these four key universities in 2009:

Figure 1.8. R&D Expenditure at Main Universities in Jordan, 2009 (USD mn)



Source: Presentation on 'Scientific research in Jordan: funding mechanisms'. Scientific Research Support Fund, Ministry of Higher Education and Scientific Research.⁵⁰

50 A presentation by Prof Nasri Rabadi, DG of the Scientific Research Support Fund, made in Washington, DC in July 2010.

Numerous internationally funded programmes have also been established in Jordan to support R&D and innovation, to assist companies in the commercialisation of new ideas and technologies, and to increase competitiveness. Examples of these programmes include:

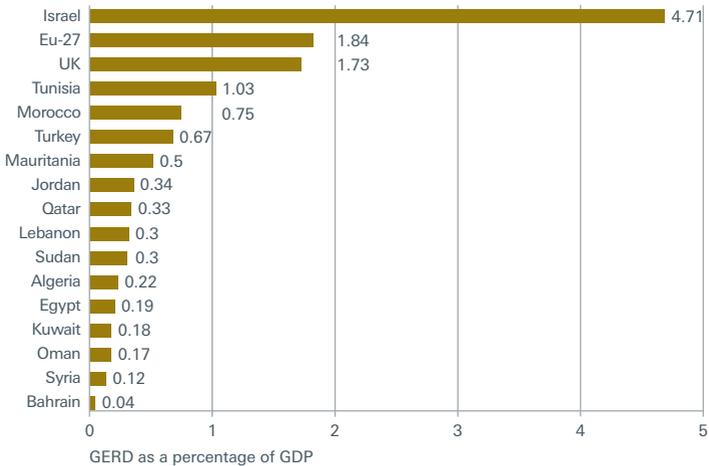
- *Support to Research & Technological Development and Innovative Initiatives and Strategies in Jordan (SRTD)*. The EU provides €4 million to fund projects that will increase Jordan's S&T capacity by fostering research and innovation linked to the private sector, including the funding of new start-ups and supporting the commercialisation of R&D. This programme also seeks to accelerate Jordan's integration into the European research community. The SRTD generally provides each project that qualifies for funding with a grant of JD15,000 (€16,000). The HCST and JEDCO also co-fund some projects.
- *USAID – Jordan*. This longstanding programme provides funding to support economic and social development in Jordan, including the funding of enterprises to assist them develop their level of competitiveness.
- *Enterprise Development Programme*. The Jordanian Investment Board and the UN Industrial Development Organisation established this programme whereby the Italian government provides €10 million of funding (via loans) to the industrial sector to help companies import machinery from Italy and promote the transfer of technology to Jordan.
- *JICA*. Areas of cooperation and assistance for Jordan are focused on meeting Jordan's needs in the improvement of their social and economic infrastructure and related human capacity development, aiming towards self-reliance and sustainability of economic development. JICA's assistance for Jordan mainly focuses on the fields of water, electricity, cultural heritage preservation and tourism.
- *German Agency for Technical Cooperation (GIZ, formerly GTZ)*. With over 30 years of experience in Jordan, GIZ provides assistance to Jordan through the management of water resources and modernising measures in the water sector.

In addition to the above, programmes under JEDCO and NAFES provide examples of programmes that support research and innovation indirectly through funding projects aimed at improving the competitiveness and productive capabilities of start-ups and SMEs in Jordan. Most recently, the JUST Innovation Fund was established in 2011 with the objective of transforming research and innovation outcomes from academia into enterprises and entrepreneurships.

Level of funding

A lack of data prevents a detailed analysis of R&D funding in Jordan. Furthermore, much of the data available is fragmented and dated. According to Jordan's National Agenda 2006–2015, the gross expenditure on R&D (GERD) as a percentage of GDP was 0.34% in 2003. *UNESCO's Science report 2010*⁵¹ estimated that Jordan ranked fourth highest in the Arab world in terms of GERD as a percentage of GDP. Its ratio of 0.34% compares to GERD in the Arab region of between 0.1% and 1.0% of GDP, and an average in advanced countries of over 2.5%. The National Agenda indicates the intention to raise GERD as a percentage of GDP in Jordan to 1.0% in 2012 and 1.5% by 2015. The following chart illustrates GERD as a percentage of GDP in Arab countries and other comparator countries:⁵²

Figure 1.9. R&D expenditure in the Arab world and other regions of the world, 2007–2008



The HCST's *2005 S&T potential study* provides the most recently available official data indicating estimates of the level of total expenditure on S&T activities in Jordan.⁵³ Data are for 2003–2004, and are expressed in JD. The study covered 1,583 S&T units across Jordan, including both the public and private sectors, and estimated that in 2003–2004, total S&T expenditure was in the vicinity of JD500 million (US\$706 million).⁵⁴ Of this, slightly less than 5% (JD23 million or US\$35 million) was spent on R&D activities, while 74% was attributed to S&T services, and 21% to education and training. The study estimated that the public sector represented 58% of total expenditure on R&D activities.

51 UNESCO (2010). *The current status of science around the world*. Science Report, November, pp 258–259.

52 Source: Badran A (2009). *Science & technology landscape of the OIC Arab countries in*

focus: toward K-society in the Islamic world. 7th IAS Science Conference, Shah Alam, Malaysia, 14–17 December.

53 Elshuraydeh K, Mustafa I, Al Majali M, Al Assaf M, Sarraf F & Hamarneh O (2006). *Science &*

technology and innovation profile of Jordan, October. ESTIME, HCST: Amman, Jordan, pp 58–64.

54 Assuming exchange rate of 1 JD = 1.41 US\$.

A more recent study of Jordan's innovation policy by the Rapid Innovation Action Learning Team (RIAL), conducted in early 2010, estimated Jordan's total annual R&D expenditure to be currently less than US\$100 million.⁵⁵ If a valid comparison can be drawn with the US\$35 million figure published in the HCST's *2005 S&T potential study* for 2003–2004, this suggests that R&D expenditure has almost tripled over the period, before adjusting for inflation. Interestingly, the RIAL report indicated that almost none of this expenditure came from the private sector, a view supported by many people interviewed as part of this project.

A report by the Jordan Competitiveness Team within the MoPIC summarises the situation of STI and R&D funding in Jordan as follows:⁵⁶

'To sum up, it is evident that Jordan is not fully capitalizing on existing potential in the field of R&D and the amount of funds available for innovation activities and the incentives provided by the Government are not fully utilised by the private sector. Furthermore, innovation still doesn't play a crucial role in generating revenue for Jordanian firms. This is mainly due to companies' unresponsiveness in absorbing new technology coupled with their relatively low expenditure on R&D. This form of behaviour can be attributed to many interactive factors, the most important of which are the following:

- An innovation culture is lacking among individuals and firms in Jordan.
- Firms do not recognise the positive impact of R&D in enhancing competitiveness.
- Financial institutions are still reluctant to provide loans for R&D purposes, and venture capital availability is still low.
- Linkages between universities and businesses are weak.
- Although Jordan is rich in terms of its human capital, 'brain drain' is proof of the country's weakness in recognising the potential and capabilities of its researchers and scientists.'

What do the people say?

Many individuals and organisations interviewed for this report expressed their frustration with a lack of early-stage capital for start-ups, and funding for SMEs from private sector investors—including banks and other financial institutions—that would enable micro, small and middle-sized companies to commercialise new technologies. The consensus view was that banks are geared towards funding larger companies. Moreover, there is a strong perception that private investors in Jordan are risk adverse and reluctant to invest in R&D and innovation. As a result, SMEs struggle to raise capital, and most early-stage capital for start-ups comes from individuals and their families and friends, or from publicly sponsored programmes. Nevertheless, there is evidence that suggests that this is slowly changing, with the recent emergence of a small number of private equity and venture capital investors, including companies such as Riyada Ventures and IV Holdings.

55 Rischard J, White J, Chung S & Kim J (2010). *A candid review of Jordan's innovation policy*. World Bank/Korea RIAL Team for Jordan, April.

56 Jordan Competitiveness Team (<2003?). *Research and innovation: a futuristic vision of public-private partnerships*. Ministry of Planning and International Cooperation, pp 7–8.

Feedback from interviews, as well as information gathered through a review of past studies, also highlights a lack of critical mass in R&D funding as a problem. A relatively low level of R&D expenditure is typically spread over a large number of projects, causing R&D activities to focus on projects that have a low capital cost and are mostly theoretical. UNESCO's *Science report 2010*⁵⁷ suggests that this problem is not isolated to Jordan, but exists across the Arab world. The report makes the following observation:

'Given the meager resources allocated to R&D in Arab countries, it is imperative that an attempt be made to synchronize research strengths, R&D initiatives and national S&T policies. Each country will have to optimize resources carefully between investment in basic sciences—the backbone of S&T capacity—and investment in demand-driven research that can address national S&T priorities and/or increase national wealth.'

However, regardless of how R&D funding is allocated between research projects, levels of both public and private sector expenditure on R&D remain low. Moreover, recent tax reforms have resulted in the elimination of one of the more plentiful sources of funding for R&D, namely the mandatory contributions made by public shareholding companies out of their annual net profits that were allocated to scientific research and vocational training and administered through the SRSF. This funding source typically generated around JD10 million annually.⁵⁸ Nevertheless, and despite fears that this change would have a negative impact on R&D funding, in 2011, subsequent to the new tax reforms being put in place, the treasury allocated JD10 million for research activities administered through the SRSF.

Despite the government's support of R&D administered through the SRSF, many of the major research-oriented universities are required to be largely self-supporting, and receive little direct government support, further constraining R&D funding levels. For instance, both the UoJ and JUST have annual allocations of around JD1 million to fund research across faculty and graduate students, as well as to fund attendances at conferences and to purchase scientific journals.⁵⁹

1.5 Key outputs from the STI system

Scientific publications, the registering of patents, and the level of high-tech exports are tangible measures of output of a country's STI system. However, other important outputs of a STI system include innovations that lead to the generation of new products, services and processes that are not patented, but nevertheless, as they are adopted and commercialised, lead to income and job creation. Unfortunately, the economic impact of innovation beyond the output of scientific publications and patents is difficult to quantify and beyond the scope of this project.

57 UNESCO (2010). *The current status of science around the world*. Science Report, November, p 260.

58 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

59 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

1.5.1 Publications

While Jordan represents a relatively small share of scientific publications globally, its level of publication production is reported to be increasing.⁶⁰ Of publications produced, the research strength in Jordan, particularly in terms of published journal articles, is reported to be in the field of clinical medicine (similarly to regional neighbours including Kuwait, Lebanon, Oman, Saudi Arabia, Tunisia and the UAE), ICT, pharmacology/chemistry and energy engineering.

Encouragingly, data released by Thomson Reuters (Scientific) Inc., and cited in UNESCO and ESTIME reports, indicate strong growth in the past two decades in the number of scientific research articles originating from Arab countries, increasing from 7,466 in 2000 to 13,574 by 2008. However, to put this into context, the average number of articles published per million people in the Arab world remains low at 41, compared to a world average of 147. Nevertheless, in 2008 Jordan ranked third in the Arab world with 157.1 scientific publications per million people; Kuwait was in first position with 222.5 publications, positioning both countries above the global average of 147. In absolute terms, Egypt published 3,963 of scientific articles in 2008, the highest number in the Arab world, compared to 928 in Jordan.^{61,62} Data produced by Thomson Reuters also named Jordan as the most collaborative nation in the region, with 43% of the country's research papers involving an international author.

While research is carried out in public and private universities, NGOs, private research centres and research centres linked to the HCST, most scientific research is concentrated in public universities. Unfortunately, heavy teaching loads restrict the amount of time available for faculty to undertake research activities. Further to this, while applied research appears highly regarded, there is little financial incentive for faculty to engage with the private sector in problem-solving R&D, nor in the development of new technologies. A lack of mechanisms to advance research activities at public universities is also hindering the research advancement process. Even if a faculty member is successful in generating grant funding for research, there is no mechanism to enable him to buy-out of teaching with his/her research funding.⁶³ And while faculty are evaluated and promoted on the basis of their level of publications, most publications reflect theoretical rather than innovative research that could drive greater innovation capacity in Jordan.

1.5.2 Intellectual property and patents

Jordan has proved its commitment to economic reform efforts in the region, being the first Middle Eastern nation to implement 'Trade-related aspects of intellectual property (IP) rights' (TRIPS) when it joined the WTO in 2000. The 2010 WEF Global Competitiveness Assessment ranked Jordan 38th in the world for IP protection.

60 http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/sc_usr10_arab_states_EN.pdf, p 265.

61 UNESCO (2010). *The current status of science around the world*. Science Report, November, pp 263–267.

62 ESTIME (2007). *Towards science and technology evaluation in the Mediterranean countries—final report*. ESTIME, pp 31–32.

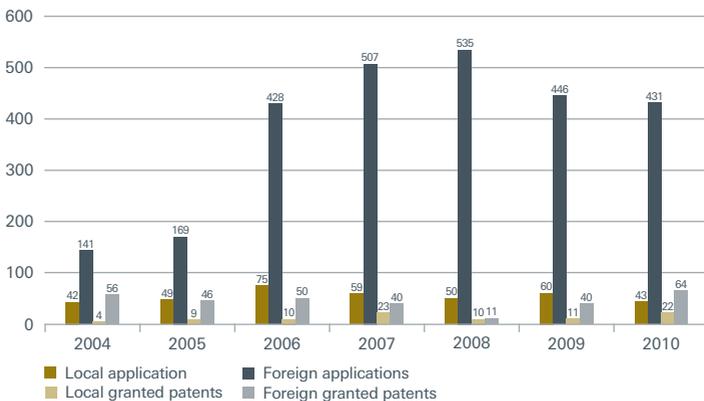
63 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

Further to this, Jordan earned a 4.4 rating out of seven in a survey of business executives conducted by the WEF.⁶⁴

Various businesses have commented that Jordan has a strong IP environment, although experiences and opinions differed. Jordan has indeed attempted to implement a strong regulatory framework for IP. It could be argued that the benefits of this framework have underpinned growth in the pharmaceuticals sector over recent years.⁶⁵ However, areas of concern in IP implementation and policy in Jordan include the absence of sufficient staffing and expertise within Jordan's patent administration office. One manifestation of this is Jordan's delay in joining the Patent Cooperation Treaty. Jordan's capability to adjudicate IP disputes is also yet to be tested. Nevertheless, a 2007 study by USAID noted that judges are reluctant to pass significant penalties for IP infringement, and have little training or information on best practices. Discussions with industry leaders suggest that Jordan requires several judges well trained in IP law to rectify this situation.⁶⁶

The chart below illustrates local and foreign patent applications and patents granted in Jordan, as registered by the Jordan Patent Office (JPO). It can be seen that foreign patents represent the majority of patent applications. The number of both local and foreign patents granted by the JPO can be seen to have increased since the onset of the global financial crisis in 2008. Unfortunately, a breakdown by field of technology is not available. JPO data also do not measure the number of patents granted to Jordanian companies or individuals in overseas markets.

Figure 1.10. Patent Applications and Granted Patents by Jordan Patent Office (Local and Foreign)



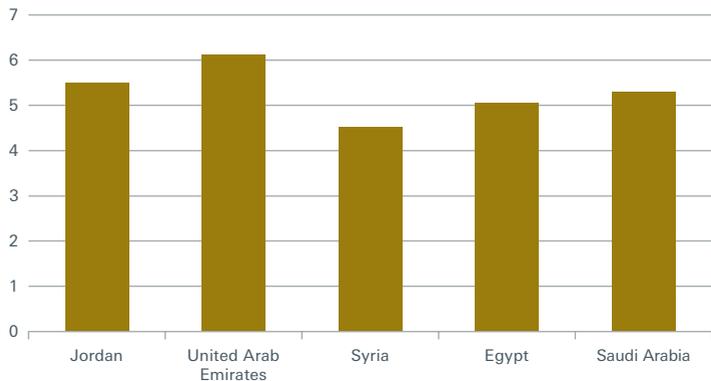
64 2010 Global Economic Competitiveness Index. World Economic Forum.

65 IHS (2010). *IHS global insight report: Jordan (Healthcare and Pharma)*, reprinted on 21 September, p 2; OBG (2007). *Pharmaceuticals growth*. Summary report, 3 December. Oxford Business Group: Oxford.

66 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

It should be noted that the granting of foreign patents is a good indicator of knowledge transfer into Jordan. Moreover, foreign patents represent the transfer of knowledge with 'commercial value'. The WEF report in 2010 gives some vindication to our assumption that Jordanian firms emerge as strong adopters of foreign technology, as indicated in the following chart.

Figure 1.11. Firm level technology absorption (Score out of 7 - Global Competitiveness Report, World Economic Forum 2010)



In 2009 World Intellectual Property Organisation records indicate that Arab countries were granted 239 patents, while the Republic of Korea alone recorded 56,771 patents. Of the 239 patents granted in 2009, the highest number were granted to Egypt (65), followed by KSA (60). By comparison, Jordan acquired 53 patents that year.⁶⁷

Discussions with Dr Adnan Badwan, General Director of JPM, a pharmaceutical company, highlighted the problems encountered by pharmaceutical companies in terms of registering patents internationally. Badwan indicated that over the years the company had registered many patents for new drugs, modes of drug delivery, diagnostics tools and biogenetic products. However, JPM encountered difficulties in meeting the high annual cost of registering patents internationally. As a result, it had been forced to make the decision to either discontinue or not proceed with the registration of a number of new products and technologies.

A lack of adequate funding, from the government, private sector investors or internal sources, to meet the high costs of commercialising new pharmaceutical and biotech products and technologies prevented JPM from realising the commercial potential of innovations resulting from the company's R&D activities. Moreover, Badwan

67 Afonso O, Monteiro S & Thompson M (2010). *A growth model for the quadruple helix innovation theory*. NIPE WP 12.

explained that the grants available from existing programmes were not sufficient in size to enable JPM to undertake the investment necessary to take their products to market. This issue is particularly relevant for the pharmaceutical and biotechnology industries, where substantial levels of investment are required to successfully develop and commercialise innovative products.

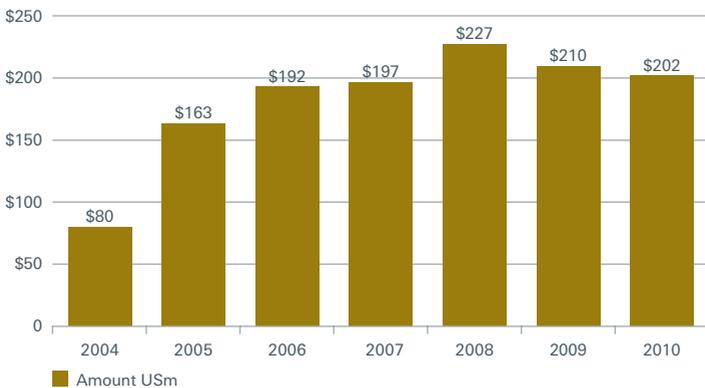
1.5.3 High-technology exports

High-tech exports provide a vehicle for knowledge transfer from Jordan to the rest of the world. They encourage innovation within Jordanian industry, as companies must innovate in order to gain and retain a competitive advantage in international markets. Growth in high-tech exports provides an indication of growth in Jordan's knowledge-intensive industries, including the ICT and pharmaceutical sectors.

The latest available World Bank development indicators show that in 2004 high-tech exports represented 5.3% of total manufacturing exports from Jordan. While this is low when compared to a world average of 21.3%, it compares relatively well with other Arab countries including Lebanon (2.4%), Syria (0.8%), KSA (0.8%) and Egypt (0.6%).⁶⁸

Jordan's ICT sector contributes to the country's total high-tech exports. The ICT industry's *2010 Yearbook* indicates that Jordan's IT export revenue grew noticeably between 2004 and 2010, as illustrated in the following chart. Despite a decline in revenue in 2010 as a result of the global financial crisis, IT export revenue totalled US\$202 million in 2010, more than double the figure recorded six years earlier.

Figure 1.12. Jordan's IT export revenue, 2004 - 2010



Source: Int@j (2010). ICT & ITES Industry statistics yearbook.

68 Source: *S&T in the OIC member countries*. SESRTC.

Accordingly, the Government has a plan for STI. The National Agenda 2006–2015 (2005) assessed the STI base along five key drivers to identify challenges for its development, in terms of: governance; funding; information and cooperation; human resources; and innovation culture. Challenges identified in relation to each driver are summarised in Table 1.3.

Table 1.3. Drivers and challenges of scientific research

Key area	Challenge
Governance	Sector disjointed as it lacks a clear governance structure and an effective strategy for prioritisation
Funding	<ul style="list-style-type: none"> • Low spending from private sector • University financial resources are spread out too thinly
Information and cooperation	<ul style="list-style-type: none"> • Channels connecting Jordan's scientists to world scientific forums are underdeveloped • Reference material is limited in availability • Lack of university interconnectedness
Innovation culture	<ul style="list-style-type: none"> • Limited merit and financial incentives • 'Brain drain'
Innovation culture	Innovation culture lacking in both education and higher education teaching methods

A summary of key STI system inputs and outputs in 2003 (the latest data available), together with targets for 2012 and 2017, as presented in the National Agenda 2006–2015, is provided in Table 1.4.

Table 1.4. Selected performance indicators for science, research and innovation

KPIs	2003	Target 2012	Target 2017
Expenditure on R&D as a percentage of GDP (domestic funding)	0.3%	1.0%	1.5%
Number of internationally published science papers as indexed by Thomson ISI	485	1,300	2,500
Number of patent applications submitted by Jordanians since 2000	246	1,300	5,000
Number of manuscripts deposited at the National Library since 1994	22,550	42,000	58,000

Source: *National Agenda: The Jordan We Strive For: 2006–2015*. National Agenda Steering Committee: Amman, Jordan, p 33.

1.6 Bright spots of innovation in Jordan

An analysis of Jordan's STI system highlights a number of 'bright spots' of innovation across different sectors of the national economy. The success of these sectors, in some cases individual firms, will play an important role in driving Jordan's future economic development and job creation to support its growing population. While it is beyond the scope of this report to explore each sector in detail, a brief discussion of key examples of successful and emerging innovation in Jordan is provided below.

Like most Arab countries, Jordan has focused much of its S&T priorities on water, health and energy issues, as well as medicine and pharmaceuticals and, more recently, the ICT sector. Severe water shortages have driven the need to develop improved water management practices, and the growing demands of Jordan's electricity sector are driving a need for Jordan to develop new and renewable energies. The emergence of Jordan's high-tech sectors can be traced back to the military, which sponsored the development of Jordan's medical services industry in the 1970s and 1980s. The liberalisation of Jordan's telecommunications sector in the 1990s subsequently led to the emergence of the ICT sector. Each of these sectors is discussed below.

1.6.1 ICT sector: young but successful

Jordan has a relatively young but successful ICT sector. It was the first country in the Arab world to fully liberalise its telecommunications sector in the 1990s, and led the region by establishing the first independent telecommunications regulatory body in order to create a fair, transparent and competitive investment environment.⁶⁹ In addition, the country has low barrier to entry into this market, which has helped in the creation of a vibrant community of IT entrepreneurs. These factors, together with the fact that Jordan is quickly developing a critical mass in programming and coding, has a well-educated, young population—the primary resource needed to achieve ICT sector growth—strong government backing, and the personal support of HM King Abdullah II, are driving growth in the ICT sector in Jordan.

Significant opportunities exist to develop internet-related services in the Arab world, with Arabic estimated to be the fastest growing language on the internet. The *Arab knowledge report* estimated that Arabic-speaking internet users increased by a startling 2,064% between 2000 and 2008. The number of internet users in the Middle East is estimated to have grown from 3.2 million users in 2000 to 41.9 million in 2008, according to the *Internet world statistics report*. Online

69 Source: <http://www.jordaninvestment.com/IndustrySectors/InformationCommunicationTechnologySector/tabid/89/language/en-US/Default.aspx>.

Arabic content is also expected to grow significantly over the coming years, as while there are more than 320 million Arabic speakers worldwide, less than 1% of all online content is in Arabic.⁷⁰ In Jordan, the internet penetration rate increased from 20% in 2007 to 38% by 2010.⁷¹ Jordan has achieved 41% internet penetration by the end of 2011, while the government was aiming to achieve an internet penetration rate of 50% by the end of 2011.⁷²

An economic impact study commissioned by the Ministry of Information and Communications Technology estimates that Jordan's ICT sector contributed to⁷³:

- 14% of GDP in 2008;
- 22% of Jordan's labour productivity;
- 85,154 new jobs, including both direct and indirect employment;
- IT export revenue of US\$202 million in 2010.⁷⁴

Over 75% of the region's Arabic content comes from Jordan, making it the top contributor. DIG, Maktoob, Jeeran and other firms are driving Arabic content in the region and across the world.⁷⁵

Key benefits of developing the ICT sector in Jordan include the fact that developing new technologies in this sector, while complex, does not require the industry to invest significant amounts of capital in expensive and elaborate laboratory equipment. Instead, developing the ICT sector requires investment in human capital, a resource abundant in Jordan. These factors make developing the ICT sector more attractive for Jordan than other industries that require a higher level of capital investment. Over recent years, an informal ICT cluster has formed to support the growth of the industry.⁷⁶

The CEO of Jordan's Information Technology Association (Int@j), Mr Abdelmajeed Shamlawi, has indicated that private ICT companies do not always have sufficient time or resources to invest in R&D, and the industry would benefit greatly if Jordan were to adopt the overseas model whereby universities undertake R&D to assist in the generation of new and innovative technologies that can then be adopted by industry. However, there is no guarantee that university-driven R&D will be sufficiently responsive to market needs.

Shamlawi highlights the enormous potential of the ICT sector to generate income for the Jordanian economy, with the ICT sector currently representing just over 14% of GDP but employing only 1% of the local workforce. Clearly, increasing productive employment in this sector has the potential to increase national income substantially.

70 Source: http://info.maktoob.com/ym_partnership_en.php.

71 Source: http://www.trc.gov.jo/index.php?option=com_content&task=view&id=2018&lang=english.

72 National ICT Strategy of Jordan 2007–2011. Int@j.

73 Ministry of Information and Communications Technology (2009). *Assessment of the economic impacts of ICT in the Hashemite Kingdom of Jordan project: final report*. MOICT, 30 December.

74 *ICT & ITES Industry Statistics & Yearbook 2010*, p 12.

75 OBG (2010). *IT overview. The Report, Jordan*. Oxford Business Group: Oxford, p 83.

76 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in Jordan*. VDI/VDE Innovation + Technik GmbH: Berlin, p 26.

Of the 5,000 ICT students graduating from Jordanian universities each year, Shamlawi indicates that, while many are of a good standard, high standards will need to be demonstrated by all graduates in order to meet the needs of future industry. One initiative being adopted by Int@j to bridge the skills gap between graduates and industry is the development of a virtual academy that will provide graduates with three to six months of training, to ensure the ICT industry has access to people with the right skill sets in the future.

Perhaps the most recognised success story in Jordan's ICT sector to date has been Maktoob.com, an Arab internet services company, founded in Amman in the late 1990s. Following successful growth after developing a large user base, strong brand name and the first Arabic online auction site (souq.com), Maktoob.com was sold to Yahoo! in 2009. The newly formed Yahoo! Maktoob.com estimates its user base has subsequently expanded to 18 million.⁷⁷ Other success stories in Jordan's ICT sector (including several that are the product of young, tech-savvy entrepreneurs who have built—or are in the process of building—their companies from the grassroots through sheer determination and with little financial support) include:

- Umniah—provides mobile cellular and wireless internet (fixed WiMax) services;
- Rubicon—provider of e-learning and simulated training material, as well as animation, gaming and themed entertainment;
- Jeeran—Arabic web-hosting community;
- D1G—online Arabic community platform;
- Eskadenia—software developer;
- Kindisoft—develops software to help clients protect their Rich Internet applications;
- Minerets—developer of wireless technology company;
- Simlab Soft—developer of 3D software;
- Quirkat—developer of video games (leader in the Middle East);
- ITG—EduWave Platform (world summit award winner);
- Iris Guard—state-of-the-art design for authentication of individual identity;
- Younivate—telecom equipment design and manufacturer;
- Optimiza, Estarta and STS—regional system integrators.

⁷⁷ Source: http://info.maktoob.com/ym_partnership_en.php.



Citrus field, Jordan Valley, Jordan

However, a number of key challenges remain ahead for the ICT sector. Jordan's ICT Strategy 2007–2011 has identified the following⁷⁸:

- Currently low internet penetration levels;
- Minimal R&D by global standards;
- The gap between academia and industry, with universities failing to produce a sufficient number of ICT graduates with the competencies required to sustain industry growth. The strategy indicates that outdated curricula at universities are not keeping pace with advancements in the field;
- Difficulty in attracting and retaining ICT experts in Jordan.

The medical services industry is well established in Jordan, and is a big importer of elements ranging from international best practices in medicine to the importing of high-tech equipment. The industry hosts many conferences and seminars annually, with guests attending from around the globe to promote the transfer of the latest medical knowhow. Jordanian medical staff also travel overseas regularly for training. This has provided Jordan with a reputation as a supplier of high-quality medical services. Combined with a competitive cost structure, Jordan has long been regarded as a centre of medical excellence and a leader in medical tourism in the region, attracting a large number of patients to Jordan for treatment each year. In fact, Jordan is now reportedly considered the leading destination in the Middle East and the number five destination globally in medical tourism.⁷⁹

78 Int@j (2007). *National ICT Strategy of Jordan, 2007–2011*. Information and Technology Association of Jordan, 22 July, pp 3–4, 43.

79 <http://www.jordanembassyus.org/new/newsarchive/2011/02202011003.htm>.

The Jordanian medical sector is considered to be particularly strong in treating cardiovascular disease, renal disease and IVF treatments. A large number of public and private hospitals and medical centres have been established in Jordan over the years, drawing graduates from the UoJ and JUST. Historically, Jordan has also supplied medical personnel to countries across the region and internationally. Nevertheless, while the local medical services industry has shown a strong capacity to absorb and apply new technologies, our research indicates that it does not currently undertake significant investment in R&D to generate new technologies at a local level.

The strength of Jordan's medical tourism is confirmed by the growing number of hospitals accredited by the Joint Commission International (JCI) and by the Health Care Accreditation Council (HCAC) as meeting the standards set out by the International Society for Quality in Health Care (ISQua). The *Genetic Engineering & Bioengineering News* publication explains the importance of JCI accreditation: 'This accreditation assures patients that the quality of medical care is comparable to that offered in recognised hospitals in the U.S. and E.U.' It is viewed as one of the principal components of an international patient care industry. From 2009 to 2010, the number of hospitals accredited with the JCI grew from four to seven, with five being private hospitals and the other two being the two major academic health centres.⁸⁰

A 2008 study of medical tourism by Jordan's Private Hospital Association (PHA) found that over 250,000 patients travelled to Jordan from over 84 countries for treatment in private hospitals, clinics and medical centres in 2007.⁸¹ Nevertheless, recent media reports suggest medical tourism has been decreasing, with medical tourism increasingly being attracted to other countries in the region, including KSA and the UAE. The increasing cost of medical treatment and monopolistic industry practices, including barriers to the entry of foreign-trained medical specialists, have been cited in the Jordanian press as reasons behind the declining competitiveness of the local medical industry.⁸² So has another challenge confronting the industry, namely 'medical accountability law', which prevents US health insurance companies from referring patients to Jordanian hospitals.⁸³

Recent articles in the media also highlight concerns that low wages are causing many doctors to leave their jobs in the public health sector and pursue better paid jobs and superior training opportunities in the Gulf. Further to this, an estimated 200 doctors working for the Ministry of Health are reported to have resigned and left Jordan in 2010.⁸⁴ PHA figures indicate that 1,200 of the 20,000 doctors registered with the Jordan Medical Association live and work abroad, with 250 in the United States. Hence, while considerable opportunities exist for Jordan to further develop its medical sector, it must also address a number of challenges in order to ensure its pre-eminence as a regional centre of excellence going forward.

80 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

81 Vequist DG (2009). *Medical tourism economic report—Jordan*. Medical Tourism Magazine, 1 October.

82 Mansur Y (2010). *Requirements of the medical board*. The Jordan Times, 30 November, p 9.

83 Malkawi K (2011). *Kingdom's medical tourism sector cracks global top five*. The Jordan Times, 20 February.

84 Venture Magazine (2010). *Medical Braindrain*, November, p 24.

Despite the challenges Jordan's medical sector is facing, Jordan's medical tourism was ranked first in the region and fifth globally as a destination, according to a 2009–2010 World Bank report. Another report by Deloitte on medical tourism, *Patients beyond borders*, conducted a three-part assessment that identified 42 foreign medical sites that provide value and quality for US patients travelling abroad. This report identified Jordan as one of 14 nations with leading medical institutions, and noted Jordan Hospital and the King Hussein Cancer Center as among the 42 high-value, high-quality sites.⁸⁵

The CEO and GM of the Speciality Hospital in Amman, Dr Fawzi Al-Hammouri, attributes much of Jordan's success as a regional centre of medical excellence to the heavy investments made by the late King Hussein in the 1970s in medical education and training, in order to support the Kingdom's military sector. These investments had consequent flow-over effects leading to strong growth in the private medical sector. Al-Hammouri claims that the medical sector's subsequent high level of investment in purchasing technologies from overseas, its focus on the training and development of its human capital and the local industry's relative cost competitiveness have seen Jordan develop as a regional hub for medical tourism across a range of specialities. Al-Hammouri cites future challenges as including barriers to entry for foreign-trained doctors and specialists, as well as the need for Jordan to undertake more R&D activities at the local level.

1.6.2 Pharmaceuticals: a magnet for private R&D investment

The Jordanian pharmaceutical industry was established in the late 1960s, and is one of the main private sector investors in S&T-related R&D activities in Jordan. The Jordanian pharmaceutical industry's economic output is reported to have grown by 95% to US\$177 million between 2001 and 2007.⁸⁶ The Jordan Investment Board (JIB) estimated that there are 18 successful firms operating in the industry, which together accounted for approximately 20% of manufacturing GDP in 2006.

Pharmaceutical exports are estimated to have grown by 17% since 2000, making pharmaceuticals the second largest export industry in Jordan. The industry is estimated to export around 80% of its local production, primarily to growing regional markets. Between 2003 and 2008, pharmaceutical exports rose from US\$211 million to US\$532 million, a gain of 152% over the period. From 2008 to 2009, as the global recession progressed, Jordan recorded a slight decline in pharmaceutical exports from US\$532 million to US\$522 million. This marginal decline in pharmaceutical exports in turn affected the country's overall exports which declined by 20% in total over the same period.⁸⁷

85 Deloitte (2009). *Medical tourism: update and implications*.

86 Scientific and Engineering Indicators (2010). *Report from the US National Research Council documents Jordan's rise*.

87 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

The local pharmaceutical industry benefits from a skilled labour force—with high-quality graduates recruited from local universities including JUST and UoJ—and a low-cost operating environment, reflecting access to relatively cheap labour and land compared to Europe or the US. The existence of a ‘Bolar provision’, an exemption to patent law that allows generic manufacturers to prepare generic drugs in advance of the patent expiration date, enables Jordanian companies to commence development work on a generic equivalent of a patented medicine and provides local companies with a first-mover advantage on expiring patents.

Jordan’s pharmaceutical industry comprises two main markets, namely over-the-counter (OTC) and prescription drugs. The local industry specialises in antibiotics, anti-ulcer drugs, hormones, anti-AIDs and cancer treatments, as well as dosage equipment (eg. patches, injectables). Opportunities also exist for the industry to expand further in the use of Dead Sea products for therapies, healthcare treatments and cosmetics.⁸⁸ Moreover, the pharmaceutical industry is seeking to shift into new markets beyond traditional generics, such as biosimilars and natural products/herbals. A number of companies are reported to be pursuing more than one diversification approach.⁸⁹

What do the business leaders in this sector say?

Leading companies in the pharmaceutical industry include Hikma Pharmaceuticals International (Hikma) and JPM. Both companies indicate that they invest around 5% of their revenue in R&D, although JPM indicates that only 1% of this is directed towards truly ‘innovative’ R&D activities. JPM has a large number of patents registered internationally; however, Adan Badwan, General Director of JPM, indicated that the size of investment required to both register patents annually as well as to bring new chemical entities and new technologies to market—and thereby commercialise the output of their R&D activities—was prohibitive. The Chairman of Hikma, Samih Darwazah, also supported this view, indicating that the size and cost of developing new molecules was beyond the resources available to local industry. For this reason, most R&D in Jordan is focused on developing new formulas and modes of delivery of existing patented drugs, or on developing generic equivalents of drugs coming off patent. Notwithstanding, the pharmaceutical industry has historically represented an important sector of the Jordanian economy, providing a significant contribution to employment, high-tech exports and GDP.

Triumpharma is a contract research organisation that was founded in Jordan in the early 2000s by Ahmad Al-Ghazawi, who had worked for large international pharmaceutical companies before returning to Jordan to establish Triumpharma. Al-Ghazawi indicates that in his view Jordan provides an excellent platform for

88 Source: Jordan Investment Board. See <http://www.jordaninvestment.com/IndustrySectors/PharmaceuticalSector/tabid/91/language/en-US/Default.aspx>.

89 Phase 1—Situational assessment of Jordan’s medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.



Hikma Pharmaceuticals PLC, Jordan

pharmaceutical companies in the region due to its well-educated workforce and relatively low establishment and operating costs. The company's most notable innovation to date has been the development of oral insulin for diabetes patients. The company's future R&D activities are to focus on the development of high-value drug absorption solutions, and to expand the company's clinical research and animal testing activities.

1.6.3 Biotechnology and nanotechnology: two areas for the future

Despite some major shortcomings in Jordan's biotechnology sector resulting from, *inter alia*, a lack of funding and knowhow at the technical level, limited collaboration between industry and academia, and the impact of a 'brain drain' from the country, Jordan has nevertheless managed to make progress in biotechnology-related R&D activities.⁹⁰

By way of example, the King Hussein Institute for Biotechnology and Cancer (KHIBC) is a not-for-profit, non-governmental organisation that aims to provide state-of-the-art care for the purpose of eliminating cancer-related deaths. This is to be achieved through increased education, awareness, prevention, diagnosis and treatment, and perhaps most significantly through advancing life sciences and biotechnology and their contribution to medicine by way of innovative research and scientific discoveries. Unfortunately, the KHIBC's construction process has slowed in recent times due to funding constraints. Nonetheless, the KHIBC has

90 Ajlouni M & Malkawi H (2000). *Jordan: status and future prospects of biotechnology*. In Persley GJ & Lantin MM (eds) *Agricultural biotechnology and the poor*. Consultative Group

on International Agricultural Research/World Bank: Washington, DC.

recently finalised the National Medical Biotechnology Strategy of Jordan, in collaboration with the HCST. The strategy provides a roadmap for advancing national biosciences development in consultation with national stakeholders.

Unfortunately, Jordan does not as yet have a well-developed and targeted entrepreneurial development and business incubation programme for medical biotechnology. Currently there is very limited risk-oriented venture capital financing in Jordan for emerging or existing biomedical companies seeking to develop or launch new products. Despite this, Jordan's first private biotechnology incubator, Copiatec, is currently under development. Copiatec has already secured space for the coming five years at the Mafraq Development Company within the Irbid Development Zone.⁹¹

In another area of biotechnology, research dedicated to improving the efficiency of the agricultural sector can also be applied to the fruit and vegetable industry. The majority of agriculture research and plant breeding in academia is currently undertaken at the UoJ. While there is a great deal of interest and generation of ideas in relation to R&D opportunities in this field, to date the market has not demonstrated a strong level of support for these R&D activities. Nevertheless, R&D investment for the future on Jordan's largest vegetable crops such as tomatoes, zucchinis and eggplant offers a potential area of focus in the future, and would contribute to achieving national food security objectives.

The National Programme for Biotechnology (NCB), operating under the National Center for Research and Development at the HCST, functions as a virtual centre and provides NCB grants for biotechnology-based R&D activities. It is also trying to create a database of talent in this field in Jordan. Unfortunately, the centre has very limited funding, and can only finance projects with clear pathways to technology applications in a short timeframe. As a result, most of the NCB's funding to date has been directed towards agricultural biotechnology-related projects.

In addition to the above, the Princess Haya Biotechnology Center at JUST is engaged in advancing and disseminating fundamental knowledge concerning all fields of molecular biology and its applications in biotechnology. The centre has expanded its activities beyond the national level and has established scientific cooperation with regional and international institutions.

91 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

Nanotechnology is still a developing field in Jordan. The healthcare sector is currently the most active sector in developing nanotechnology applications, with medicinal and pharmaceutical sciences involved in R&D activities within research universities. For example, researchers at universities are advancing new nanomaterial for diagnosing cancer. In the pharmaceuticals arena, work is being done to advance drug delivery through the use of polymer-based drug delivery systems and nanotechnology.⁹²

Further to this, the King Abdullah II Design & Development Bureau (KADDB) is intending to establish a National Nanotechnology Network in order to organise and assist all nanotechnology themes in universities and research centres. It is hoped that this will avert the duplication of research efforts, and enable institutes to work together in a complementary manner. The KADDB will also carry out R&D activities in nanotechnology in areas that are not covered by other centres.

Penelope Shihab, General Manager of Monojo, an Amman-based biotechnology company that specialises in the development, production and marketing of cell lines and antibodies, claims that it is the only company in Jordan seeking to commercialise university research in the field of biotechnology. Shihab indicates that, as biotechnology is relatively new to the region, and due to the long-term and risky nature of the sector's R&D activities, biotechnology companies face considerable challenges in attracting investors. Samih Darwazah, Chairman of Hikma Pharmaceuticals, a recent investor in Monojo, also points out that a general lack of practical experience and knowhow in the commercialisation of technology is a major hurdle for the future expansion of biotechnology companies operating in Jordan. Partnering with larger pharmaceutical companies, as in the case of Monojo, as well as exploring opportunities for greater international collaboration, are seen as possible ways forward.

1.6.4 Renewable and alternative energies

Jordan has limited indigenous energy sources, and energy imports accounted for nearly 14% of GDP in 2010.⁹³ The Kingdom currently imports 96% of its energy needs. Moreover, Jordan's growing population and continuing economic development are expected to significantly increase the demand for energy going forward. Table 1.5 indicates estimates of Jordan's available energy resources by type.

92 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

93 Jordan Times, 7 February 2011.

Table 1.5. Estimated available energy resources

	Fossil fuels		Nuclear	Renewables		
	Solid	Liquid	Gas	Uranium	Hydro	Other renewables
Total amount in specific units*	40.0**	–	300.00	70,000.0	–	0.0
Total amount in exajoules (EJ)	251.0	–	0.95	38.1	–	0.5

*Solid, liquid: million tons; gas: billion m3; uranium: metric tons; hydro, renewables: TW.

**Resources of oil shale.

Source: Ministry of Energy and Mineral Resources (2010).

As a result, Jordan has adopted a policy of increased energy efficiency, and diversification of energy supplies away from its current reliance on imports. This includes developing a higher dependence on locally produced, unconventional forms of new and renewable energy sources.

The government is aware of the importance of private sector involvement in such a demanding, high-cost and capital-intensive sector. For instance, the government has granted the country's first independent power producer (IPP) status to AES Jordan to construct a combined-cycle natural gas-fired Amman East thermal power plant with a capacity to produce 370 MW of power; the project is a Japanese–American joint venture.⁹⁴ This facility is to be supplemented by a second IPP, namely the 373 MW Al Gatrana Power Station. This will be operated by Qatrana Power Generation Company, which is owned by the Korea Electric Power Corporation and Xenel Industries. The new plant will be developed on a build-own-operated (BOO) basis.

On the level of international cooperation and partnership, the Ministry of Energy and Mineral Resources (MEMR) has entered into concession agreements with a number of international organisations to develop Jordan's large reserves of oil shale. Under existing technology, Jordan's oil shale reserves are not economically viable to extract. The volume of oil shale (deep and shallow) in Jordan is vast but difficult to quantify. Nevertheless, the ratio of resource to soil is almost 1:1, which should work in favour of easy and economically viable extraction as technologies develop. Moreover, Jordan has thick and rich layers of oil shale, reaching widths of up to 75 m in thickness.⁹⁵ Discussions with the former Minister of Energy and Mineral Resources, Khaled Irani, indicated that it is hoped that, through collaboration with international companies including Shell and Estonian companies experienced in the extraction of oil shale, new technologies will result and make oil shale a viable energy source for Jordan in the future.

94 OBG (2010). *Energy overview*. The Report, Jordan. Oxford Business Group: Oxford, p 138.

95 OBG (2010). *Energy overview*. The Report, Jordan. Oxford Business Group: Oxford, p 139.

Jordan's growing demand for natural gas for electricity generation has resulted in the country reaching its limit in terms of the gas import agreement it entered into with Egypt in 2008. Compounding this problem, technical difficulties resulted in natural gas imports from Egypt being significantly reduced in 2010. Further to this, Jordan's National Electric Power Company (NEPCO) estimates that electricity demand will grow by an average annual rate of 6% in the period running up to 2015. As a result, and in an effort to reduce Jordan's energy bill, the government is harnessing its domestic resources of natural gas. This has included awarding British Petroleum an exploration concession at the Risha gas field in 2009. It is expected that the Risha gas field will generate more than 50 million cubic feet in the first three years of operations. By 2009, revenues generated by the Risha gas fields had already reached JD11.1 million.⁹⁶

The Jordan Atomic Energy Commission's (JAEC) nuclear programme is also in line with the national energy policy.⁹⁷ JAEC's strategic goals and activities are composed of three major components: uranium mining with estimated conventional reserves of some 140,000 tonnes; capacity building through the establishment of a research reactor in JUST/Irbid with a capacity of 5 MW; and a nuclear power plant to be constructed in either Aqaba or at the Majdal site. In this way, Jordan's energy production policy aims to achieve adequate energy provision for sustainable development at least cost.⁹⁸

HE Dr Hisham Khatib, Honorary Vice Chairman, World Energy Council, Jordan, has stated that energy is needed to fuel economic growth and sustainability. While oil shale, natural gas and uranium will play a part in facilitating this growth, Khatib believes solar power solutions across the country, and electricity generation in remote areas, will provide the most viable energy prospects for Jordan going forward. In Khatib's opinion, innovation will be achieved through developing cheap mass products for water-heating systems and electricity generation solutions.

1.6.5 Water management: the biggest challenge of them all

With water scarcity a pressing issue in the region, Jordan being the fourth most water-deprived country in the world,⁹⁹ and with demand outstripping freshwater availability, the country has embarked upon efforts to improve water management practices. These concerns are being addressed at the highest level, with HM King Abdullah II defining water in Jordan as representing a strategic challenge that cannot be ignored. The King stresses that, while a balance must be reached between drinking water needs and industrial and agricultural needs, drinking water remains the most essential and highest priority issue.¹⁰⁰ In a region of low rainfall,

96 OBG (2010). *Energy overview. The Report*, Jordan. Oxford Business Group: Oxford, p 139.

97 At the time of writing, it was unclear what impact the nuclear disaster in Japan in March 2011 might have on future nuclear power programmes in Jordan.

98 OBG (2010). *Energy overview. The Report*, Jordan. Oxford Business Group and Jordan Atomic Energy Commission: Oxford, p 139.

99 Source: Boston University. See https://bu.digication.com/jordan-water-scarcity/Situational_Analysis accessed 12 April 2013.

100 His Majesty King Abdullah II's introduction on water; see <http://www.mwi.gov.jo/>.

the idea of water conservation is not new to Jordan. The people have survived by harvesting rainwater and minimising water usage. This behaviour has continued into modern times. An IDRC-supported study shows that nearly two-thirds of households in Amman, and one-third in rural areas, reuse water within the household.¹⁰¹

Importantly, technology is being used to better manage the demand for water.¹⁰² This in turn promotes an industry for water-efficient products and water-saving devices. The availability and consumer adoption of these water-efficient fixtures and appliances, such as dishwashers and washing machines, is expected to have a significant impact on future water use without requiring any significant changes in water-using behaviour or diminishing the basic functions of this equipment. The resultant water savings are expected to provide monetary savings in the future that will offset the cost of investment in water-saving devices and improved methods of wastewater disposal. The adoption of water-efficient appliances will also achieve savings in energy use.

In addition to employing technology to generate more water-efficient appliances, two types of water-harvesting applications are also being considered for application in Jordan. These are 'urban water harvesting', such as roof harvesting, and 'agricultural water harvesting', such as artificial recharges at potential catchment areas. Numerous projects have been identified and implemented to use the excess water available during the rainy season by enhancing natural recharge (eg. through rainfall). According to the Jordan Water Master Plan in 1977, about 5% of the total rainfall was infiltrated as natural recharge. Water harvesting has always been practised in Jordan, and is a technique popular in rural areas, making use of simple engineering techniques whereby rainwater is collected from little watersheds or the roofs of houses and stored in concrete-lined wells.

Reclaimed wastewater is another important non-conventional source of water in Jordan. About 52 MCM/year is used currently for restricted irrigation purposes.¹⁰³ In addition, industries are encouraged to recycle water within industrial facilities, use lower quality water wherever possible, reuse treated wastewater in industrial processes wherever possible, and adopt technologies that use less water for the same level of industrial production. Economic instruments for pollution control are also important in the use of recycled water.

The Water Demand Management (WDM) Unit of the Ministry of Water and Irrigation (MWI) is undertaking special studies of water use in the municipal, industrial, agricultural and other sectors. The purpose of these studies is to support and guide the ongoing water demand management policies and programmes in the country. Nevertheless, a long-term research programme on water demand management needs to be undertaken by the MWI in collaboration with major universities and research institutes in Jordan.

101 Faruqui A & Al Jayyousi B (2002) *Greywater reuse in urban agriculture for poverty alleviation. A case study in Jordan.* Sustainable Sanitation Alliance.

102 <http://www.mwi.gov.jo/sites/en-us/SitePages/Water%20Policies/Water%20Policy.aspx>.

103 <http://ressources.ciheam.org/om/pdf/a65/05002212.pdf>.

The MWI is to adopt and promote applied research into water use efficiency, integrated water use, and soil and crop management. Outcomes are to be assessed based on a criterion of the overall economic return per cubic metre. The MWI has emphasised through its National Water Demand Management Policy that participatory research programmes shall be developed based on actual sector needs, and shall target on-farm water demand management, the use of brackish and treated wastewater for irrigation, and related best management practices. Irrigated agriculture is to apply research-based WDM best management practices. R&D is also to address the use of salinity-tolerant plants and irrigation practices for water-scarce environments. To this end, field-scale experiments are currently being conducted at Jordanian universities.

In addition to the MWI, discussions with other national centres indicated that they are also involved in R&D activities directed at improved water management, including:

- *NCARE*. Discussions with Dr Mohammed Jitan, Irrigation & Water Management Project Coordinator and his colleagues at NCARE, indicate that, with the support of international sponsor organisations including USAID, the EU and JICA, together with the Jordanian Ministry of Agriculture, NCARE is undertaking a large range of R&D projects, including developing:
 - New crop types and varieties for use in local agriculture that are less water intensive than traditional crops;
 - Fertigation technology whereby fertiliser is dissolved in irrigation systems and in the process saves water in farming;
 - Grey water management practices in rural farming communities;
 - Improved surface irrigation systems using laser technology through land levelling.
- *Jordan Badia R&D Programme*. Mohammad Shahbaz, President of the Jordan Badia R&D Programme, indicated that the programme was involved in conducting extensive R&D into, *inter alia*, the safe and sustainable use of Jordan's water basins, as well as projecting future water usage patterns in Jordan. In conducting its R&D activities, Shahbaz indicated that the centre aims to develop its knowledge platform both internally and through the acquisition of new knowledge from external sources.
- *Jordan Valley Authority (JVA)*. Secretary General of the JVA, Saad Abu Hammour, indicated that the JVA has several R&D projects aimed at developing improved water management technology in irrigation, including developing computerised drip irrigation systems. Over the longer term, Hammour pointed to the Red Sea to Dead Sea desalination project as being the only viable solution to solving Jordan's water shortage.

- The private sector is also actively involved in R&D activities aimed at more efficient use of water. Examples of this include:
 - *Kleenwash*. Hassan Atmeh, Managing Partner, and Dr Nader Atmeh, General Manager of the Kleenwash car washing company, indicated that the company had developed its own waterless car-washing technology which it hopes to export to overseas markets. Kleenwash claimed it has developed a waterless car-washing technology requiring 17 ingredients compared to over 50 ingredients used in the equivalent US-developed product, providing the Kleenwash technology with an advantage over its competitors.
 - *The Arab Potash Company*. Engineers interviewed at the Arab Potash Company indicated that the company is developing ways to more effectively harvest grey water from agriculture to use in the production of potash, a water-intensive process.

1.6.6 The defence industry

The KADDB was established by a royal decree in 1999 to provide an indigenous capability for the supply of independent, high-quality, efficient and cost-effective scientific and technical services to the Jordan Armed Forces (JAF). Its R&D facility provides a 'one-stop solution' for the development and supply of innovative defence and commercial equipment designed to meet the requirements of the Middle East environment. The KADDB is described as an independent governmental military–civilian agency existing within the JAF. It is currently financed through the defence budget as well as through income generated from the sale of technology, products and services.¹⁰⁴

The KADDB's R&D facility aims to act as a catalyst within Jordan for the design and manufacture of defence and commercial equipment and services, including light aircraft, armoured vehicles, armour and rifles, intended for use by both the JAF and for the civilian and military export markets in the Middle East. The KADDB operates out of its own industrial zone, and is actively involved in training its staff in the research, technical and soft skills necessary to meet its future development requirements. With growing export markets in the global defence industry, the KADDB is contributing to the growth and innovative development of the Jordanian manufacturing sector.

Former Chairman and CEO of the KADDB, Dr Moayad Samman, discussed plans to restructure the organisation into 22 for-profit companies operating under the KADDB umbrella. Samman indicated that each company—operating in different areas ranging from armoured vehicles to food supply for the military—would be responsible for conducting and commercialising its own R&D activities. KADDB companies would be required to identify joint venture partners that are

¹⁰⁴ See http://www.kaddb.com/public/English.aspx?Page_Id=376&Menu_ID2=32&Menu_Id=31&lang=2.

leaders in their field and from which KADDB companies can gain technological knowhow in exchange for information on how to tailor products and services to suit the requirements of the MENA region, as well as providing JV partners with guaranteed orders from the Jordan government. Samman explained that, historically, R&D has been funded directly from the defence budget and that R&D activities lacked a financial imperative for outputs to be put to practical or commercial use.

2 People

“We are fully aware of the obstacles and difficulties that stand in the way of this country’s progress. They consist of the lack of resources, and modest means. Yet, at the same time, we realize that the Jordanian citizen who is educated, qualified, committed and diligent is our asset and our means of overcoming these difficulties. He is the tool of development, and his good is its objective.”

His late Majesty King Hussein I

Address to Mu-tah University, Karak, Jordan, May 1996¹⁰⁵

The people of Jordan represent the country’s key resource to drive future economic growth. At the same time they embody the very reason Jordan needs to identify new avenues for future development to ensure job creation and viable employment for its growing labour force and increasing number of young jobseekers. A strong NIS that promotes scientific and technological R&D and innovation is crucial if Jordan is to ensure the future prosperity of its people.

This chapter provides an assessment of the human capital of Jordan. It looks at Jordan’s youthful population, the influxes of refugees, the country’s large diaspora, and the challenges Jordan faces in retaining skilled workers. The ability of the national education system to provide an educated workforce with the skills relevant to industry is examined, with a particular focus on higher education. Consideration is also given to the education system’s ability to foster a culture of creative enterprise and innovation.

2.1 The Jordanian people: a youthful asset

Along with other countries in the Arab world, Jordan has a young population. Jordan’s population in 2011 was estimated to be approximately 6,249,000 of which just over one-third were less than 15 years of age, and almost 60% were below 25 years.¹⁰⁶ Jordan has the ninth highest population growth rate in the world at 2.2% per annum.¹⁰⁷ Nevertheless, a slowing rate of population growth, projected by the DOS to decline to just over 1% per annum by 2020, compared to an annual growth rate of between 2.3% and 2.6% per annum over the last decade, should see a decline in the proportion of youth and a gradual aging of the Jordanian population going forward.

105 Source: <http://www.kinghussein.gov.jo/>.

106 DOS (2011). *Jordan in figures*. Jordan Department of Statistics, September.

107 SFG (2011). *The blue peace, rethinking Middle East water*. Strategic Foresight Group, p 88.

The present young population profile in Jordan can be regarded as a double-edged sword. On the one hand, a young population that is well educated and employed productively can provide strong stimulus to economic growth and compensate for a lack of natural resources. Conversely, the associated education costs, together with the pressing need to expand productive capacity to create jobs and thereby avoid rising unemployment, are considerable.

Jordan's overall unemployment rate has declined over recent years, falling from 15% in 2000 to just below 13% by 2011.¹⁰⁸ Nonetheless, research points to a lack of jobs for both school leavers and university graduates, with youth unemployment rising from 26.7% in 2000 to 32.9% by 2008.¹⁰⁹ Costs related to youth exclusion due to unemployment, joblessness, school-dropouts, adolescent pregnancy and migration are estimated to be as much as US\$1.5 billion annually, or approximately 7% of Jordan's GDP.¹¹⁰ Government reductions in recruitment, low-wage migrants and a lack of job creation in the national economy are cited as factors contributing to the high rate of youth unemployment.

Jordan's Ministry for Social Development is implementing programmes aimed at tackling unemployment, especially among Jordan's youth. Programmes include a scheme to encourage private sector companies to train youths once they turn 18 years of age, and to provide them with relevant workplace experience as well as possible future employment opportunities. Another programme provides incentives to companies operating in Jordan's 'Qualified Industrial Zones', in return for establishing factories in poor areas designated as satellite industrial zones.

With the ICT sector identified as a key growth sector and source of job creation, in May 2009 the Ministry of Information and Communication Technology (MoICT), Ministry of Labor, USAID, and sector associations including Int@j, launched the Graduate Internship and Employment Programme. The programme sponsors 500 university graduates annually by subsidising 50% of the graduates' salaries for the first 12 months of employment, and 25% during the subsequent six months, if they are hired by private sector companies in ICT positions. The Minister of Information and Communication Technology indicates that, under the national ICT strategy, the goal is to increase employment in the sector to 35,000 by 2011. Graduates included in the programme also receive a two-week soft skills training course. As part of the programme, Microsoft Jordan is sponsoring 100 university graduates by providing a number of free training courses that will help develop the IT skills of graduates hired under the programme.¹¹¹

108 Source: Department of Statistics, Amman, Jordan (2013). See http://www.dos.gov.jo/dos_home_a/main/jorfig/2011/1.pdf accessed 15 April 2013.

109 2003 figure sourced from UN data. 2008 figure sourced from paper by Kanaan T (2009). *Financing higher education in Jordan*. Economic Research Forum, Regional Conference on Financing Higher Education in Arab Countries: Amman, Jordan, 17–18 June.

110 Source: Middle East Youth Initiative. See <http://www.shababinclusion.org/content/article/detail/982>.

111 See <http://www.ameinfo.com/185885.html>

2.2 An influx of refugees

Jordan is considered to be a relatively stable and tolerant Arab country. Traditionally seen as a relatively safe haven in the region, it is home to a large refugee population from surrounding countries including Palestine, Kuwait and, more recently, Iraq. The UN Relief & Works Agency estimates that approximately two million Palestinian refugees currently reside in Jordan, many having fled Palestine during the Arab–Israeli conflict of 1946–1948, and having since been granted Jordanian citizenship.¹¹² In 1990, when Iraq invaded Kuwait, Jordan experienced an influx of in the vicinity of half a million Palestinians and Jordanians who had been working in the Gulf States and Iraq at the time of the invasion. Then in 2003 approximately one million Iraqis fled to Jordan as a result of the war. The international migrant stock in Jordan in mid-2010 was estimated to be 45.9% of Jordan’s total population (this figure includes both foreign citizens and refugees).

These large influxes of refugees have placed considerable pressure on Jordan’s already limited resources, including water, energy, and infrastructure such as schools, housing and healthcare services. Refugees settling in Jordan also require productive employment as a means to support themselves and their families. At the same time, many refugees displaced due to war or occupation bring with them skills and resources that can contribute to growth in the national economy.

2.3 Developing the national education system

‘Knowledge: the beginning of it is bitter to taste, but the end is sweeter than honey.’ Samarkand proverb.

A clear need exists in Jordan to develop an education system and society that nurtures creative minds and scientific enquiry. Graduates must be well equipped to adapt to rapid technological change. They should also display tolerance and understanding of those around them in what is a volatile and politically sensitive region. While investment in education comes at a high cost, it has the potential to provide high returns on investment. By investing in the creation of a highly skilled and competitive workforce, and moving Jordan towards a knowledge-based economy, future generations will be better placed to develop to their full potential, and contribute to the future prosperity of their nation.

112 OBG (2010). *The Report, Jordan*. Oxford Business Group, p 9. See http://www.oxfordbusinessgroup.com/full_content/report-jordan-2010.

2.3.1 Primary and secondary education

Data produced by the UN indicate that in 2010 Jordan directed approximately 8% of public expenditure towards basic and secondary education. This compares relatively favourably to 9% in the UAE, 4% in Egypt and 6% in Saudi Arabia.¹¹³ The country's population over the age of 15 has a high literacy rate of approximately 92.8%,¹¹⁴ and the region's largest proportion of bilingual Arabic–English speakers.¹¹⁵ By regional standards, the Jordanian population is considered to be relatively well educated.

Traditionally, Jordan's education system was directed towards reinforcing traditional values including obedience and conformity. The system focused on imparting knowledge and rote learning rather than teaching students how to be critical thinkers who could solve problems, develop their imaginations and creativity, and ultimately innovate. Moreover, education was traditionally valued for the social status it provided rather than the skills it taught students. While reforms to Jordan's education system have gone a long way towards improving the quality of education provided in schools, the importance of the social status education provides continues to this day, resulting in a strong preference for young Jordanians to pursue university education at the expense of alternative forms of training and employment. This issue is discussed in more detail in the section dealing with higher education.¹¹⁶

The MoE began reforming the education system in the early 1990s. Then in 2001 HM King Abdullah II called for a remodelling of the education system to move Jordan towards becoming a regional leader in the ICT sector, and to contribute to the country's development as a knowledge-based economy. Reforms targeted a wide range of areas including an improved curriculum, better trained teachers, and accreditation and standards systems to ensure the quality and consistency of schools.¹¹⁷

In July 2003 significant reform efforts were undertaken by the Jordanian government to transform the public education system to meet the requirements of the knowledge economy, through the launch of phase one of the Education Reform for the Knowledge Economy, (ERfKE) programme. Phase two of the ERfKE programme was launched in 2008 in order to continue reform efforts implemented during phase one of the programme; very few changes were made to the format of the programme during phase two. Alongside ERfKE, the Jordan Education Initiative (JEI) was launched in 2003. It was marketed as a mechanism for enabling and accelerating social and economic development across the region, and represented a successful PPP model that enjoyed the support of the WEF.

113 UNDP (2010). *Human development report 2010, 20th Anniversary*. Country profiles. International Human Development Indicators.

114 DOS (2009). *Jordan in figures*. Jordan Department of Statistics, September.

115 Rischard J, White J, Chung S & Kim J (2010). *A candid review of Jordan's innovation policy*. World Bank/Korea RIAL Team for Jordan, April, p 1.

116 Seeley N, Ejeilat L & Washington K (2010). *Education: a dream deferred*. Education, 4 November.

117 For more on Jordan's education reforms, see Al-Bataineh A and Nur-Awaleh M (2005). *International Education Systems And Contemporary Education Reforms*. University Press of America, 30 Jan 2005

In 2007 JEI moved from the externally supported PPP project to national status. It was registered as a NGO in 2008. To support the MoE's reform processes, JEI established a test bed for the introduction of ICT and e-content resources into classrooms that could support innovative practices. The test bed comprised 100 public schools in Amman called 'discovery schools'. According to the Trends in International Mathematics and Science Study (TIMSS) and Programme for International Students Assessment (PISA) tests, these discovery schools were academically superior to other public schools, and students attained higher scores in subject areas than those in non-discovery public schools.¹¹⁸ In addition to JEI, the MoICT has participated in numerous projects to promote the development of ICT in education.

Despite the reforms introduced so far, Jordan's primary and secondary school system still faces a number of challenges which include the need to:

- Improve the current examination system of the Tawjihi by including more analysis-based questions;
- Improve the quality of teachers, including introducing a teacher qualification beyond that of holding a basic degree;
- Address the lack of a reading culture among students;
- Reduce class sizes and uneven teacher:student ratios;
- Address the mismatch between curricula in schools and workplace requirements and revise curricula in order to cover a wide range of cognitive and social skills (eg. critical thinking, personal and social competencies);
- Evaluate the current process of staffing through the Civil Service Bureau which affects the quality of teaching staff;
- Introduce effective monitoring and evaluation mechanisms to assess teacher training programmes that are incorporated into classroom teaching;
- Provide support to private sector schools in recognition of the large number of students enrolled in private schools that could not be readily absorbed under the public system.

In addition to the above, the Jordanian education system must continue to move away from rote learning where students are required to memorise a large volume of facts in order to pass examinations. Instead, students should be taught to be critical thinkers who can apply theories and principles to real-world problems. Without this ability, students will be unable to solve problems where there are no existing facts in order to be able to develop innovative products or services in the future.¹¹⁹

118 JEI (2009). *A multi-stakeholder partnership model to support education reform: case study*. Jordan Education Initiative.

119 For more on the Jordanian education system, see <http://www.mohe.gov.jo/UniversitiesE/tabid/611/language/en-US/Default.aspx?x=1>, accessed 5 February 2013

Dr Osama Obeidat, Head of Monitoring and Evaluation at JEI, stated that policy-making processes in relation to education are not evidence based in Jordan. Obeidat also added that teachers lack motivation because of the absence of financial incentives and the apparent lack of appreciation of their efforts. Obeidat believed these two factors had contributed to a decrease in innovation within schools.

2.3.2 Tertiary education

'The system seems to have created a supply of unskilled, unqualified graduates with a poor quality of education, not in demand by the labor market.'

Dr Taher Kanaan

Regional Conference on Financing Higher Education in Arab Countries, Amman, June 2009

Following the end of World War II, when many countries in the Arab region gained independence, there was a growing awareness of the important role education and S&T play in economic development. This saw the founding of a number of universities and research centres in the region. Accordingly, the Jordanian government established the UoJ in 1962. Since that time, a number of both public and private universities have been established in Jordan. By 2010 Jordan had 10 public and 20 private universities.¹²⁰

Universities are seen as the drivers of discovery and invention, both creating and disseminating new knowledge. However, the Shanghai Jiao Tong University (SJTU) in China, and the *Times Higher Education Supplement* (THES) in the UK—two globally recognised rating providers—indicate that the quality of universities in the Arab world is not high by world standards. Cairo University (2007) and King Saud University (2009) are the only Arab universities to have been ranked in the SJTU's top 500 universities in the world, and no Arab universities have ever appeared in the THES ranking. The OIC also produces a list of the top 50 universities of OIC member countries. Only nine Arab universities appear on this list. JUST was ranked in 44th position, and was the only Jordanian university to appear on the list. The American University in Beirut was the highest ranking Arab university, at eighth position. Interestingly, Cairo University was ranked in 25th position, showing the subjectivity of these ranking systems.

UNESCO's *Science report 2010* indicates that the higher education sector across the Arab region is in need of reform, and claims that in most countries universities are producing bureaucrats with little innovative capacity. The report indicates that this is leading to a mismatch between the skills companies are seeking and what most universities are producing. Our research confirms this also to

120 Source: <http://www.mohe.gov.jo/HomePage/tabid/36/language/en-US/Default.aspx>.

be true in Jordan, with many interviewees indicating a mismatch between the skills of graduates and the technical skills and innovative capabilities industry is demanding. Moreover, graduates were reported as having a poor ability to undertake the applied research necessary to drive successful innovation. For example, Jordan's biomedical workforce is viewed as lacking sufficient focus on scientific inquiry and laboratory training. University curricula are viewed as being too theoretical, producing students who lack the skills necessary to apply their knowledge.¹²¹ This deficit could possibly reflect curricula being supply driven rather than demand driven by industry. A greater involvement of industry in curriculum development, the provision of internships and vocational training, together with improved links between academia and industry, could help contribute to the development of more relevant curricula and teaching in the higher education system.

Interviewees also indicated the need to embed entrepreneurial and commercialisation skills within the higher education curricula. These skills are necessary if university graduates are to successfully apply new technologies to processes, products and services that effectively meet market needs.

Overall, it would appear that the higher education structure in Jordan needs to be reviewed in terms of the increasing demand for university placements, the need for more practical learning within university curricula and the need to address the impact of different social and economic factors. Issues that need to be addressed include:

- The demand for community college qualifications has been decreasing with students showing a strong preference for university education. Moreover, a large proportion of those students undertaking community college courses are doing so as a 'bridging' measure to gain university entrance;
- Public universities, which educate a substantial proportion of Jordan's university population, are facing increasing financial and related pressures;
- Constraints on public expenditures directed towards public universities, including reduced investments in facilities and faculty development, are occurring at the same time as the demand for admissions is increasing. This in turn is having a negative impact upon the quality of education provided at public universities.

In the face of the existing deficiencies in higher education curricula, organisations including the KADDB, National Paints and Rubicon indicated that they have established their own internal training programmes. In the case of Rubicon, the company is offering a 3D design course that is also open to outsiders. It is also

121 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

collaborating with the PSUT by sponsoring an animation lab for students. The KADDB also offers staff training in a range of areas, including applied research, management and customer service.

A number of reasons have been cited for the low academic standards of Jordan's universities. These include:

- Supply- rather than demand-driven demand for higher education resulting in a mismatch between the type of students graduating from universities and the skills mix industry is seeking;
- An archaic hierarchical system of promotion and incentives within universities that provides few incentives for applied R&D and innovation, nor collaboration with industry;
- Faculty being frequently required to take on heavy teaching loads to supplement their income, leaving little time for scientific research;
- The need to increase the salaries of university faculty so they are highly qualified when recruited, committed to their public duty, and do not engage in other forms of income-generating activities to supplement their incomes¹²²;
- Student:teacher ratios falling short of the OECD average of 14 students per faculty member, and the world average of 16 students, with statistics showing the student:teacher ratio in Jordan was 1:38 in 2004. Lebanon was the only country in the Arab region that performed better than the OECD and world averages with a ratio of 1:8 students.¹²³

Community colleges' reform efforts are also viewed as unsatisfactory. These include unsatisfactory progress in terms of employer satisfaction with the skills or graduates, failure to grow enrolments despite the establishment of new associate degree programmes developed in collaboration with the private sector, and limited improvements in college management and governance.¹²⁴

Dr Taher Kanaan, Managing Director of the former Jordan Center for Policy Research & Dialogue, in his presentation to the Regional Conference on Financing Higher Education in Arab Countries held in Amman in June 2009, called for a range of reforms to the higher education sector, including:

- Curriculum reform to improve the quality of education;
- Improvements to educational facilities and teaching standards;
- Revisions to legislation governing higher education, guaranteeing universities' independence;
- Reassessing existing university admission criteria;

122 Tzannatos Z (2009). *Financing higher education: what have we learnt?* Presentation at the Conference on Access and Equity in Financing Higher Education in Arab Countries, Amman, 17–18 June.

123 Badran A & Zoubi MR (2009). *Science & technology landscape of the OIC Arab countries in Focus*. 7th IAS Science Conference, Malaysia, December.

124 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

- The implementation of accreditation processes for universities/courses;
- Changes to the examination culture from internal self-testing to independent and competitive examinations by professional boards;
- Better incentives for investment in R&D at universities;
- Better compensation for investors in private commercial universities.

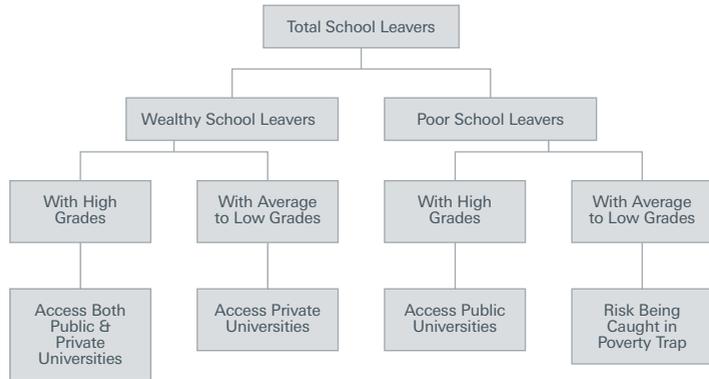
The level of public spending on higher education is also an issue in Jordan. While it is unlikely that public spending on higher education can grow in proportion to the growing demand driven by a large youth population with a strong preference for a university education, Kanaan indicates that public spending on higher education has dropped over recent years.¹²⁵ Moreover, MoPIC estimates that public spending on higher education is a small 0.8% of GDP, compared to private sector expenditure on higher education estimated to be around 3.7% of GDP. The decline in public spending on higher education occurred despite growing student enrolments, with the number of students enrolled in public universities increasing from approximately 50,000 in 1990–1991 to 160,000 in 2006–2007. At the same time, enrolments in private universities rose from zero in the early 1990s when they were first established, to almost 58,422 by 2008–2009.¹²⁶

Kanaan¹²⁷ observed that enrolments of students from the richest wealth quintile of the population are over three times the level of enrolments from the poorest wealth quintile (37% and 11%, respectively). This suggests a possible bias in the current system whereby access to higher education is not always based on a student's academic abilities, but also on their ability to pay. It can be argued that such occurrences represent an opportunity cost to Jordan as educational resources will not always be directed towards the most able students who can potentially contribute the most to the country's future economic development. This also highlights the potential poverty trap students from less affluent families might face when negotiating entrance into the higher education system in Jordan, as illustrated in the following diagram:

125 Kanaan T (2009). *Financing higher education in Jordan*. Regional Conference on Financing Higher Education in Arab Countries, Amman, Jordan, 17–18 June. Economic Research Forum.

126 Ministry of Higher Education & Scientific Research (2008–2009). *Annual statistical report on higher education in Jordan*.

127 Kanaan T (2009). *Financing higher education in Jordan*. Regional Conference on Financing Higher Education in Arab Countries, Amman, Jordan, 17–18 June. Economic Research Forum.

Figure 1.13. Sketching the roadmap to the poverty trap

One possible strategy to address this poverty trap, as well as to overcome the strong bias towards attaining a university education, would be to better educate school leavers regarding the different options available to them upon leaving school, which include but are not limited to university education. This should include promoting an awareness of the benefits of vocational training, as well as increasing the availability of well-designed and targeted vocational training programmes. Furthermore, improving the social perception of vocational training, which affects the quality of programmes and the employability of trainees, is also important. It is noteworthy, however, that existing vocational training programmes are also reported to suffer from being mismatched with the needs of industry.¹²⁸

In a possible response to these issues, the Minister of Higher Education and Scientific Research, Wajih Owais, indicated that the government was in the process of drafting a new legislation to pave the way for the establishment of polytechnic schools at public universities. This initiative aims at reducing the burden on overcrowded bachelor's degree programmes; it is estimated that it will ease the demand on some faculties by half, and at the same time provide the local labour market with required technical specialisations. The MHESR is also reported to be currently drafting a system to rate universities and courses in order to evaluate the effectiveness of each university.¹²⁹

Despite the strong demand for tertiary education in Jordan, it is perhaps surprising to see the unemployment rate highest among university graduates, at around 15% in 2008. This compares to an unemployment rate in 2008 of 10% for secondary school leavers, and 12% for people who leave school before completing secondary school.¹³⁰ It could be argued that the high volume of university

128 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in Jordan*. VDI/VDE Innovation + Technik GmbH: Berlin, p 25.

129 Jordan Times (2011). *Government to focus on employment-oriented higher education*. Jordan Times, 15 March.

130 Kanaan T (2009). *Financing higher education in Jordan*. Regional Conference on Financing Higher Education in Arab Countries, Amman, Jordan, 17–18 June. Economic Research Forum.

graduates, together with the apparent mismatch of graduate skills to industry needs, is giving rise to this relatively high rate of unemployment among graduates. An alternative view is that the Jordanian economy, given its industrial structure (grounded in low added value activities), is failing to develop at a sufficient rate to absorb the number of educated jobseekers. Whichever case is true, the high rate of unemployment is leading university graduates to seek employment opportunities outside Jordan, representing a lost opportunity for the Jordanian economy.

In terms of postgraduate studies, research indicates the majority of Jordanian students opt to study overseas, especially in the US and UK. Companies also indicated a preference for staff to undertake postgraduate training overseas. UNESCO's *Science report 2010* indicates that, in terms of postgraduate studies in S&T-related fields, Jordan ranks sixth in the Arab region, with a total of 809 students enrolled in 2006.

2.4 Jordan's diaspora

Jordan has a large diaspora living throughout the world. High unemployment, low salaries and better employment opportunities are key reasons driving the emigration of Jordanians to countries in the region as well as further abroad. The tendency for university graduates to undertake postgraduate studies overseas also results in many finding employment opportunities abroad and settling in these countries.

Research indicates that the relatively small entrepreneurial basis in Jordan combined with cultural issues that sometimes hinder entrepreneurial spirit and risk taking in Arab society results in talented citizens sometimes making the decision to pursue businesses opportunities in overseas markets, and to develop as entrepreneurs in environments more conducive to entrepreneurship than that provided locally.

Dr Wisam Rabadi, CEO, iPark, estimates that around 800 academics have left academia in Jordan to go overseas or to work in other sectors in the local economy. Recent media reports also indicate that approximately 200 doctors employed in the public health sector left Jordan during 2010 in pursuit of higher wages and better training opportunities elsewhere.

Offsetting the obvious opportunity costs of losing many of Jordan's most talented and skilled citizens, Jordan's large and highly skilled diaspora generates significant remittances into country, and provides Jordan with an important source of national income.¹³¹ Jordan's diaspora also enables locally based nationals to access international networks for collaboration in S&T, as well as to pursue business development opportunities abroad.

131 Rischard J, White J, Chung S & Kim J (2010). *A candid review of Jordan's innovation policy*. World Bank/Korea RIAL Team for Jordan, April, p 1.

Returning diaspora often return with valuable skills and experience gained overseas. In many cases they also return with sufficient financial resources to establish businesses in Jordan and exploit the well-educated workforce and relatively low labour costs Jordan provides.

Examples of talented diaspora that have returned to Jordan to establish successful businesses or assume important public or institutional positions include:

- Dr Usama Fayyad, Chairman, D1G and Executive Chairman, Oasis 500. A leading international expert in data mining who has worked extensively in the US, and has held numerous positions in the international ICT industry, including serving as Vice President of Research & Strategic Data Solutions with Yahoo!, was invited by HM King Abdullah II to head up Oasis 500, an initiative designed to help entrepreneurs in Jordan's ICT sector turn their ideas into viable business propositions.
- Samih Darwazeh, Chairman, Hikma Pharmaceuticals. Worked overseas for the leading pharmaceutical company Eli Lilly, before returning to Jordan to found Hikma. He has held many positions since returning to Jordan, including serving as the Minister of Energy & Mineral Resources. Darwazeh was appointed as a member of the Senate in 2010.
- Dr Issa Batarseh, President, PSUT. After completing his postdoctorate degree in Electrical and Computer Engineering from the University of Illinois at Chicago in 1990, Dr Batarseh joined the University of Central Florida (UCF). For nearly 20 years at UCF he carried out teaching and research activities in the area of energy conversion, focusing on the development of advanced systems for solar energy conversion to improve cost, power density, efficiency and performance. Dr Batarseh and his team have published more than 350 journal and conference papers, and he has also published a textbook entitled *Power electronic circuits* with John Wiley & Sons. He has supervised 26 PhD dissertations, 39 MS theses and 13 undergraduate honour theses. He has more than 20 US patents and licences granted to commercial products. He is a co-founder for two start-up companies: Advanced Power Electronics Corp. (APECOR) and Petra Solar. Dr Batarseh is a fellow of IEEE, AAAS and IEE.
- Dr Ahmad Al-Ghazawi, President & CEO, Truimpharma. Worked for a number of leading international pharmaceutical companies, including GSK and Merck, before returning to Jordan to establish Truimpharma. Regarded as a 'supergeneric innovator', Al-Ghazawi was inspired by a speech made by HM King Abdullah II to a group of Jordanian alumni. This led him to return to Jordan and establish Truimpharma, a company that develops innovative formulations of known generic medicines that improve efficacy for the patient.
- Dr Taher Kanaan, Managing Director of the former Jordan Center for Policy Research & Dialogue. Worked extensively overseas, including in positions with the UN, Arab Development Fund and in private consulting, before returning to Jordan in the 1980s to assume various cabinet positions, as well as serving a term as Deputy Prime Minister.

- Dr Yahya H. Zweiri, Design and Development Manager of the KADDB. From 2000 to 2007, Zweiri worked as a Research Fellow at the British Ministry of Defence (MoD) and Kings College, London, where he worked on unmanned vehicles used for autonomous tasks. During his stay at the MoD, he worked as a research scientist for more than one year at the Field and Space Robotics Laboratory at the Department of Mechanical Engineering, Massachusetts Institute of Technology (MIT), USA. Zweiri has over 20 years research and practical experience in machine intelligence, neural networks and control of non-linear systems. Dr Zweiri has published over 75 referred research papers in international journals and conference proceedings, and filed nine patents in the USA and Europe.

2.5 Retaining and attracting talent

'I cannot handle the government bureaucracy, tax laws, and control over the private sector. It is stifling the growth of the economy. The government must support the private sector, not vice-versa.'

Respondent, Survey of Jordanians living abroad,
Jordanian Competitiveness Team, Ministry of Planning

For Jordan to maximise its innovative capabilities and potential in S&T innovation there is a clear need for the country to mitigate future 'brain drain', especially of scientists, innovators, entrepreneurs and technicians. UNESCO's *Science report 2010* suggests that good governance, fair laws, government support of business, and attracting investment to the country will help stem the outflow of talent to other countries.¹³²

In order to foster a positive environment for innovation and entrepreneurship, Jordan also needs to display a fair and predictable rule of law. A 2008 World Bank report ranked 'the rule of law' resulting from governance in Jordan as being in approximately the 60th percentile on a global scale in 2007,¹³³ placing it 11th out of 18 in the Arab world.¹³⁴ (Note: the higher the score the better the ranking.)

A study by the MoPIC of Jordanians living abroad found that a weak economy and high unemployment were considered key barriers to their returning to Jordan.¹³⁵ This suggests the need to push for the development of Jordan as a knowledge-based economy. A strong NIS that fosters scientific endeavour and innovation, and provides an environment conducive to entrepreneurship and investment will assist Jordan to retain and attract a talented and highly skilled workforce, as well as encouraging the return of talented diaspora.

132 Kaufmann D, Kraay A & UNESCO (2010). *The current status of science around the world*. Science Report, November, p 253.

133 Kaufmann D, Kraay A & Mastruzzi M (2008). *Governance*

matters VII: governance indicators for 1996–2007. World Bank: Washington DC, June.

134 UNESCO (2010). *The current status of science around the world*. Science Report, November, p 253.

135 Jordan National Competitiveness Committee (2005). *Expatriate & immigrant community networks: Jordan as a case study*. Ministry of Planning.

3 Places

Jordan is small, almost landlocked country, situated at the junction of the Levantine and Arabian areas of the Middle East. Jordan shares borders with KSA, Iraq, Syria and Israel. The following map indicates the Kingdom's geographical location in the Middle East region:

Figure 1.14. Map of Jordan



Source: The world factbook. CIA: Washington, DC.

Jordan covers an area of 96,188 km² including the Dead Sea, making it similar in size to Portugal. Jordan has only 27 km of coastline on the Red Sea, which is home to its only port in the city of Aqaba. Jordan sits on the East Bank of the River Jordan, and has the longest border of any country with Israel.¹³⁶

The western region has a Mediterranean climate, experiencing hot, dry summers, and cool, wet winters. However, most of the country is arid desert, with approximately 75% of the country experiencing less than 200 mm of rainfall annually. Jordan can be divided into three geographic regions, comprising the Jordan Valley in the west, the Mountain Heights Plateau, and the eastern desert or Badia region. The Jordan Valley is the most fertile region, and enjoys a slightly warmer climate and higher rainfall than the rest of the country. It is the centre of Jordan's agricultural industry and is often referred to as the 'food bowl' of the country. The Mountain Heights Plateau separates the Jordan Valley from the desert region, and is home to most of Jordan's large population centres. The desert region forms part of the North Arab Desert, and has a harsh desert climate. The most famous desert in this region—described by T.E. Lawrence as 'vast and echoing and God-like'—is Desert Rum, home to the beautiful desert landscapes of Wadi Rum.¹³⁷

Jordan has experienced increasing urbanisation over recent years, with World Bank Development Indicators showing Jordan's urban population as a share of total population rising from approximately 50% in 1960 to almost 80% in 2009.¹³⁸ While the Kingdom comprises 12 governorates, much of the population is concentrated in the national capital of Amman. Overall, approximately three-quarters of the population resides in the three governorates of Amman (40%), Irbid (18%) and Zarqa (15%) (DOS 2009 estimates).

136 Source: http://www.kinghussein.gov.jo/geo_env1.html.

137 Source: http://www.kinghussein.gov.jo/geo_env1.html.

138 World Bank Development Indicators as cited on Global Finance website: <http://www.gfnag.com/gdp-data-country-reports/246-jordan-gdp-country-report.html>.

A map indicating the 12 governorates that make up Jordan is provided below:

Figure 1.15. Map of the 12 Governorates of Jordan



Source: http://upload.wikimedia.org/wikipedia/commons/e/e0/Jordan_governorates_named.png.

With much of country being desert, and with water scarcity a major issue, Jordan's geography has strongly influenced the distribution of its population, wealth and industry. Rural areas tend to be poorer and provide fewer opportunities for education and employment. A further defining characteristic of Jordan's demographic profile, as well as its relatively youthful population discussed earlier, is that the more economically productive 15-64 year age group accounts for under 60% of the total population.¹³⁹

139 JAEC (2010). *Country overview*.

Jordan's leading industry is phosphate and potash mining, accounting for approximately 20% of total exports. Jordan is also the world's second largest global exporter of phosphates. Strong global demand for fertilisers to support the growing demand for food production internationally is expected to support the future growth of Jordan's mining industries.

Jordan's tourism industry is expanding rapidly, with locations such as Petra, the Dead Sea and Wadi Rum, as well as Jordan's rich historical and religious heritage, providing unique attractions for tourists. The tourism industry is believed to offer considerable opportunities for future expansion and income generation.

Nevertheless, neither the mining nor tourism industries are considered to be involved in undertaking significant levels of scientific R&D or innovation activities.

3.1 STI in Jordan's regional centres

Jordan's capital, Amman, is not only the centre of government and home to the country's largest population, it is also the focal point of the NIS. This is not surprising given that Amman is where most S&T and innovation activities take place.

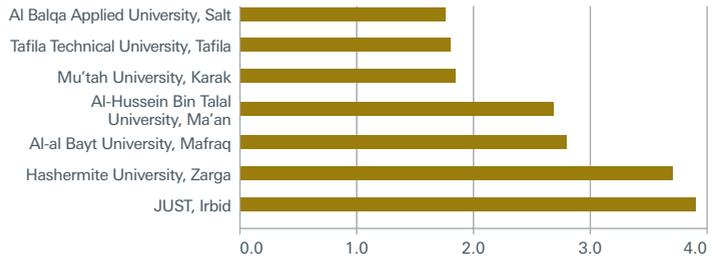
Nevertheless, with almost two-thirds of the country's population located outside the capital, it could be argued that opportunities to develop STI activities and innovative capacity in regional areas should also be explored and supported. These could include building on identified areas of geographic comparative advantage, such as solar power generation in Maan, or agricultural research in Irbid in the north. Unfortunately, little data exists to provide a clear indication of the levels of expenditure on R&D or outputs of the STI system in regional areas of Jordan.

Notwithstanding, research indicates some level of S&T-based R&D and innovation activities being undertaken in regional universities. A number of leading universities are located outside Amman, including JUST, near Irbid, which HM King Abdullah II indicated to be the 'best scientific institution in the Kingdom'.¹⁴⁰ Other important universities located in regional areas include the Hashemite University in Zarqa, Al-al Balqa University in Mafraq, Al-Hussein Bin Talal University in Ma'an and Mu'tah University in Karak. The chart below is based on data gathered by a survey conducted by the HCST, and illustrates leading regional universities in Jordan in terms of expenditures on R&D projects in 2006, although how much R&D was related to S&T is unclear¹⁴¹:

140 See <http://www.just.edu.jo/Pages/default.aspx>.

141 Elshuraydeh K, Mustafa I, Al Majali M, Al Assaf M, Sarraf F & Hamarneh O (2006). Science & technology and innovation profile of Jordan, October. ESTIME, HCST: Amman, Jordan, pp 62–63.

Figure 1.16. Expenditure on R&D Projects by Regional Unis, 2006 USD (mn)



In addition to university-based R&D activities, examples of government-sponsored R&D activities in regional areas include:

- Improved agricultural practices. The Ministry of Agriculture and NCARE undertake activities aimed at transferring knowledge generated through R&D into improved and more sustainable agricultural practices to local farmers;
- New and renewable energy. The Ministry of Energy & Mineral Resources has granted concession agreements to private companies to research the feasibility of exploiting Jordan's oil shale reserves, as well as conducting other studies to develop improved methods for harnessing renewable energy sources (solar, wind and thermal);
- Water management. The JVA and Jordan Badia R&D Programmes are undertaking R&D activities into improved water management practices, including more efficient irrigation systems, the use of Jordan's water basins and grey water desalination.

IRADA is a national development programme run by MoPIC and provides 'virtual incubator' services to support the establishment of micro-businesses in regional communities across Jordan. However, discussions with IRADA indicated that, while supporting the creation of many businesses throughout Jordan—thereby creating employment opportunities and generating income for regional communities, most projects are not involved in S&T activities, nor the commercialisation of innovative products or services. Nevertheless, IRADA is seeking to redress this situation. To this end it has requested the RSS provide it with 200 new business ideas which it can support in regional communities, converting innovative ideas in S&T into viable business opportunities.

While the above examples provide evidence of the national STI system extending at least to some extent beyond the borders of greater Amman,¹⁴² it is unclear to what extent the private sector in regional areas is involved in S&T-based R&D activities or technological innovation. However, anecdotal evidence suggests that it is limited. Reham Gharbiyeh, CEO of Al Urdonia Lil Edda, operator of several regional business incubators, expressed frustration at a perceived resistance to change within regional communities, particularly those located in the south of Jordan. Gharbiyeh felt this resistance represented a significant cultural barrier for future development within these communities.

While a detailed analysis of the state of STI in Jordan's regions is beyond the scope of this report, a brief discussion of developments in key governorates is provided below.

3.1.1 Amman

The capital of Jordan and centre of government, Amman is also the focal point of STI activities and the NIS. The HCST, RSS and EHSC are all located in Amman, as are many of the Kingdom's leading universities, including the UoJ and PSUT. Further underpinning Amman's pivotal role as the knowledge and innovation base of Jordan is its position as the location of numerous organisations established to promote entrepreneurship, innovation and the commercialisation of technology, examples of which include, *inter alia*:

- iPark. Located within EHSC, iPark is a technology incubator supporting ICT start-ups;
- QRCE. Located within EHSC, the QRCE runs programmes aimed at encouraging and supporting entrepreneurial endeavour and the commercialisation of innovative technologies;
- JTTON. Established to facilitate the movement of novel Jordanian technologies from their original academic sources to the general public, coordinated by IPCO at EHBP;
- ESCWA Technology Centre. UN-based body recently established in Amman to promote and support technological innovation and economic development in Jordan and regionally;
- Oasis 500. An early-stage and seed investment programme providing support and access to early-stage finance to entrepreneurs in the ICT, mobile and digital media sectors. Oasis500 aims to launch 500 start-up companies within the next five years.¹⁴³

Amman is also the business and financial hub of Jordan, with most businesses and financial institutions headquartered in the capital. DOS estimates an unemployment rate in the Amman governorate of 12.0% (2003), the lowest in Jordan. This compares to a national unemployment rate of 14.5%.¹⁴⁴

142 'Greater Amman' is defined as including companies located within a 50 km radius of the metropolitan centre (eg. JPM).

143 Source: <http://www.oasis500.com/>.

3.1.2 Irbid

Irbid is located 55 km from Amman, and the governorate has the second highest population in Jordan. The JIB considers the Irbid governorate to be a future regional leader in technological innovation. It is home to JUST, one of Jordan's leading S&T universities, specialising in ICT and healthcare, and encompassing the King Abdullah University Hospital. The university is committed to the advancement of R&D activities and to this end hosts a number of research centres, including the Pharmaceutical Research Center, Biotechnology Center and the Agricultural Center for Research & Production.

The Northern Development Corporation (NDC) was established in 2007 with the objective of partnering with the private sector in the development of the Irbid Development Area (IDA) adjacent to JUST. It is intended that the IDA will facilitate the establishment of cutting-edge ICT and healthcare industries in the governorate, and utilise the knowledge and skills generated by JUST, as well as providing a source of employment for students, graduates and the governorate's workforce.¹⁴⁵

The governorate is also home to three Qualified Industrial Zones (QIZs): Prince Hassan Industrial City, Cyber City and Jordan River Crossing City. The QIZs provide companies based within them with infrastructure and facilities including roads, maintenance, utilities, and sewage and disposal treatment plants. They also provide additional services such as free zone areas, banking, customs clearing centres, insurance and marketing offices.¹⁴⁶

Al Urdonia Lil Ebda—established in 2007 through funding provided by the SRTD—operates two business incubators in the governorate:

- **Jordan Innovation Centre (JIC)** provides support for the establishment of industrial, electronic, agricultural or educational companies to assist in the successful development and exploitation of innovative products, services and processes;
- **Irbid ICT Business Incubator** assists ICT graduates to establish their own software companies.

The incubators support entrepreneurs and start-ups involved in S&T-based R&D activities and innovation through the provision of pre-incubation, incubation and other capacity-building and technical assistance services. These support activities

144 Mayen G, Guégnard C, Matheu X & Shteivi M (2005). Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

145 Jordan's development areas offer tax and financial incentives to local, regional and foreign investors. All development areas host diverse range of industries. The 2008 Development Areas Law is focused on the development of mixed-use educational and high-tech zones in Jordan, and is designed to encourage private sector

developers and operators take the lead. Source: <http://www.kinghussein.gov.jo/economy9.html>.

146 Source: <http://www.kinghussein.gov.jo/economy9.html>.

include providing networking opportunities, increasing recognition and awareness of start-ups, and the provision of funding. Two examples of innovation supported in Al Urdonia Lil Ebda's JIC in Irbid include:

- Jordan Rolls for Rubber Manufacturing. Currently being incubated in the JIC, the founder of the company was the first person in the region to develop proprietary technology to coat printing rolls, packaging and other items with rubber or synthetic coatings. With the support of the JIC, the company is winning business from companies, especially those in the printing industry, that have in the past sent items overseas for coating. Jordan Rolls enables companies to save time and transportation costs, while offering services of equal quality to those provided by international competitors.
- Edom for Technology. Working within the JIC, Edom is developing new applications for renewable energies, including working with local farmers to develop solar-powered irrigation systems. The company is also working on the development of locally produced wind turbines, as well as novel applications for solar batteries in items including backpacks and laptop bags to enable laptops, cameras and mobile phones to be recharged without the need to connect to conventional power supplies.

Agriculture also represents a significant part of the local economy, with citrus, olives and wheat being important crops. DOS data indicate that the Irbid governorate recorded an unemployment rate of 16.4% (2003), ranking it sixth lowest in Jordan, and compared to a national rate of 14.5%.¹⁴⁷

¹⁴⁷ Mayen G, Guégnard C, Matheu X & Shteivi M (2005). Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

3.1.3 Zarqa

Zarqa has the third highest population of Jordan's governorates. The governorate's capital, Zarqa City, is located a short 25 km east of Amman. The governorate is estimated to be home to around half of Jordanian industry, and hosts Jordan's largest military and air bases.¹⁴⁸ Zarqa governorate is also home to the Kingdom's only oil refinery. The Hashemite University, ranked second in terms of R&D expenditure by regional universities in 2006,¹⁴⁹ is also located in the Zarqa governorate.

Zarqa governorate recorded Jordan's second lowest unemployment rate of 13.4% in 2003.¹⁵⁰

3.1.4 Aqaba

Aqaba governorate is located to the south of Jordan and ranks 10th largest in terms of population. Aqaba is home to Jordan's only coastal area, running for a mere 27 km and located on the Red Sea, with the rest of the country landlocked. As such, Aqaba has Jordan's only seaport, through which most of Jordan's foreign trade comes. This, together with an international airport, has seen Aqaba develop as a regional transport and logistics hub. Tourism also plays an important role in Aqaba's economy, with visitors drawn to its coastal resorts and the famous Wadi Rum.

The Aqaba Development Corporation (ADC), supported by USAID, developed the Aqaba Special Economic Zone (ASEZ). Utilising cutting-edge technology, the ASEZ has emerged as a model for numerous economic development reforms and good governance for the rest of Jordan. Development is currently focused on tourism, light industry and logistics sectors rather than heavy industry.

Aqaba governorate recorded Jordan's third lowest unemployment rate of 13.8% in 2003.¹⁵¹

3.1.5 Balqa

Balqa governorate is located to the west of Amman on the eastern plateau of the Jordan Valley. It has the fourth highest population of the Jordanian governorates, with an economy largely based on agriculture. Balqa also has a small light industry base which includes the Jordan Cement Factories Ltd in Fuhais, owned by the French company, LaFarge.

148 <http://www.eis.hu.edu.jo/Deanshipfiles/pub1041582.pdf>.

149 Elshuraydeh K, Mustafa I, Al Majali M, Al Assaf M, Sarraf F & Hamameh O (2006). Science & technology and innovation profile of Jordan, October. ESTIME, HCST: Amman, Jordan, pp 62–63.

150 Mayen G, Guégnard C, Matheu X & Shteiwi M (2005). Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

151 Mayen G, Guégnard C, Matheu X & Shteiwi M (2005). Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

Perhaps most notably, Al Balqa University is located in the governorate's capital, Salt. The university is home to the UNESCO-sponsored International Centre for Synchrotron Light for Experimental Science and Applications in the Middle East, more commonly known as SESAME. The SESAME project involves the establishment of a laboratory providing a synchrotron radiation facility which is expected to draw researchers from across the region. The facility is expected to be completed in 2014, and marks a notable contribution to STI-based initiatives in regional Jordan.¹⁵²

In 2003 the Balqa governorate recorded the fourth lowest unemployment rate of all governorates in Jordan, at 14.1%.¹⁵³

3.1.6 Ma'an

The largest governorate in Jordan, Ma'an is the second least populated in the Kingdom, comprised primarily of desert. Ma'an is home to the UNESCO world heritage site of Petra, one of the seven new wonders of the world, and as such draws much of its income from tourism. Current industries include the manufacture of ceramics, plastics and electrical appliances.

A new economic zone, known as the Ma'an Development Area (MDA), is being established in the governorate to encourage the growth of new industries. MDA will comprise four clusters including an Industrial Park and Skills Development Centre. The Industrial Park is to focus on the development of existing manufacturing bases, as well as other light, medium and heavy industries, including:

- The manufacture of building and construction materials;
- Renewable energy, including a dedicated R&D centre;
- Minerals-related manufacturing industries.

The Skills Development Centre is to provide vocational training through joint programmes run with the local Al-Hussein Bin Talal University, with the objective of enhancing knowledge and capabilities in the fields of manufacturing, sciences, engineering and renewable energies.^{154,155}

The Ma'an governorate recorded Jordan's fourth highest unemployment rate of 19.6% in 2003.¹⁵⁶

152 See www.sesame.org.jo.

153 Mayen G, Guégnard C, Matheu X & Shteivi M (2005). Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

154 <http://www.jordaninvestment.com/BusinessandInvestment/Wheretoinvest/MaanDevelopmentAreaMDA/tabid/267/language/en-US/Default.aspx>.

155 <http://www.mda.jo/>

156 Mayen G, Guégnard C, Matheu X & Shteivi M (2005). Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

3.1.7 Madaba

With its capital city, Madaba city, located just 30 km southwest of Amman, Madaba governorate has the eighth largest population of the Jordanian governorates. The governorate is famous for its Byzantine and Umayyad mosaics, wealth of historic sites, and the Dead Sea. Not surprisingly, it depends on tourism for its main source of income. The governorate also derives income from agriculture, including fruit and olive farms.

Companies such as the Jordan Company for Dead Sea Products and Areej Natural Products manufacture and supply a wide range of Dead Sea products and export to countries worldwide. However, many companies are located in Amman and not the Madaba governorate.

In 2003 the Madaba governorate recorded an unemployment rate of 14.7%, ranking it fifth lowest of all the governorates in Jordan.¹⁵⁷

3.1.8 Karak

The Karak governorate is situated on the southeastern coast of the Dead Sea, and its capital, Karak city, is located 140 km from Amman. The Karak governorate has the sixth largest population in Jordan.

The business incubator, Al Urdonia Lil Ebda, also operates a business incubator in the governorate, known as the South Business Incubator Centre. This incubator is located in the Al Hussein Bin Abdullah II Industrial Estate and aims to provide support for innovative people who have the ability to produce industrial, marketing, agricultural and Dead Sea products. The Karak Free Zone, established in 2001, is also located in the Al Hussein Bin Abdullah II Industrial Estate.

Karak governorate is home to Mu'tah University which in 2006 was ranked fifth among regional universities for expenditure on R&D projects.¹⁵⁸

The Karak governorate recorded Jordan's highest unemployment rate of 21.1% in 2003.¹⁵⁹

3.2 Regional innovation policy

At present no regional innovation policy exists in Jordan. Nevertheless, each region could clearly benefit from the development and implementation of region-specific innovation policies in order to identify and support appropriate, innovation-related activities that could contribute to the economic development of each region.¹⁶⁰

157 Mayen G, Guégnard C, Matheu X & Shteivi M (2005). Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

158 Mayen G, Guégnard C, Matheu X & Shteivi M (2005).

Unemployment in Jordan. European Training Foundation. [http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

159 Mayen G, Guégnard C, Matheu X & Shteivi M (2005). Unemployment in Jordan. European Training Foundation.

[http://www.etf.europa.eu/pubmgmt.nsf/\(getAttachment\)/4E4904B283AC4CAAC12570E0003D00E7/\\$File/NOTE6KCEZX.pdf](http://www.etf.europa.eu/pubmgmt.nsf/(getAttachment)/4E4904B283AC4CAAC12570E0003D00E7/$File/NOTE6KCEZX.pdf).

160 Seidel U, Dömrose W & Meier zu Köcker G (2009). Study on the national innovation system in Jordan. VDI/VDE Innovation + Technik GmbH: Berlin, p 23.

4 Business

Industry plays an important role in a nation's STI system. A strong and well-functioning NIS requires that the private sector be actively engaged in the commercialisation of new and innovative products, services and processes. Moreover, established businesses, entrepreneurs and start-up companies also have a vital role to play in both developing and commercialising innovative ideas and technologies that will drive future economic growth, industrial renewal and job creation.

The HCST's 2005 *S&T potential study* indicated that private sector investment in R&D activities was over 40% of total investment (2003–2004). However, the resounding message conveyed through both field and desk research was that private companies in Jordan are not traditionally technologically innovative by nature, and do not invest significant amounts in R&D activities. Reasons for this low level of private sector R&D are discussed below, including government policies and regulations that impact upon the private sector, and whether the business environment in Jordan is conducive to scientific research, innovation and entrepreneurship. Access to the finance necessary to fund R&D and innovation is also discussed. This is followed by an assessment of the opportunities that exist to improve private sector R&D activity and innovation in the future. The chapter closes with an examination of several 'home-grown heroes' in terms of successful scientific innovation in Jordan.

4.1 R&D and innovation in the private sector

It's a truism but people and businesses don't know what they don't know.

Dr Rowan Gilmore, Chief Executive Officer, Australian Institute of Commercialisation

Private sector companies in Jordan are not generally considered innovative in a technical sense, or likely to undertake significant levels of R&D. Exceptions to this rule exist, mostly in the services sector and notably in the ICT sector, including companies such as Maktoob.com (Arab internet services company acquired by Yahoo!), D1G (online Arabic community platform), Jeeran (Arabic webhosting community), Rubicon (a provider of e-learning and simulated training material, as well as animation, gaming and themed entertainment), and software developers such as Eskadenia and Kindisoft. Jordan's pharmaceutical and biotechnology sectors are also known to be actively involved in R&D and innovation, including pharmaceutical companies such as Al Hikma and JPM, and Contract Research Organisations (CROs) such as Triumpharma and Pharmquest. Beyond these pockets of R&D and innovation, there is limited evidence of significant levels of investment by private companies in R&D or innovation.

4.1.1 Industrial sector

Perhaps the most notable absence of investment in R&D and innovation is in the industrial sector. Unable to compete with low-cost countries in Asia, Jordan's industry leaders realise that they need to develop sustainable competitive advantage through innovation. While the development of niche markets can create short-term growth, sustainable growth can only be achieved through true innovation. As a result, the sector needs to increase GERD and the number of engineers and scientists engaged in R&D in order to increase its technical and innovative capacity.

The industrial sector in Jordan has grown in the past 20 years, encouraged by the government through, among other initiatives, the establishment of industrial estates. These estates operate as free-trade zones, and provide companies with infrastructure, business support services and incentives including tax exemptions. Examples include:

1. Al-Hassan Industrial Estate (Irbid);
2. Al-Hussein Ibn Abdullah II Industrial Estate (Karak);
3. Jordan Cyber City (Irbid);
4. Al-Tajamouat Industrial Estate (Amman);
5. Jordan Cyber City (Irbid);
6. Aqaba Special Economic Zone (Aqaba);
7. El-Zai Ready-wear Manufacturing Company (Zarqa).

By 2009, the industrial sector was estimated to account for approximately 30% of national GDP,¹⁶¹ with Jordan's relatively advanced pharmaceutical sector producing the main source of high-tech exports. The nascent biotechnology sector, in some cases comprising subsidiary companies of pharmaceutical companies, shows promise as a contributor to Jordan's high-tech exports in the future. However, Nabil Ismail, a member of the Board of Directors of the Jordan Chamber of Industry, explains that innovation culture is missing in most industrial companies, and is something that sorely needs to be developed. Ismail explains that most companies tend to focus on imitating others rather than generating new products or services. Moreover, investments in innovation are typically high risk and have long-term returns, whereas the majority of Jordanian companies are risk adverse and focus on short-term gains.

Dr Maher Al-Mahrouq, General Manager of the Jordan Chamber of Industry (the Chamber), points to another factor influencing the willingness and preparedness of Jordanian companies to invest in R&D and innovation. Al-Mahrouq explains that the vast majority of Jordanian companies are family-owned SMEs that do not typically have a culture of investing in R&D or innovation. Nor do family

¹⁶¹ Source: <http://www.gfmag.com/gdp-data-country-reports/246-jordan-gdp-country-report.html>.

companies generally invest sizeable amounts in staff development—beyond family members—that would build capacity within their companies. Family members also hold most senior management positions, sometimes stifling creativity and innovation.

Corroborating these views, a recent review by the World Bank/Korea RIAL Team for Jordan (April 2010) noted that 95% of private sector companies in Jordan are SMEs, mostly family businesses. The team found that these companies tend to operate in ‘undemanding fields’, are run in a ‘conservative manner’, and the culture of risk taking necessary for innovation is limited. Moreover, the team determined a general lack of familiarity with what is required to innovate within many companies. In addition to this, success is often determined by management’s ‘relationships’, or ‘wasta’, rather than the company’s performance, highlighting concerns expressed both in interviews and the Jordanian media regarding nepotism and corruption.¹⁶²

Beyond this, technical staff are reported often to lack the basic knowledge necessary to conduct effective R&D. In other cases, people possess the technical skills and knowhow, but lack the ability to communicate R&D outcomes or promote their ideas. Presentation, R&D proposal writing and public speaking skills could help to bridge this gap.

In response to the issues confronting the industrial sector, the Chamber offers members training programmes to improve their innovative capacity. Training includes programmes on business management and other soft skills.

In another initiative, the Chamber has recently signed a memorandum of understanding with the chemical industry to establish an ‘innovation centre’ to help develop the innovative capacity within this sector, one the Chamber considers to show strong growth potential.

Despite the general absence of investment in R&D and innovation in Jordan’s industrial sector, there are some notable exceptions. Two companies often cited as innovative companies actively involved in R&D are Petra Engineering Industries, a successful company that designs and manufactures commercial and industrial heating, ventilation and air-conditioning equipment, and the Nuqul Group, a large conglomerate involved in a range of sectors including FMCGs, construction, stationery, automotive, packaging and printing, and paper mills.

The KADDB invests heavily in R&D in the military sector, and is actively developing a manufacturing base in Jordan, including its own dedicated industrial zone. Although not strictly private sector, the KADDB’s R&D capacity has been developed through funding sourced from the public defence budget. Former

162 Rischard J, White J, Chung S & Kim J (2010), *A candid review of Jordan’s innovation policy*. World Bank/Korea RIAL Team for Jordan, April, p 2.

Chairman and CEO, Moayad Samman, has outlined plans to commercialise the KADDB's R&D activities, requiring the military to fund specific R&D projects on a commercial basis, with the R&D reflecting specific needs for the development and supply of new products and services. This compares to the current system whereby R&D and production capacities are separated. Under the planned model, the KADDB would no longer receive R&D funding directly from the defence budget.

4.2 Entrepreneurial innovation

Successful innovation requires the effective and fruitful partnering of the people with ideas with the people who have the necessary business acumen and entrepreneurial skills to successfully take this innovation to market. Discussions with David Tee, former team leader of the SRTD, indicate that efforts are being made to see these links being developed through partnering researchers and entrepreneurs. Incubators, such as iPark, Urdonia Lil Ebda and Oasis 500 (business accelerator), supporting the ICT sector, also work to bridge this gap by developing collaborative networks between the companies located within the incubators and mentors, business consultants and investors, who can help companies commercialise their products and services. They also provide training and support to develop capacity within the companies themselves. The JTTON is another example of linking between innovation and commercialisation (for more details please refer to the discussion in Section 1.3.6 Institutional and programme support for innovation).

A range of other factors also appear to contribute to the lack of a well-developed entrepreneurial base in Jordan. For example, social or cultural barriers to risk taking, and the importance of financial security and social status play an important role in influencing entrepreneurship in Jordan, and in the Arab world more generally. Other factors influencing the environment for entrepreneurship and innovation in Jordan include:

- A lack of seed and venture capital necessary to fund start-up companies seeking to commercialise innovation. This is discussed in more detail in the next section;
- The absence of tax incentives, such as tax concessions on R&D expenditures, that would promote greater investment in innovation-generating R&D activities by the private sector;
- High taxation on some sectors of the economy, including the telecommunications sector (estimated to be taxed up to 55% of total revenues)¹⁶³;

¹⁶³ Based on information provided by Ihab Hinnawi, CEO, Umniah.

- University policies and regulations that demotivate faculty from becoming engaged in business development activities, including the difficulty of access to funding, systems for academic promotion that do not always recognise commercially related activities, the heavy burden of teaching loads, a general lack of mechanisms to advance research activities, and the need to access equipment and laboratory facilities;
- Weak IP implementation processes. This includes judiciary and government patent staff lacking the knowledge and skills necessary to effectively monitor and enforce IP laws. Further to this, Jordan has been slow to implement the Patent Cooperation Treaty, the consequence of which is an increased risk that local patents will be used by others in markets outside Jordan;
- The ‘culture’ within Jordanian universities is widely reported to be very academically focused, with teaching largely based on lectures and less on practical application of learning;
- Regular changes to laws and regulations governing industry, often reflecting ministerial changes, provide an obstacle to long-term planning for business investment and future growth;
- Banks require high collateral from start-ups, while sophisticated financial products such as venture capital and equity financing are immature or do not exist;
- The brain drain to other countries where people possessing entrepreneurial skills see more potential to succeed—an issue raised by respondents to the survey of Jordan’s diaspora conducted by the MoPIC—also reduces entrepreneurial capacity in Jordan.

Despite the impediments that currently stand in the way of entrepreneurs and innovation in Jordan, evidence suggests that the government, industry and academia are increasingly recognising the need to foster a culture of innovation, creativity and entrepreneurship. To this end, measures are being progressively implemented to encourage the creation of innovation and technology-based businesses.

4.3 Access to capital

Access to capital is a major issue for the private sector in Jordan. Whether it is accessing funds to undertake R&D, or the capital necessary to take a new product or service to market, or to start up a new company, money is constantly cited as a key constraint to innovation and commercialisation activities.

Various programmes provide funds for R&D and innovation, including the SRSF and IRDF. However, the level of funding remains very low due to Jordan's limited resources. As a result, Jordan places a lot of emphasis on initiatives that involve donor agencies and PPPs. Some incubators, including those run by Al Urdonia Lil Edda, as well as private incubators that run schemes that exchange capital for equity, also provide avenues for funding R&D and innovation for start-up companies. In other cases, companies such as Hikma, JPM, Truimpharma and National Paints fund R&D activities internally through sales revenue.

A survey conducted by the Jordanian Association of Pharmaceutical Manufacturers (JAPM) of its largest members indicated falling levels of R&D expenditure over recent years. However, the level of expenditure on R&D made by the pharmaceutical industry was considered to be higher than the national average across all industries in Jordan. The JAPM reported that the R&D expenditures of seven of its 13 pharmaceutical member companies reached 5% of sales in 2006, but declined to 4% in 2007 and 3% in 2008.¹⁶⁴

Despite the existing level of funding that is available to support R&D and innovation in Jordan, GERD is estimated to amount to only 0.34% of GDP (2003), well below the average level of expenditure in advanced countries of 2.5%. Moreover, many stakeholders argue that the funding that is available is spread too thinly to be effective. This points to the need for funding to be both increased, and more focused on key areas of national priority, in order to achieve tangible results. This is particularly true for investments in the pharmaceutical industry, an industry in which Jordan has an established strength, but in which the size of the capital investments needed are large in order to be able to commercialise innovation. Companies such as JPM have many registered patents; however, accessing the levels of capital necessary to take a drug to market are prohibitive. As a result, patented drugs, modes of drug delivery and diagnostic tools remain unexploited, waiting for investors to enable the next step towards the commercialisation of these home-grown innovations.

Another key source of funds for R&D and start-ups in Jordan is family and friends. An example of a company founded on the basis of funding provided by family and friends is Jeeran. Established in 2000 by two university students, Jeeran developed an online Arabic community platform with finance provided by family and friends in exchange for equity in the company. Jeeran also sold domain names and internet space to generate revenue to fund expansion. Co-founder and Chief Product Officer, Laith Zraikat, explains that in the early 2000s no initiatives existed to support start-ups in the ICT arena in Jordan. Investors and banks showed

164 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

little interest in ICT companies such as Jeeran, as they did not understand their business, and were more interested in ‘bricks and mortar’ than the less tangible assets of an internet company. Growth was slow in the initial years. However, they were accepted into the iPark incubator in 2003; iPark provided the company with office space and an ecosystem to grow. The company subsequently expanded into blogging, file and video sharing, as well as other services, increasing the number of registered Jeeran members. Then in 2006, on the back of an established track record, Jeeran attracted funding from the newly established venture capital firm supporting entrepreneurs in the ICT sector, IV Holdings. This marked a turning point for Jeeran. After receiving this capital injection, the business began to grow quickly, with revenues doubling every year since. More recently, on the back of strong revenue growth, Jeeran has also secured funding from Intel Capital in 2009, together with a second tranche in 2010.

Jeeran’s story exemplifies the difficult path many start-ups and SMEs encounter in attracting investors in Jordan. An interesting concern raised by Dr Usama Fayyad, Executive Chairman of Oasis 500, was that many family-owned companies that have self-funded their development are reluctant to allow outside investors to acquire an equity interest in their companies in order to fund further expansion. Having developed a culture of self-reliance and ‘going it alone’, many companies fail to appreciate the benefits that can be gained by opening up to outside investors who can fund growth and provide more mature knowledge and experience with regards to growth opportunities and management.

Increased access to early-stage funding and venture capital is necessary to support a strong and vibrant entrepreneurial base in Jordan. The recent emergence of venture capital companies such as IV Holdings and Riyadh Venture is encouraging and indicates some progress in this area, but more needs to be done going forward. Another example of an initiative aimed at overcoming the difficulties many start-ups face in accessing finance is the Bedaya Angel Network, established in 2009. The network aims to provide financing opportunities for innovative business start-ups with a focus on S&T. Entrepreneurs seeking funding opportunities are required to present their projects to an audience of business angels willing to provide capital funding to successful business proposals (ie. through a process of pitching and matchmaking). The network also provides support and resources to investors on business proposals submitted across different industries and sectors in Jordan and abroad.

4.3.1 Incubators, business parks and other forms of assistance

Incubators, business parks and programmes such as the business plan competition run by the Queen Rania Centre for Entrepreneurship (QRCE)—which provides business support and training, together with a small amount of financial

assistance to winners—go some way towards bridging the gap in start-up funding in kind if not through actual funding. However, long waiting lists and strong competition from companies seeking access to these facilities suggest the need for more and/or expanded business incubators, possibly including incubators specialising in new and emerging areas of growth, to support entrepreneurs and start-ups in Jordan. The development of additional business incubators in regional areas should also be investigated.

A micro-finance venture fund launched in early 2010 by the Nuqul Group, a leading industrial conglomerate in Jordan, in conjunction with a local NGO, provides an example of a private sector initiative aimed at supporting entrepreneurship within the company's local community.¹⁶⁵ Described as the first of its kind, the fund seeks to encourage entrepreneurship in the local community and to transform jobseekers into job creators. The programme is reported to have attracted more than 300 community participants, who received skills training in business planning and operations, costing, accounting and bookkeeping, marketing and sales, human resources, purchasing, and inventory management. Upon completion of the training course, shortlisted participants were screened by a committee which evaluated each project according to specific scoring criteria that considered the target market, the product or service, development plan, competition and financial projections. By late 2010 the programme claimed to have established 23 limited liability companies (by 19 women and four men), which received funding from the SHABAKAT Nuqul Group Micro Venture Fund.

4.3.2 Foreign direct investment

In addition to domestic sources of funding and foreign aid, foreign direct investment (FDI) also provides a source of funding available to companies in Jordan. To date, FDI has been sporadic for the most part, focused on privatisation programmes or real estate investment, and heavily influenced by the geopolitical situation in the region. While Jordan can do little to control the political instability and war in the region, it can implement policies and laws to encourage further FDI. For example, the Investment Promotion Law No. 16 of 1995 aims to encourage FDI through, *inter alia*, providing exemptions to custom duties and allowing 100% foreign ownership in specific industry sectors.¹⁶⁶ The extension of this law to additional industry sectors—such as telecommunications—as well as amending the law to reduce the minimum capital investment required of non-Jordanian investors, would encourage further FDI in Jordan. These types of initiatives would help to promote an environment that is more conducive to entrepreneurship, innovation and private sector growth which would attract increased levels of FDI.^{167,168}

165 See <http://www.nuqulgroup.com/home/news/newsid373/38.aspx>.

166 See <http://www.jordaninvestment.com/AboutJIB/>

InvestmentPromotionLaw/tabid/207/language/en-US/Default.aspx.

167 Mansur Y (2008). *Overcoming barriers to foreign direct investment in Jordan*. Discussion

paper. International Research Foundation of Oman and Fraser Institute of Canada. www.freetheworld.com.

168 National ICT Strategy of Jordan 2007–2011. Inf@jib.gov.jo.

4.4 Home-grown heroes

Despite the challenges and obstacles that have stood in the way of the STI system in Jordan, including shortcomings of the NIS as it currently stands, Jordan can boast a significant number of corporate success stories. Several examples are briefly outlined below.

4.4.1 Maktoob

Perhaps one of the most high-profile success stories in Jordan in recent years has been the Arab internet services company, Maktoob. As discussed earlier in this report, Maktoob was established in the late 1990s. Its founders, Samih Toukan and Hussam Khoury, spoke with their mentor, Fadi Ghandour (CEO and Founder of Aramex, another Jordanian success story) in 2009, shortly after they sold Maktoob to Yahoo! in a multimillion dollar deal that has inspired many in the industry, and would-be entrepreneurs in the wider Jordanian community. Toukan and Khoury explained that they started Maktoob as a consulting company, and then changed it to become one of the first Arab website developers. Seeing a niche in the market, the company went on to develop Arabic web emailing. In doing so Maktoob developed a unique product at the right time and for the right geography. The founders explained that they focused on building value in the company (building value mattered more than their equity share, with 10% of US\$100 million worth more than 50% of US\$10 million), conserving cash (by not paying themselves salaries until the business could afford it), and building a strong team who were given the freedom to innovate and rewarded with equity shares in the company.¹⁶⁹

4.4.2 Rubicon

Rubicon, a provider of e-learning and simulated training material, as well as animation, gaming and themed entertainment, is another example of a local success story. Established in 1994, the company first traded as the Jordan Training Technology Group. It initially developed computer-based training programmes for professionals (banking) and later developed educational material for text books and other educational products. After 2000 the company expanded its operations by providing material for mainstream education projects, including online materials for grades 1 to 6. The company subsequently expanded its service range to include simulated employee vocational training, e-learning, CGI animation, gaming and themed entertainment, and claims to have no major competitors in the region. In a recent success, Rubicon signed a shared project deal with MGM to produce the new animated series of the famous *Pink Panther* franchise. The company now has offices in Amman, Dubai, Manila and Los Angeles, and attributes much of its success to its flexibility which enables an innovation-friendly environment where ideas can be presented directly from any member of the organisation. The company prides itself on its creativity and innovation.

169 See Gara T (2012). *Tea with FT Middle East: Samih Toukan*. Financial Times, 9 July 2012. For Fadi Ghandour's take on the Yahoo deal, see <http://>

www.aramex.com/news/item.aspx?id=b6873536-22bd-40f8-bdd1-e776b1b726b0 accessed 16 April 2013.

4.4.3 Orange–Jordan Telecom Group

Orange (Jordan Telecom Group; JTC) provides an excellent example of a multinational corporation that has successfully established operations in Jordan. Sophie Berger-Gerard, Director of the Orange Technocentre based in Amman, explains that innovation is central to what they do in the region. Berger-Gerard estimates that Orange generates approximately 10% of its revenues from innovation and new services. Moreover, the company aims to increase this to 20% by 2012. In 2009 Orange spent around 1.7% of group revenues on investments in innovation activities. Since 2008 Orange's innovation centre has been managed out of Jordan, with a staff of approximately 25 people and with control over all R&D staff globally. The Amman-based Technocentre focuses on developing and deploying innovative products and services, particularly for developing countries. Berger-Gerard explains that a key reason for locating Orange's innovation centre in Jordan was access to Jordan's highly educated workforce, as well as to collaborate with Orange Jordan which is already the best in its class in terms of innovation in Africa and the Middle East.

5 Culture

UNESCO's *Science report 2010* discusses the absence of a strong scientific culture in the contemporary Arab world.¹⁷⁰ Indeed, research shows that Jordan is no exception to this prevailing condition, especially when placed in a global context. The establishment of universities and research centres—typically the epicentres of a nation's scientific research community—has only been a relatively recent occurrence in Jordan, with the country's oldest university, the UoJ, established as recently as the 1960s. Consequently, the development of an institutionalised framework for S&T and a NIS is a relatively new phenomenon in Jordan.¹⁷¹ Several other factors that explain the impact of culture on S&T and the NIS in Jordan are discussed below.

5.1 A 'tribal society'?

Many of those interviewed for this report argued that modern-day Jordan remains an essentially tribal-based society, with tribal connections and '*wasta*' reported to continue to play an important role. The research illuminated pockets of concern that personal connections and tribal factors influence the appointment of people to key positions within the government and private sectors, and also impact upon the commercial success of business. Concerns exist that operating with this framework influences both the direction and the quality of scientific endeavour, and potentially distracts attention away from S&T-based innovation as a means of gaining competitive advantage. It has been argued that the tribal heritage favours the improvement of one's social capital on one's intellectual capital.

Notwithstanding, Jawad Al-Hamad, Director General of the Amman-based Middle East Studies Centre, reported that increasing exposure to western cultures, promoted by improved communication technologies, is changing the value systems and expectations of Jordan's younger generations, resulting in increasing pressures on family structure and the existing tribal system. As in other parts of the world, Jordan's younger generations are demanding more expensive lifestyles, including cars, access to new technologies (eg. mobile phones, laptops, internet) and quality education. Al-Hamad expressed concerns that these pressures are having a destabilising effect on families and tribes in Jordan, who are often unable to meet the associated expenses and may not appreciate the implications of the changes that are unfolding.

In the face of rapid technological and social change, it could be argued that attention should be directed towards ensuring that all sectors of society are given an opportunity both to understand and to participate in the changes that are taking

170 UNESCO (2010). *The current status of science around the world*. Science Report, November, p 274.

171 Waast R (2008). *Draft regional report on Arab countries: study on national research systems. A meta-review compiled by Roland Waast*. UNESCO Forum for Higher Education, Research and Knowledge, Symposium

on Comparative Analysis of National Research Systems, 16–18 January, UNESCO Headquarters, Paris, France, pp 20–23.

place, especially in the field of information technology. Such initiatives would have the potential, not only to contribute to greater social stability, but also to promote a better understanding and appreciation throughout Jordanian society of the existing and potential benefits that can arise from increasing the intellectual capital of both individuals and subsequently society at large. This could thereby work towards diminishing cultural barriers and encourage greater scientific endeavour in the future.

In order to achieve significant success, innovation has to be supported by a series of dynamic adjustments both at the institutional and at social levels. These should include addressing issues of: technology transfer; financing; structural and strategic reorganisation at the enterprise level; improvements to skill levels through educational schemes; and the reorganisation of S&T policies.¹⁷²

5.2 A highly educated nation

As in other parts of the Arab world, a strong social demand exists in Jordan for higher education. In many cases this reflects societal pressures, including what Zafiriz Tzannatos, in a presentation to the Conference on Access and Equity in Financing Higher Education in Arab Countries (Amman, June 2009), described as the 'schooling, socialisation and screening process', whereby everything from marriage prospects to employment opportunities is subject to an individual's level of educational attainment. Indeed, citing a World Bank report on education in the MENA region, Tzannatos concluded that the labour market in the region is becoming 'over-educated', and that 'education does not seem to have had a commensurate impact on economic growth or job creation or income distribution'. As a result, the private return to education was considered to be low.¹⁷³ The high rate of unemployment for university graduates in Jordan supports these findings, with unemployment among university graduates reaching 16% in 2008, above the OECD average of 3.5%.¹⁷⁴

Perhaps equally worrying were findings in a UNESCO report in 2008 into national research systems in Arab countries, which observed that in Jordan 'the degree rather than the record of scientific research is what gives the person a social status in society'. Moreover, the social power afforded to university faculty was considered the major concern, rather than the scientific learning involved in achieving this qualification.¹⁷⁵

This bias toward higher education in Jordan also can explain the existence of a high number of engineers in Jordan (in excess of 80,000), many of whom are unemployed, at the same time as there is a lack of mid-level technicians who could

172 ISESCO (2003). *Strategy for the development of biotechnology in the Islamic world*. Islamic Educational, Scientific and Cultural Organization.

173 Tzannatos Z (2009). *Financing HE: what have we learnt?* Presented at the Conference on

Access and Equity in Financing Higher Education in Arab Countries, Amman, 17–18 June. 174 <http://www.jcef.jo/background.html>.

175 Waast R (2008). *Draft regional report on Arab countries: study on national research systems*.

A meta-review compiled by Roland Waast. UNESCO Forum for Higher Education, Research and Knowledge, Symposium on Comparative Analysis of National Research Systems, 16–18 January, UNSECO Headquarters, Paris, France, p 22.

play a critical role in the NIS.¹⁷⁶ Greater social acceptance of vocational training qualifications could help to reverse this situation, while at the same time reducing the pressures on the higher education system.

5.3 The Jordanian entrepreneur

As discussed in Chapter 4, research undertaken for this study indicates that Jordan currently lacks a sufficient pool of entrepreneurs with the requisite business acumen to take a new product or service from start to finish through the innovation-to-commercialisation lifecycle. A number of reasons have been identified that explain this lack of a well-developed entrepreneur base in Jordan. Perhaps the most important reasons, and also the most difficult to redress, are the prevailing social and cultural barriers to risk taking, a phenomenon not only of Jordanian culture, but also of the wider Arabic community. Unlike countries such as the USA, where business failure is often regarded as an important experience that young entrepreneurs should experience and learn from, business failure (particularly bankruptcy) and financial loss in the Arab world results in a loss of face, not just for the individual but for the family as a whole.

Financial security and social status are of paramount importance, thereby influencing the entrepreneurial culture of the country. This goes part way to explaining the strong preference for public sector jobs in Jordan, even among the best university graduates. Setting up a business is often seen as a last resort for people who cannot get a job.¹⁷⁷ The lack of a social safety net contributes to the fear of financial insecurity. In addition, the judicial system is penal when it comes to defaulting on financial commitments. Regretfully, this also acts as an obstacle to innovation and entrepreneurship.

Individuals' socio-economic positions are also likely to influence their risk preferences and the likelihood that they will innovate and become entrepreneurs. Those at either the upper or the lower ends of the socio-economic spectrum are often more willing to take risks, with those at the upper end in a stronger position to absorb financial risk, while those at the lower end of the spectrum have limited choices if they wish to earn money. In contrast, people in the middle of the socio-economic spectrum tend to be more risk averse, being less able to absorb financial risk, but also lacking the same degree of financial imperative as those in the lower brackets to take risks.¹⁷⁸ In Jordan, many of those in the middle of the socio-economic spectrum are public sector employees who have relatively comfortable lifestyles, with prospects of good pensions on retirement, which they seek to maintain. Hence, the cultural preference for government employment among even the most talented citizens can be seen as a contributing factor to the country's relatively small entrepreneurial base.

176 Rischard J, White J, Chung S & Kim J (2010). *A candid review of Jordan's innovation policy*. World Bank/Korea RIAL Team for Jordan, April, p 3.

177 Tee D (2006). *A practical guide to wealth creation: proposals for an innovation policy for Jordan*. EJADA & EC, April, p 21.

178 Tee D (2006). *A practical guide to wealth creation: proposals for an innovation policy for Jordan*. EJADA & EC, April, p 21.

Notwithstanding, even private sector employees often lack entrepreneurial skills and experience. Probably reflecting the cultural context in which businesses operate, the country's private sector primarily consists of conservative, risk-averse, family-run businesses, the majority of which are SMEs. Manufacturing has traditionally been orientated towards low-cost manufacturing rather than producing high value-added products, and a strong culture of innovation and entrepreneurial risk taking is lacking. It is not surprising then that would-be entrepreneurs typically lack the direct experience necessary to hone their skills. Mentoring programmes run by organisations such as the QRCE, the Endeavour Foundation and business incubators go some way towards bridging this gap.

An interesting comment made by the head of one of Jordan's incubators was that, from their experience, it was important that dynamic companies operating in Jordan identify and recruit bright new graduates as soon as possible – as once graduates enter the local workforce, they quickly lose the work ethic necessary to succeed as entrepreneurs and operate in the US and other international markets.

The development of a strong entrepreneurial base in Jordan, essential to innovation and the production and commercialisation of new technologies, processes, products and services, will clearly require a shift in the cultural attitudes toward entrepreneurship, risk taking and work ethic. Methods for addressing the cultural and social barriers that currently exist must be found. Possible measures include embedding a culture of S&T and problem-solving within the national education system at all levels, together with a greater emphasis on mentoring, and collaboration with highly innovative and entrepreneurial companies overseas.

The Director of the Queen Rania Center for Entrepreneurship, Farhan Kalaldeh, explained that over recent years the government and NGOs have introduced measures aimed at promoting entrepreneurship and redressing many of the barriers, often cultural, that have historically inhibited the entrepreneurial spirit in Jordan. Kalaldeh indicated that in the past many successful Jordanian technology entrepreneurs fitted a particular profile, such as being educated in the US or Europe, coming from certain social backgrounds, or having access to the financial resources necessary to support their start-ups over the short to medium term. As a result, technology entrepreneurship was limited to a small segment of Jordanian society.

However, Kalaldeh indicated that the situation has changed over recent times, and that Jordan appears to be succeeding in establishing enabling platforms and programmes that foster a culture of entrepreneurship, and encourage capability building and the establishment of start-ups. Kalaldeh concluded that continuous efforts in these areas will assist with the development of a stronger entrepreneurial base in Jordan in the future.

5.4 The gender factor

Sixteen years after the United Nation's Fourth World Conference on the Women's Beijing Platform for Action proclaimed that 'shared power and responsibility should be established between women and men at home, in the workplace, and in the wider national and international communities', people around the globe have embraced the document's key principles. Nevertheless, cultural issues still play an important role in determining gender preferences for different fields of study and employment in Jordan. A study of factors affecting women's participation in the private sector concluded that the low participation rates of women, ranging from 16% to 25% of the total workforce (depending on the source of measurement), represents a considerable opportunity cost for the Jordanian economy, particularly given that many women are highly educated.¹⁷⁹

According to the National Agenda 2006–2015, male and female participation rates in the national workforce are estimated to remain at their historical averages of 55% and 21% (when measured as a percentage of corresponding gross gender supply figures). Table 5.1 shows DOS estimates for 2009 of the employment status of Jordanians aged over 15 years by gender. It can be seen that approximately 95% of females are classified as 'paid employees', compared to 81% of males. Males accounted for 10.4% of the 'self-employed' workforce, and 7.7% of 'employers', compared to 2.4% and 2.2% of the female workforce, respectively.

Table 5.1. Employment status of Jordanians aged over 15 years, 2009

Employment status	Females (%)	Males (%)	Total (%)
Paid employee	94.7	81.3	83.4
Employer	2.2	7.7	6.8
Self-employed	2.4	10.4	9.1
Unpaid family worker	0.5	0.5	0.5
Unpaid worker	0.3	0.1	0.1

The ICT sector provides an example of the benefits of developing S&T-based industries in Jordan in order to provide greater work opportunities for women. A 2009 economic impact study conducted by the Ministry of Information and Communication Technology determined that the ICT sector is a beneficial source of employment for the female workforce by providing employment that 'does not require physical effort, minimise(s) location restrictions, and increases the flexibility of (the) working environment'.¹⁸⁰ This is also reflected in university enrolments. In 2008–2009, over 20% of all female students enrolled in engineering courses

179 Darwazeh N, Ghosheh H, Peebles D & Sabbagh A (2004). *Factors affecting women's participation in the private sector in Jordan*. National Centre for Human Resource Development/ Canadian International Development Agency.

180 Ministry of Information and Communications Technology (2009). *Assessment of the economic impacts of ICT in the Hashemite Kingdom of Jordan project: final report*. MOICT, 30 December, pp 4–5.

at Jordan's universities were in the field of computer engineering, making it clearly the most popular field of engineering study for women. Moreover, females represented just over 60% of all students enrolled in computer engineering programmes.

The location of universities in regional areas—especially universities with strong scientific research bases such as JUST near Irbid—also provides important opportunities for women to become involved in the STI system. The travel required to study at universities based in the capital of Amman, requiring students to live away from their families, would otherwise, due to cultural factors, preclude many women from pursuing studies and thereby careers in the ICT sector and other S&T-based fields.

5.5 Good governance

Another factor that influences the environment for entrepreneurship in a country is the existence of a culture of good corporate governance. This is necessary for companies to secure the external funding required to support entrepreneurial activities. In order to secure finance from external sources (eg. private investors, private equity firms, venture capitalists), companies must be able to demonstrate they have a credible board, strong management, robust internal processes and external accountability (eg. through auditing processes). This can present a particular challenge for start-up companies. Many family-run SMEs can also find demonstrating the strong governance and transparency necessary to secure finance from external sources challenging. As a result, entrepreneurial companies are often forced to resort to internal sources of funding, or sourcing finance from family and friends.

The National Agenda 2006–2015 proposed the creation of a National Commission for Scientific Research to coordinate governance and funding efforts, agree on national scientific research priorities, and develop a means to encourage innovation. Furthermore, it was also intended that the commission would secure funding resources that can be directed towards high-priority research projects in line with the national scientific research strategic policies. This commission has not been formed, to date.

5.6 Political climate

The political climate in a country also plays an important role in determining the environment for entrepreneurial activity. An oppressive political regime, which discourages innovative and creative thinking or the production of new ideas, will work against an entrepreneurial culture. A high level of political uncertainty will also be detrimental to the development of a strong entrepreneurial base, as potential changes in government policies can render once-viable commercial propositions no longer feasible, as the parameters in which businesses operate shift and change.

Jordan's STI benefits from the patronage of the monarchy. This comes through the support of royal-sponsored NGOs such as the RSS, as well as being reflected in government, with the King taking an active role in the selection of ministers and political affairs. Nevertheless, regular reshuffles among government ministers are also claimed to create a degree of political uncertainty that can create a disabling environment for innovation in which entrepreneurs operate.

On the other hand, Jordan's strong level of international diplomacy benefits the economy and has generally provided a relatively stable business environment not always enjoyed by its regional neighbours. On the international stage, while not strong economically, Jordan enjoys a strong international profile due in a large part to the high profile of HM King Abdullah II and members of the royal family. Jordan's foreign policy enables the country to survive in a very turbulent geopolitical environment, through moderation and tolerance.

6 Sustainability

Issues of sustainability are not new to the Jordanian consciousness. Ensuring access to secure water, energy and food supplies have long presented challenges to Jordanians. With a growing population, augmented by waves of immigration and resettlement from neighbouring countries, growing urban populations, economic development and a long and enduring drought, never have issues of sustainability been so pertinent to the country.

Keenly aware of the imperative to secure sustainable supplies of water, energy and food, Jordan is addressing these issues on many fronts. Identifying water and energy as Jordan's biggest constraints to sustainable economic growth in the future, the government is developing strategies targeting the water and energy sectors, including a number of mega-projects. The government is also aware that these issues are highly interlinked and this requires coordinated work and solutions among diverse stakeholders. S&T plays an important role in these processes. The total portfolio of mega-projects, which also extends to transportation, is estimated to be worth in the vicinity of US\$30 billion and will be carried out over a period of more than 20 years.

The potential of creating a green economy could bring tremendous opportunities for achieving sustainable growth in Jordan. The mega-projects together with other issues pertaining to sustainability, including the pressures of immigration and resettlement on Jordan's natural resources and the role of S&T-based R&D activities directed towards achieving sustainable development, are discussed below.

6.1 The pressures of immigration and resettlement

Jordan's position and location in the region has, for over 60 years, been the recipient of millions of refugees as well as influxes of returning diaspora from neighbouring countries. The first wave of refugees came as a result of the Arab–Israeli conflict in 1946–1948, which saw a mass exodus of Palestinians fleeing Israeli forces to Jordan, and has resulted in Jordan hosting the largest number of Palestinian refugees of any single country in the world. In other cases, Palestinians living in countries such as Kuwait have been forcefully 'repatriated' to Jordan as a result of the 1991 Gulf War. Ongoing political turmoil and wars in the region—the most recent being the war in Iraq in 2003—have also resulted in influxes of refugees and diaspora returning to Jordan. Added to this inward migration has been an influx of cheap labour from countries such as Egypt and Sudan.

These often sudden influxes of refugees and migrants have placed enormous strains on Jordan's scarce resources, including water, energy and food supplies. They also present major challenges in terms of the provision of adequate housing, healthcare, education and other infrastructure necessary to support these sudden increases in population.

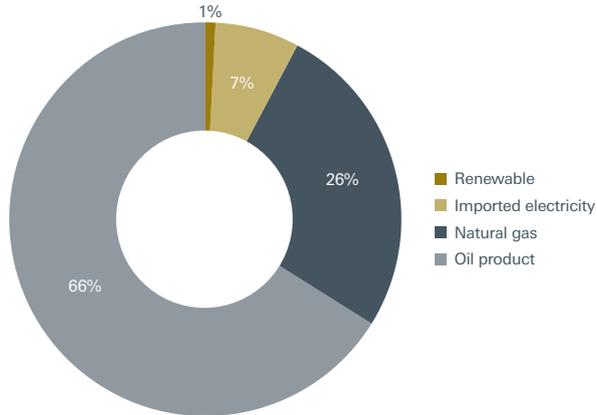
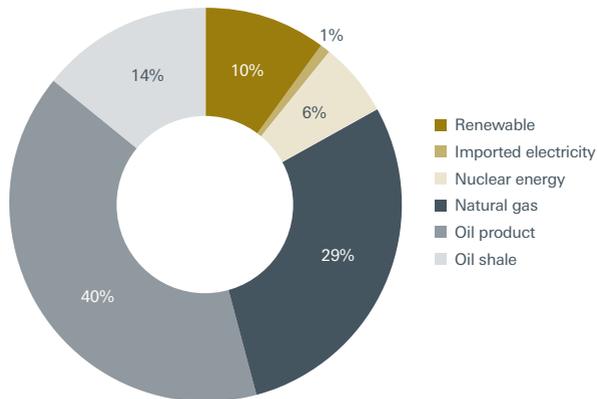
The UN Relief & Works Agency estimates that approximately 1.9 million Palestinian refugees and their descendants currently reside in Jordan, out of a total population of approximately six million people, although others estimate that approximately half of the Jordanian population is of Palestinian origin. Many of these refugees have also gained citizenship in Jordan. As a result, the unresolved issue of Palestinian statehood remains a constant challenge for Jordan, and places huge pressures on the ability of this economically poor country, already lacking in water and energy resources, to ensure sustainable development for its growing population.

Despite the challenges posed by Jordan's large migrant populations, it also receives large amounts of development assistance from the international community in order to help it to resettle and integrate refugees. Further to this, as Palestinians move to other countries seeking employment, along with other members of Jordan's diaspora, they provide Jordan with remittances that contribute to the country's economic growth. Palestinians have also provided Jordan with a pool of often well-educated and cheap labour that has contributed to the economic development of the country.¹⁸¹

6.2 Energy mix

Jordan's Energy Master Plan for 2007–2020 emphasises the need for the efficient and clean generation of power, and the reduction of the country's reliance on oil imports through the adoption of an 'energy mix' policy that stipulates targets for the use of new and renewable energies. Moreover, the policy foresees Jordan's potential to become an energy exporter within the region. This compares to a situation where Jordan's oil imports were estimated to amount to almost 25% of GDP in 2008. Below is a description of Jordan's current energy mix portfolio, followed by the country's proposed energy portfolio by 2020:

181 Chatelard G (2010). *Jordan: a refugee haven*. Institut français du Proche-Orient (Ifpo): Amman. Migration Information Source, August. See <http://www.migrationinformation.org/Feature/print.cfm?ID=794>.

Figure 1.17. Current Energy Mix**Figure 1.18. Anticipated Energy Mix 2020**

Source: National Energy Research Centre.

The proposed energy mix for 2020 would see a significant reduction in the reliance on oil and imported electricity, and an increase in oil shale and renewable energy sources, together with the introduction of nuclear energy.¹⁸² The Energy Master Plan focuses not only on major cities, but also calls for enhanced access to energy services in remote communities.

¹⁸² It was unclear at the time of writing what impact the nuclear disaster in Japan might have, if any, on Jordan's proposed nuclear energy plans.

Jordan is also working on projects to develop wind and solar energy technologies in order to capitalise on these renewable sources of energy. To this end, Jordan has established research centres and, with support from the EU of a grant of €10 million for solar projects, is working with the Desert Tech programme to develop Jordan as a hub for R&D in solar energy technologies. Jordan is also investigating the feasibility of establishing a regional R&D centre to develop new technologies for the exploitation of oil shale reserves. The SRSF has also invested approximately JD500,000 (US\$705,000)¹⁸³ in a three-year renewable energies R&D project, investigating new technologies aimed at developing Jordan's solar, wind and thermal energies.

At the institutional level, the Energy Research Programme under the National Research and Development Centre is involved in extensive R&D and training activities in new and renewable energy sources. This includes the development of projects harnessing and applying energy from wind, oil shale, solar, thermal and bioenergy sources. The centre's role is to bridge between academia and the energy industry through its applied research development and technology transfer activities.

6.3 Water sufficiency

A growing population, economic development and ongoing drought conditions are making water security an increasingly critical issue for Jordan. Approximately 90% of Jordan is estimated to receive less than 200 millilitres of rainfall per annum. In 2010 the *per capita* renewable freshwater availability was 85 cm per year, and is projected to fall to 73 cm by 2020.¹⁸⁴ By way of comparison, by 2020 *per capita* renewable freshwater availability is projected to be 556 cm in Lebanon, 625 cm in Syria, 1,470 cm in Iraq and 1,350 cm in Turkey.¹⁸⁵ Demand outstrips the supply of water, and as a result the Water Authority of Jordan has implemented a system of water rationing. Table 6.1 provides estimates of water demand and supply, together with the consequent water deficit from 2010 to 2040.

183 Assuming an exchange rate of 1 JD = 1.41 USD.

184 SFG (2011). *The blue peace, rethinking Middle East water*. Strategic Foresight Group.

185 SFG (2011). *The blue peace, rethinking Middle East water*. Strategic Foresight Group.

Table 6.1. Estimates of water demand and supply, 2010-2040

Future water demand, supply and deficit in Jordan (million m ³ /year)	2010	2020	2040
Total water demand	1383	1602	2236
Domestic	477	670	1263
Industrial	110	130	170
Irrigation	996	802	803
Total water supply	1054	1152	1549
Surface water	470	470	470
Groundwater	271	277	277
Water deficit total	-329	-451	-687

Source: <https://www.uni-hohenheim.de/fileadmin/einrichtungen/hebrew-university/Literature/Hadadin-et-al-Desalin2010.pdf>

Table 6.1 shows that the current water deficit is expected to increase over the coming years, pointing to a growing need for strategies aimed at redressing this situation. And although the largest demand for water currently comes from irrigation, this is projected to change over the coming years, with domestic consumption projected to increase sharply.

To date most efforts have been concentrated on addressing demand-side issues, including improved water management practices such as reducing water wastage, improved irrigation systems and the imposition of water restrictions.

In order to fulfil the country's growing demand for water in the future as well as at present, Jordan will have to rely on supplementing its freshwater availability with additional or non-conventional water resources, as shown in the following charts which provide a comparison between current and projected water resources.

Figure 1.19. Water Resources - 2007

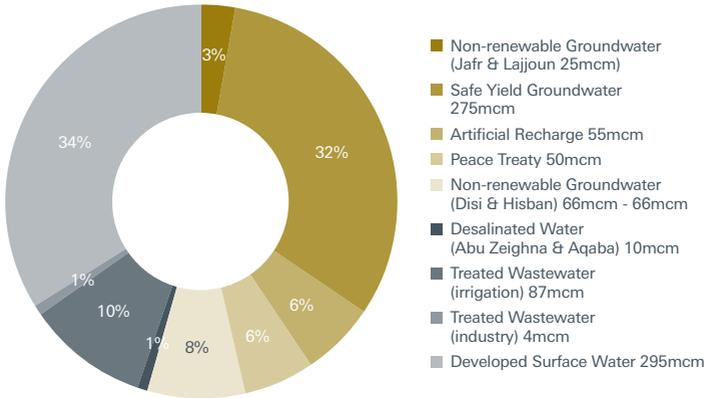
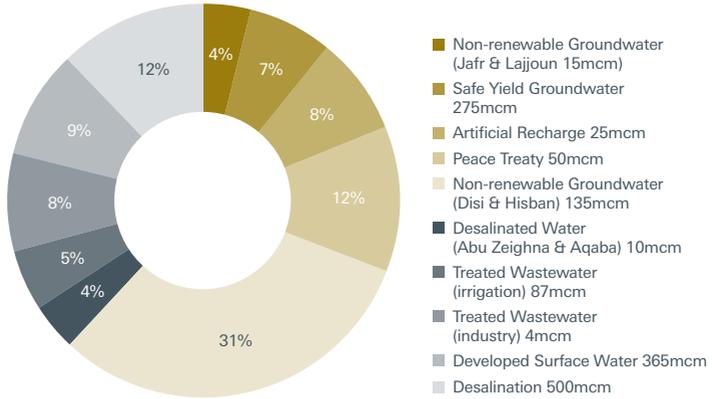


Figure 1.20. Projected Water Resources - 2022



Source: Jordan's Water Strategy, 2008–2022.

It is hoped that planned mega-projects will contribute significantly to a reduction in the water deficit. The former Minister of State for Megaprojects, HE Imad Fakhoury, has discussed the two mega-projects aimed at tackling the need to increase Jordan's water supply, particularly to the north of the country where around 90% of the population lives. These projects are:

1. The *Disi project* that aims to supply Amman, via 325 km of pipes, with an estimated 107 million cubic metres of water annually from the Disi aquifer in southern Jordan¹⁸⁶;
2. The *Jordan Red-Dead Conveyance System* that is planned to convey desalinated water from the south of Jordan to the north.¹⁸⁷ A water desalination plant at the Red Sea is forecast to cost up to US\$5 billion, while it is estimated that the total project will cost over US\$10 billion. It is anticipated that the project will extract around 400 million cubic metres of water a year from the Red Sea, and produce in the vicinity of 200 million cubic metres of freshwater after desalination.¹⁸⁸

Both projects are considered as long-term strategic projects that require regional coordination and international support.

6.4 Food security

The Ministry of Agriculture (MOA) is actively pursuing strategies aimed at achieving food security by making Jordan self-reliant in food production through, among other measures, the efficient utilisation of available resources.

NCARE is the main governmental body undertaking agricultural research in Jordan, and is charged by the MOA with both R&D and technology transfer functions. NCARE is actively involved in a large range of R&D projects aimed at raising the productivity, efficiency and sustainability of Jordan's agricultural sector. Projects include: developing improved water management practices; developing and testing new seeds and crop varieties that are less water intensive and more tolerant to heat stress; improved pest control; and animal husbandry. NCARE works closely with industry as well as with international agencies in its R&D activities.

186 For more on the Disi project, please see Sweis R (2012). *A Parched Jordan Places Hopes in Reservoir*. New York Times, 28 November 2012. See also Namrouqa H (2010). *Disi project back on track*. The Jordan Times, 17 December 2012.

187 Steityeh Z (2010). *Jordan gears up for mega ambitions*. Jordan Business, June, pp 55–61. See also <http://newswatch.nationalgeographic.com/2013/03/04/desalinating-holy-waters-with-the-red-sea-dead-sea-conveyance/> accessed 16 April 2013

188 See <http://www.bloomberg.com/news/2010-10-26/jordan-will-invite-bids-for-first-phase-of-red-sea-desalination-project.html>

A viable agricultural sector is dependent upon the conservation of the country's natural resources, and ensuring their sustainable use. To this end, the MOA is implementing development projects aimed at the conservation of soil and water resources, ceasing the degradation of existing forests and maintaining Jordan's biodiversity. NCARE is actively involved in these projects.

The MOA estimates that in 2009 agriculture directly contributed to approximately 3% of GDP, and indirectly to 27% of GDP. It also estimates that agriculture is the main source of income for 15% of the Jordanian population. This highlights the importance of the agricultural industry not only for achieving food security, but also for maintaining the livelihoods of a significant proportion of the population, often households from the lower socio-economic spectrum.¹⁸⁹

Table 6.2 indicates DOS estimates of Jordan's 'self-efficiency rate' for different plant and animal products from 2006 to 2009.

Table 6.2. Jordan's rate of self-sufficiency by product type

Product	2006	2007	2008	2009
Wheat	4.6	2.0	0.7	2.0
Barley	2.1	1.6	1.5	2.7
Potatoes	90.6	85.8	79.7	80.9
Olives	101.8	108.5	106.7	109.2
Olive oil	112.1	113.6	99.6	82.2
Tomatoes	226.3	273.3	290.9	293.9
Oranges	72.0	59.7	64.2	63.7
Apples	75.2	62.7	63.6	52.8
Beef	12.2	16.8	22.6	15.9
Mutton	41.7	46.0	45.0	45.4
Goat meat	98.4	98.0	98.6	100.0
Chicken meat	90.0	85.8	85.8	90.0
Fresh milk	100.0	100.0	100.0	100.0
Table eggs	102.0	109.6	105.0	108.4
Fish	5.0	4.8	3.6	4.0

Source: Jordan Department of Statistics.

189 *The Hashemite Kingdom of Jordan: the agricultural sector.* Presentation provided by the Ministry of Agriculture.

It can be seen that Jordan is currently self-sufficient in the production of milk, some vegetables, goat meat and eggs, and indeed exports some of these products. Jordan is also close to self-sufficiency in the production of olive oil and poultry. However, the country is not fully self-sufficient in the production of fruit, and is highly dependent on imports of cereals. Water scarcity is cited as a key reason restricting the expansion of cereal crops. Jordan does not produce rice, sugar or tea.

Full self-sufficiency in food is not possible in a water-scarce country such as Jordan. Moreover, the above data demonstrate the level of vulnerability Jordanians could potentially face in the case of a food crisis, ongoing global environmental change and the declining 'per capita' water supply. These factors pose very real social and economic threats to Jordan that must be addressed by a set of comprehensive remediation plans.

Global environmental change leading to rising temperatures is anticipated to have a negative impact on global food production levels. According to reports by UN organisations, climate change could result in food production efficiency declining by one-third.¹⁹⁰ Moreover, arid and semi-arid areas are likely to be the most sensitive to the impacts of climate change. Jordan's agricultural sector is the country's most water-intensive sector, but at the same time contributes the least to its GDP. Hence, the country's agricultural sector is likely to be the most vulnerable to climate change. As a result, the challenge of ensuring 'food security' as well as 'social security' will need to be addressed going forward. More studies and research projects are likely to be needed to tackle the interrelated factors of water, food and climate change.

190 Brauch H G (2009).
*Hexagon series on human
and environmental security
and peace. Facing Global
Environmental Change.
Environmental, Human, Energy,*

*Food, Health and Water Security
Concepts, Volume 4, p618.*

7 Collaboration

“Our scientists must learn to work together, across borders and disciplines. The water issues we face may only be solved if we approach them, and the science that defines them, in a holistic and interdisciplinary way.”

Her Royal Highness, Princess Sumaya bint El Hassan,
President of El Hassan Science City & Royal Scientific Society

At the first meeting of the Middle East and North Africa Network of Water Centers of Excellence Conference in Doha, Qatar, in 2011 (MENA NWC), HRH Princess Sumaya bint El Hassan urged scientists to learn to work together and made it clear that science drives development and facilitates the globalised economic machine, and offers solutions and approaches that can make development sustainable.

A global CEO survey conducted by IBM in 2006 studied over 1,000 companies and found that of the three most significant sources of new ideas for companies, two were from outside the organisation. Greater collaboration with other organisations can create synergies in R&D and innovation efforts, as organisations gain access to new skills, capabilities and experience, as well as resources not available internally. Collaboration enables organisations to source new ideas and new routes to market, and can spread and decrease the risks associated with innovation. Nevertheless, while many CEOs surveyed indicated that collaboration sounded desirable and ‘theoretically easy’, in practice they conceded that effective forms of collaboration were often difficult to achieve.^{191,192}

Scientific collaboration can take many forms, ranging from internal collaboration within an organisation, to collaboration across industries, between public and private sector parties, within regions and across international borders. Reasons driving scientific collaboration include joint R&D projects, the facilitation of knowledge and technology transfer, and the commercialisation of innovation.

Understanding the many and varied forms of collaboration will assist in the identification of key factors influencing collaborative efforts across different organisations, industries and geographies. Not all organisations will have the skills necessary to innovate and implement new ideas from external sources. Hence, differing capacities to absorb and adopt external ideas, to create ideas internally, and to collaborate externally in order to develop and adapt new ideas will also impact upon the level and nature of collaboration within a NIS.¹⁹³

An assessment follows of the extent and nature of scientific collaboration in Jordan.

191 Australian Institute of Commercialisation (2009–2010). *Cultivating business innovation*. Annual Review, p 28.

192 See http://www-935.ibm.com/services/uk/bcs/html/t_ceo.html accessed 16 April 2013.

193 Australian Institute of Commercialisation (2009–2010). *Cultivating business innovation*. Annual Review, p 28.

7.1 Collaboration within Jordan's NIS

Jordan's National Agenda 2006–2015 indicates that scientific research and innovation in Jordan 'suffers from a fragmented administration, unclear channels and linkages, limited cooperation and coordination, and inefficient financial management'.¹⁹⁴ While several years have passed since the National Agenda was prepared, research indicates a continued lack of communication and poor culture of collaboration across all levels of Jordan's NIS. Where collaboration does take place, it is often with international organisations in Europe, the USA and elsewhere. A number of reasons would appear to be driving this lack of collaboration, especially with other organisations based within Jordan in the Arab region.

It would appear that in many cases researchers tend to work alone rather than teams or networks, and much of the research output tends to be theoretical rather than problem solving. Moreover, collaboration between competing enterprises is almost unheard of.¹⁹⁵ Reasons for the lack of problem-solving and innovative R&D have been discussed elsewhere in this report, and include incentive structures that are inadequate for joint collaboration between faculty and private sector organisations and do not allow academics to commercialise the output of their research. The pressure for faculty to take on heavy teaching loads—especially given that teaching is a fee-generating activity—also prevents active participation in R&D activities by faculty members.

Moreover, the promotion points-based system in universities hinders collaboration in the publication of research in academia. Jordan's academic promotion system operates on the following basis:

Promotion points-based system structure:

- Sole author of paper receives 100 points, co-authors receive 50 points each;
- First author of a team receives 50 points, next 30 points, and so forth;
- Professors rarely place their students as first authors, hence deterring their roles as 'mentors';
- Professors prefer to work alone, hence discouraging cooperation and teamwork;
- Individual research limits the generation of a pool of ideas, hence constraining creativity.¹⁹⁶

194 National Agenda: The Jordan We Strive For: 2006–2015. National Agenda Steering Committee: Amman, Jordan, pp 31–32.

195 Rischard J, White J, Chung S & Kim J (2010). *A candid review of Jordan's innovation policy*. World Bank/Korea RIAL Team for Jordan, April, p 3.

196 *National Agenda: The Jordan We Strive For: 2006–2015*. National Agenda Steering Committee: Amman, Jordan, pp 31–32.

At the industry level, the reluctance of companies to engage with academia, or to enter into ‘corporate venturing’ with start-up companies and entrepreneurs, represents lost opportunities for greater levels of innovation.¹⁹⁷ This could in part reflect a lack of skills within companies to absorb and adapt new ideas and innovation from external sources, or to work together with external parties to develop new forms of innovation. The FFF is a model of collaboration between academia and industry whereby faculty members engage in problem solving across different industry areas, including product development and processes.

The VDI/VDE/IT study (2009) found that, while a significant number of individuals at all levels within organisations are often highly engaged in innovation processes, they generally lack support, tend to develop their own individual innovation programmes, and often compete with other innovators for funding. This suggests a lack of coordination of innovation processes across the NIS. The study also showed that the inclusion of a wider range of experts from all groups in the NIS would benefit the development of future national research strategies, and the identification and prioritisation of future areas of technological endeavour.¹⁹⁸

Examples of local, regional and international collaboration are discussed below.

7.2 Local collaboration

Despite the general lack of collaboration across stakeholders in Jordan’s NIS, a strong awareness exists of the benefits greater levels of collaboration can provide and the need to develop mechanisms to encourage this. This awareness has led to a number of initiatives aimed at promoting greater levels of collaboration going forward.

EHSC’s objective is to create an ‘environment in which Arab scientists, researchers, academics, entrepreneurs and students are given the opportunity to promote a knowledge-based economy by innovation and disseminating their intellectual wealth’. EHSC is striving to be a centre of excellence in R&D in Jordan, and to increase scientific collaboration through:

- Establishing a teamwork research culture versus single researcher projects;
- Providing industry with technical and administrative assistance, and bridging the gap between industry and academia;
- Promoting partnerships between the public and private institutions within the S&T community, industry and academia.

197 Kristensen P (2010). Challenges of being an innovator. Australian Innovation, 18 November.

198 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in Jordan*. VDI/VDE Innovation + Technik GmbH: Berlin, pp 23, 25.

The RSS, Jordan's leading applied scientific research institution, provides an example of a research institution that works on joint R&D projects with industrial companies to address the challenges they are facing. The objective of these projects is to develop industry's competitiveness and assist in the development of a sustainable knowledge-based economy in Jordan. Funding for these joint R&D projects comes in part from the IRDF. The RSS focuses its work in the following areas:

- Energy, water and environment;
- Industrial technologies;
- Construction and materials sciences;
- ICT.

The National Centre for Agricultural Research & Extension (NCARE) provides an example of a government-sponsored research institution that works closely with industry, in this case the agricultural sector, in R&D activities. NCARE aims to transfer modern technology—the results of agricultural research in both plant and animal groups targeted by the field extension activities—to industry. NCARE focuses on assisting smaller farmers, and works in a range of areas from water management to better and more sustainable crops.

Examples of private sector-initiated collaboration in the engineering, ICT and biotechnology sectors are outlined below. Unfortunately, there is little evidence of collaboration across different industry groups, or between competitors within a single industry. This can most likely be attributed to a lack of trust between competitors, a poor culture of local collaboration, and industry sometimes lacking the skills necessary to develop, absorb and adapt innovations from external sources.

7.2.1 Engineering

The Engineering Partnership Council has been established with the goal of bridging the gap between the expectations of industry and academia in the field of engineering. The council comprises members from both industry and academia, and aims to promote greater levels of collaboration. The JEA also strives to improve collaboration between industry and academia, including hosting conferences and seminars with the cooperation of universities, sponsoring engineering professors to participate in international conferences, and supporting the engineering faculty of the UoJ. The JEA also collaborates with Jordan's business incubators.

7.2.2 ICT

In a bid to increase the level of collaboration between the ICT sector and universities, at the time of writing, Int@j was in the process of building a new portal linking universities and the private sector to provide a platform for the exchange of information and ideas on R&D projects. Abdelmajeed Shamlawi, CEO of Int@j, explained that it was hoped that the new portal, to be launched in 2011, will provide an informal vehicle for communication between the ICT sector and academia.

Shamlawi also pointed to the need to raise the level of awareness within other industries of the potential applications of ICT that could lead to significant increases in efficiency and effectiveness and thereby competitive advantage. Industrial engineering and the medical profession were cited as two key sectors where an increased understanding and application of ICT is seen as offering enormous opportunities. This not only highlights the need for greater collaboration between the ICT sector and other industries, but also raises questions of whether companies have the skills necessary to absorb and adapt external ideas and innovations.

7.2.3 Biotechnology

While the biotechnology sector in Jordan is still in the early stages of development, and most activity is contained within existing pharmaceutical companies, Monojo provides an example, albeit isolated, of an emerging local success story in this sector that has been founded through a strong level of local collaboration.

Monojo is a small biotechnology company established in 2005 that specialises in the development, production and marketing of cell lines and antibodies which are diagnostic drugs for different forms of cancer. It was formed through a partnership with the HCST, RSS, JUST, Philadelphia Private University, private investors and academic scientists, with investment capital of JD400,000 provided, and was registered at the Ministry of Industry & Trade. More recently, the founder and Non-Executive Chairman, Samih Darwazeh, one of Jordan's leading pharmaceutical companies, Hikma, purchased a controlling interest in Monojo, thereby injecting significant capital into the company to help fund future R&D activities.

7.3 Regional collaboration

Nabil Ismail, a member of the Board of Directors of the Jordan Chamber of Industry, claims that levels of collaboration are relatively low in the region compared to the rest of the world, and whatever forms of collaboration take place are typically with international partners from outside the region. This view is supported by our research, which failed to identify significant levels of collaboration by academia, research institutes or industry with regional partners. This suggests that geographic proximity, common language and religion and a shared history are not sufficient to promote a culture of scientific collaboration between neighbours in the Arab region.

UNESCO's *Science report 2010* concluded that not only is there little linkage between universities and industry in R&D and its output, but collaboration including exchanges of faculty and joint research projects are rare among Arab universities compared to the level of collaboration that is conducted with parties beyond the Arab world. The report pointed to the need for increased cooperation between Arab ministries and other institutions responsible for higher education in areas including the exchange of expertise and information, as well as the recognition of qualifications provided by other Arab universities.¹⁹⁹

The report indicated that, during the Arab Summit of March 2010, the Heads of State adopted a resolution mandating the development of a S&T strategy for the entire Arab region. The strategy, to be delivered in 2011, is to address facilitating the mobility of scientists within the region, and ways to enhance collaborative research within the community of expatriate Arab scientists.²⁰⁰

However, despite the overall lack of regional collaboration, the Amman-based SESAME project²⁰¹ provides an example of a major S&T project that is based on successful regional collaboration. Launched in 2008, the SESAME project is being developed under the umbrella of UNESCO, and involves the establishment of a laboratory providing an 'international synchrotron light source', or synchrotron radiation facility. The laboratory is expected to draw users from universities and research institutions from across the Middle East, and is hoped to promote greater regional cooperation and collaboration in S&T. In 2009 its members were Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, the Palestinian Authority and Turkey. Once completed in 2014, it will offer the region a world-class laboratory for basic research and numerous applications in biology, medical sciences, physics, chemistry and archaeology.²⁰²

Another regional collaboration at the industry level was announced in late 2010, with the ICT sector reportedly disclosing plans for a regional cable network (RCN) project to be implemented by a consortium of seven regional ICT operators from Jordan, Turkey, Syria, Saudi Arabia and the UAE. The Jordanian consortium members are Jordan Telecom/Orange, and the Mada-Zain partnership. It is hoped that the project will extend from Fujairah in the UAE to Istanbul in Turkey, and provide internet services for up to two billion people. Involving the construction of the longest terrestrial cable in the Middle East, it is anticipated that the project will increase Jordan's ICT capacity fourfold, and contribute towards making Jordan a regional hub for large ICT companies.²⁰³

199 UNESCO (2010). *The current status of science around the world*. Science Report, November.

200 UNESCO (2010). *The current status of science around the world*. Science Report, November, pp 256–257.

201 SESAME: Synchrotron-light for experimental science and applications in the Middle East.

202 See www.sesame.org.jo.

203 Ghazal M (2010). *Seven telecoms to build Middle East's longest cable*. The Jordan Times, 22 December.

7.4 International collaboration

The apparent preference of Jordanian organisations to collaborate with international organisations in Europe, the USA or elsewhere, rather than to enter into local or regional forms of collaboration, can be attributed to a number of factors. In some cases international collaboration will stem from opportunities provided through international organisations that provide funding for R&D projects, and at the same time facilitate access to centres of excellence abroad. In other instances, the lack of local-level cooperation can be attributed to the limited size of the Jordanian economy and therefore the reduced scope for R&D to be performed locally. Research indicates that local partners often seek access to a level and quality of expertise and experience that they do not consider to be locally available. Perceptions regarding the prestige associated with international forms of collaboration are also likely to influence the selection of the partners with which local organisations choose to collaborate.

MoPIC and the HCST have both entered into various agreements with international governments and organisations to collaborate on joint S&T-related projects.²⁰⁴ These include joint projects with foreign governments, such as Germany's Federal Ministry of Education and Research in the recent establishment of the German Jordanian University, which focuses on applied sciences and the transfer of knowledge. In another example, the HCST has entered into an agreement with the EU to provide funding of €4 million to support the SRTD project, which aims to develop Jordan's S&T capabilities through boosting R&D and innovation activities and thereby contribute to Jordan's economic development.

The Jordanian government has entered into a number of strategic partnership agreements with leading international ICT companies, including:

- In 2003 the Ministry of Education entered into an agreement with Intel to adopt the Intel Teach program that provides ICT-based teaching programmes designed to train teachers in how to apply technology to improve classroom learning. These programmes were extended in 2008 to include advanced online training programmes. Intel Capital, the investment arm of Intel, has also invested in two Jordanian ICT companies, Jeeran and ShooFeeTV, through its Capital Middle East and Turkey Fund, and has pledged to extend its World Ahead programme—aimed at increasing the accessibility of technology to the world's population—through collaboration with the Jordanian government.²⁰⁵

204 Elshuraydeh K, Mustafa I, Al Majali M, Al Assaf M, Sarraf F & Hamarneh O (2006). *Science & technology and innovation profile of Jordan*, October. ESTIME, HCST: Amman, Jordan, pp 65–66.

205 See <http://www.intel.com/capital/news/releases/090519.htm>.

- The Ministry of Information and Communication Technology entered into an agreement with Microsoft to develop the country's ICT skills through various projects including the establishment of the Microsoft Innovation Centre (MIC) in 2009. The MIC offers programmes and services to facilitate collaboration between government, academia and industry for R&D in the development of innovative software solutions, as well as assisting start-ups with the translation of the outputs of R&D into business successes.²⁰⁶

Many forms of international collaboration also exist at the institutional level. For example, NCARE is actively involved in international collaboration with a range of international organisations, including the World Bank, the EU, United Nations Development Programme, Food and Agriculture Organisation, USAID, German Technical Corporation, and the International Development Research Center.²⁰⁷ In another example, the Water and Environmental Research and Study Center at the UoJ indicates that it has many foreign partnerships with organisations in countries including the USA, the Netherlands, Turkey, Italy and Morocco.

In an example of international collaboration at the industry level, in May 2009 the KADDB entered into a US\$40 million agreement with the South African company, Paramount Group, to manufacture 400 state-of-the-art mine-protected armoured vehicles per year at a facility established in the KADDB's free industrial zone. The project is reported to involve a substantial investment in facilities, plant, machinery, technology transfer and training. It is hoped the hi-tech vehicles—designed for use by armed forces, internal security and law enforcement agencies in peacekeeping operations and for disaster management purposes—will be exported around the world, and underpin the KADDB's vision to become a major international defence equipment manufacturer. It is also hoped that the facility will attract a cluster of complementary industries required for the production of the vehicles. Commenting on the agreement, Ivor Ichikowitz, Executive Chairman of the Paramount Group, said:

*"This project represents the largest-ever initiative between South Africa and Jordan in the field of industrial cooperation. ... it will provide an important platform for the development of substantial defence and technology collaboration between the two countries that will grow way beyond this initial project."*²⁰⁸

206 El Ajou N (2009). *Microsoft launches the Microsoft Innovation Centre in Jordan*. ameinfo.com, 23 February. <http://www.ameinfo.com/185885.html>.

207 See <http://www.ncare.gov.jo/>.
208 Ghazel M (2009). *KADDB, South Africa's Paramount to manufacture armoured vehicles*. The Jordan Times, 3 May.

8 Prognosis

This report has endeavoured to provide the reader with an overview of scientific and technology-based innovation in Jordan, including an assessment of the NIS, and how well this currently supports and promotes the development of the country's innovative capabilities. This chapter reviews the main findings of our study resulting from the mapping of key trends influencing the state of STI in Jordan, together with an assessment of the strengths and weaknesses of the NIS framework as it presently stands. Drawing on this analysis we then provide recommendations for strategies for stakeholders within Jordan's NIS—including policy makers, universities, R&D institutions and business leaders—to consider, in order to address current challenges and promote STI, thereby underpinning the country's capacity to achieve sustainable economic development going forward and ensure the prosperity of future generations.

8.1 Assessment of the Jordanian STI system

8.1.1 Strengths to be built on

Strong patronage of STI

Jordan's monarchy has a history of providing strong patronage to S&T and innovation in Jordan. This is evident through the strong support shown by HM King Abdullah II to S&T in Jordan, including initiatives aimed at promoting growth in the ICT sector.

Royal-sponsored NGOs also include the RSS and EHSC, through the active roles of HRH Prince El Hassan bin Talal and HRH Princess Sumaya bint El Hassan who support these institutions and the wider STI community in Jordan.

Rich in human capital

With close to 60% of its population aged under 25 years, Jordan has a young, well-educated and increasingly tech-savvy population which if employed productively will provide a strong engine for economic growth and future prosperity, and compensate for a lack of natural resources. Boasting a high literacy rate and the highest proportion of bilingual Arabic–English speakers in the region, Jordan's youth provide the country with considerable innovative capacity that must be developed going forward. In order to reap the benefits of this natural asset, Jordan must continue to direct efforts into developing the national education system at all levels to encourage critical thinking, creativity and innovation, and to ensure that graduates possess the skills necessary to meet the current and future needs of industry and develop the nation's entrepreneurial base.

Jordan has focused considerable attention on developing its national education system at all levels from primary and secondary education to higher education.

Educational reforms introduced in the 1990s, and by HM King Abdullah II since the early 2000s, including initiatives to improve the application of technology in the classroom, have aimed at developing Jordan as a knowledge-based economy. Since the UoJ opened, more than two dozen universities have been established. The UoJ also plans to become a 'research university' by 2015, in response to political, economic and social challenges associated with globalisation and national requirements.²⁰⁹

As a result of its strong education sector, Jordan is widely regarded in the region as having a well-educated population with a high literacy rate. It is also a source of graduates for countries throughout the region and internationally, resulting in a large and widely dispersed diaspora. Nevertheless, there are a growing number of concerns that need to be addressed going forward regarding levels of funding, academic standards, and the quality of graduates in terms of advancing critical thinking and scientific inquiry needed to support world-class R&D efforts to meet industry needs.

Regional ICT hub

Since the privatisation of the telecommunications sector in the 1990s, Jordan has developed as a regional ICT hub. The sector has grown because of the country's young, well-educated and IT-savvy population with its high level of English language skills—essential in the ICT industry—combined with strong government support. With Arabic considered the fastest growing language in the world, and Arabic content representing less than 1% of existing online content, Jordan's ICT sector shows considerable potential for future growth. A further benefit of developing Jordan's ICT industry is that, relative to other capital-intensive industries such as manufacturing, the ICT sector does not typically require large levels of capital investment for expansion, but is an intensive user of human capital, making it a perfect fit for Jordan.

Medical tourism

The medical services industry provides an example of how Jordan has developed a niche market by harnessing its human capital through education, combining this with meeting the needs of the military. As the industry has expanded, including growth in the private sector, Jordan has become a regional hub for medical tourism with a reputation of providing high-quality, low-cost healthcare in a country that offers a safe location in the region for treatment.

209 Dr Hani Al Dmour, Head of the Higher Committee of the Strategic Plan for the Development of the *University of Jordan* (2011). *University of Jordan Registered Patents are limited*. Al Ghad Daily Newspaper, 15 March.

However, the country's pre-eminent position is being threatened due to a range of factors including increasing costs, declining standards, and the loss of doctors to higher paying positions outside Jordan. These challenges must be addressed to ensure the ongoing viability of an industry in which Jordan has an already established reputation as a centre of excellence.

Good medicine

Jordan enjoys a well-established and successful pharmaceutical industry which exports approximately 80% of its production, and represents the country's second largest export industry after garment manufacturing.²¹⁰ The industry's economic output rose by 95% to US\$177 million between 2001 and 2007 (the last major period of global economic expansion), outpacing worldwide growth of 78%. Due to the competitive environment facing the pharmaceutical industry, there has been a significant level of consolidations and mergers in businesses, including with multinationals.²¹¹

The pharmaceutical industry is reported to invest more in R&D than any other private sector industry in Jordan. Different pharmaceutical companies have registered many international patents for new drugs, modes of drug delivery, diagnostic tools and biogenetic products. The pharmaceutical industry is also seeking to shift into new markets beyond traditional generics.

8.1.2 The current constraints facing the Jordanian innovation system

The STI governance system

Jordan's NIS comprises a complex network of organisations. While the government has created an NIS that represents a wide range of stakeholders and seeks to provide an enabling platform to promote S&T-based R&D and to support innovation and entrepreneurship, research suggests that its complexity presents a barrier to those who seek its support. Navigating the complex network of organisations, institutions, programmes and initiatives offering different—and sometimes overlapping—forms of assistance and support presents a barrier to its effectiveness. Many stakeholders lamented an apparent lack of coordination and communication within the NIS. This in turn can lead to opportunities for greater collaboration and economies of scale in R&D activities being missed. Moreover, linkages between different stakeholders are sometimes unclear, resulting in unproductive relationships and little collaboration or communication. The key point is that reduced complexity, possibly removing duplication where it exists, and improving coordination and communication across the NIS should work to make it a more effective instrument for promoting S&T-based R&D and innovation.

210 <http://www.jordanecb.org/library/634448627045122500>. pdf, p 4, para 3.

211 Phase 1—Situational assessment of Jordan's medical biotechnology position, competencies and strategic needs. National Medical Biotechnology Strategy of Jordan.

Shortage of innovative R&D

Most scientific R&D is concentrated in public universities. However, heavy teaching loads and a lack of financial incentives to collaborate with industry provide few incentives for faculty to engage in innovative R&D that will develop new products, services or processes. And while faculty are evaluated and promoted on the basis of their level of publications, most publications reflect theoretical rather than innovative research that could drive greater innovation capacity in Jordan.

A lack of R&D database

Jordan does not currently maintain or publish an ongoing comprehensive database of R&D activities by universities, government and the private sector. There is no complete or comprehensive list of R&D grants going to universities, and the very dated snapshot surveys of R&D activities that are available are only conducted on *ad hoc* basis. These deficiencies have hindered the determination of necessary R&D, and have not allowed trends and developments in R&D activities—such as publications and patent activities—to be properly analysed.

Nevertheless, the recent establishment of the STI Observatory by the HCST in collaboration with ESCWA should help to bridge this information gap in the future, and assist planning, decision-making and policy-making decisions in the STI arena.

A lack of collaboration

Few incentives currently exist to encourage collaboration between academia and industry that could lead to greater levels of innovation. Moreover, a history of limited collaboration or innovation suggests that companies lack the skills necessary to absorb and adapt external ideas, or to engage in external R&D that would generate innovative products and services. Nevertheless, the establishment of the JTTON in early 2010 should facilitate a greater level of technology transfer between academia and the private sector in the future.

Joint research among Arab states remains extremely rare. This presents considerable challenges for initiatives aimed at encouraging greater regional collaboration in R&D activities which could be used to pool limited resources and achieve synergies in research activities. Nevertheless, fewer barriers would appear to exist for international collaboration. This may in part reflect financial incentives provided by international organisations to collaborate in R&D activities, as well as the opportunities international collaboration provides to access expertise and experience that is not available locally. International collaboration activities are also seen as offering the collaborating parties a degree of prestige.

Diffused and poor levels of R&D funding

The most recent estimates of expenditure on R&D in Jordan indicate that GERD as a percentage of GDP was 0.34% in 2003. This compares to an average in advanced countries of 2.5%, and to targets in the National Agenda 2006–2015 of 1.0% in 2012 and 1.5% by 2015. Most expenditure on R&D occurs in the public sector, with the private sector reportedly investing very little in R&D—with the exception of the pharmaceutical sector and (to a lesser extent) the ICT sector. As a result, innovation would appear to play a limited role in generating revenue for private sector companies. Public sector expenditure on R&D is generally spread across a large number of projects and as a result tends to focus on low-cost projects that are often theoretical in nature and fail to generate new product or service innovations. The SRSF—the government’s main programme for funding scientific research—focuses on academic research and has only recently considered including the commercialisation potential of R&D outcomes as criteria when selecting projects for funding. However, this must still be balanced against the need for basic research where the potential for application is not immediately obvious.

Lack of entrepreneurial base

A lack of entrepreneurial spirit in Jordan would appear to stem in a large part from cultural barriers to risk taking and business failure. Setting up one’s own business is seen as a last resort for those unable to get a job. The natural career path for a Jordanian student is to seek a well-paying job or professional career similar to one’s father or another family member. An environment whereby the home, school, government and business community can work together in a seamless interactive open system does not exist within the local culture. This lack of interaction fails to provide adequate support for the development of an environment conducive to entrepreneurship.

It would appear that the education system at all levels in Jordan has also failed to adequately prepare students to become creative and innovative thinkers who can solve problems and generate new ideas and products, although efforts to redress this situation are being made. A lack of an innovative culture within business, with companies generally preferring to adopt a reactive approach to innovation and imitate rather than produce new products and services, also provides few opportunities for people to develop entrepreneurial skills.

It’s a family business

Approximately 95% of private sector companies in Jordan are SMEs, with the majority of those being family owned. SMEs in Jordan are generally run in a conservative manner, and the culture of risk taking necessary for R&D and innovation is limited. The importance of management relationships or personal connections rather than a company’s performance can also reduce the business

imperative for companies to invest in innovation to gain competitive advantage. Staff are often reported to lack the basic skills necessary to conduct effective R&D, and management frequently lack the entrepreneurial skills necessary to ensure the commercial success of innovation.

Difficulty in accessing capital

Access to capital presents a major barrier to entrepreneurs, innovators, start-ups and companies seeking to develop new products and services and to successfully commercialise their inventions. This is especially true in the ICT and pharmaceutical sectors where products and services are less tangible than the 'bricks and mortar' traditionally required by banks. In the past most start-ups have relied on family and friends for funding, a situation that has limited innovation processes and successful growth. Although the recent emergence of venture capital companies such as IV Holdings and Riyadh Ventures, both focused on the ICT sector, has gone some way towards filling this missing link in the NIS, greater access to finance will be essential for successful innovation in Jordan going forward.

8.2 Recommendations for the future development of STI and the NIS in Jordan

In order to address the key issues confronting STI and the functioning of Jordan's NIS, a range of strategies is presented below for consideration and discussion by stakeholders. Some challenges such as the instability of the Middle East region, influxes of refugees, water scarcity and lack of natural resources are factors that cannot be changed, but provide parameters within which Jordan must operate and a context within which all that has been achieved and can be achieved must be set.

8.2.1 Streamlining the STI governance structure

The World Bank/Korea RIAL Team that reviewed innovation policy in Jordan in early 2010 described the NIS as a 'traffic jam' of organisations in which duplication and the dilution of effort indicate a need to streamline the current framework.²¹² This streamlining process should entail reducing the number of organisations, programmes and initiatives currently in place to support innovation. This should also be combined with improved coordination and communication across the NIS. These processes will reduce the costs associated with the complex structure that currently exists, and also contribute to greater efficiency and effectiveness across the NIS system. Greater structural simplicity and clarity regarding the specific roles and responsibilities of each organisation within the NIS, together with improved communication and coordination of the programmes and initiatives available to researchers, innovators and entrepreneurs, should help raise the level of awareness and accessibility to mechanisms available to support R&D and innovation.

212 Rischard J, White J, Chung S & Kim J (2010). *A candid review of Jordan's innovation policy*. World Bank/Korea RIAL Team for Jordan, April, p 6.

Questions that should be asked when assessing the organisations, programmes and initiatives that together make up the NIS include whether they are strong enough to be effective, whether their efforts are synergistic or duplicative, and whether streamlining or consolidation would be beneficial to the overall efficiency and effectiveness of the NIS.

Clear authority and responsibility for overall coordination and communication across all stakeholders within the NIS should rest with an umbrella organisation, possibly the HCST, or a single government ministry.

The recent establishment of the JTTON should assist in raising the level of communication and coordination between different NIS stakeholders and encourage greater technology transfer between academia and industry.

Stakeholder alignment

In order to ensure that the NIS has maximum impact promoting STI and economic growth, effective coordination across all stakeholders is of key importance. It is crucial that all stakeholders are fully aware of the role and contributions of other stakeholders, as well as their own role in the overall NIS framework. Furthermore, the national innovation policy must be effectively communicated to all stakeholders, and each programme and initiative must be aligned to meet the objectives of that policy. This will include common goals to develop key sectors, or niche markets, targeted for development (eg. the ICT sector). To this end, R&D projects, educational programmes, funding programmes and incubators should all be aligned to ensure they achieve maximum impact in developing these sectors. A strong umbrella organisation overseeing this alignment process is critically important.

8.2.2 Improving the policy framework

Jordan currently lacks a formal 'national innovation policy', with the HCST's S&T Strategy 2005–2010 (currently in the process of being updated) being the closest thing to a national innovation policy that currently exists.

In developing a future national innovation policy, efforts should be made to ensure practical and demand-oriented strategies are developed that will be applied in practice. Strategies should also be developed to ensure the improved coordination of policy implementation across different stakeholders. Greater involvement of expert stakeholders in policy and strategy development processes should be encouraged, possibly through the formation of a workshop of national policy makers supported by high-level expert advisory groups. An associated communication strategy should also be developed in conjunction with the umbrella organisation overseeing the NIS, to ensure a high level of awareness and understanding of the national innovation policy across all stakeholders within the NIS.²¹³

213 Seidel U, Dömrose W & Meier zu Köcker G (2009). *Study on the national innovation system in Jordan*. VDI/VDE Innovation + Technik GmbH: Berlin, pp 45–56.

In order to overcome the problems associated with the often short-term tenure of government in Jordan, consideration should also be given to establishing high-level innovation policy leadership to oversee ongoing policy development and implementation processes.²¹⁴

Regional innovation policies

National innovation policy should also cascade down into a series of interconnected and complementary regional innovation policies. These regional innovation policies should be developed in collaboration with key stakeholders from each region to ensure that they reflect the specific characteristics and issues pertaining to each region, and that each region has ownership of their respective innovation policies.

Foresight exercises

A need also exists for the implementation of systemic benchmarking and foresight exercises to support the future development of STI in Jordan. Existing foresight exercises such as the 'National S&T Requirements and Potential Surveys' and the 'Jordanian Scenarios 2020' conducted by the HCST are spasmodic, reflecting, in a large part, the financial constraints involved in conducting more regular studies.

National cluster policy

It is recommended that consideration be given to the development of a national cluster policy to support the development of key sectors within the Jordanian economy which demonstrate strong potential for innovation and growth. The clusters could provide opportunities for increased cooperation and collaboration within industries, including collaboration in joint R&D projects aimed at increasing the competitiveness of national industry groups, as well as developing economies of scale in a variety of areas such as accessing suppliers or customers, or sharing infrastructure. While several industry clusters currently exist in Jordan, these have mostly been developed by industry groups and do not represent any planned or coordinated policy by the government. The development of a national cluster policy should also include the implementation of leadership/management training to build capabilities for cluster management.

8.2.3 Overcoming cultural barriers to entrepreneurship and innovation

Tackling cultural barriers to entrepreneurship and innovation will not be an easy or quick process. The national education system represents potentially the most effective method of doing this, by its continuing efforts to move teaching away from an emphasis on memorising facts and theoretical knowledge towards teaching methodologies to solve problems and improve critical thinking. Increasing the number of programmes within schools and universities which

214 Rischard J, White J, Chung S & Kim J (2010). *A candid review of Jordan's innovation policy*. World Bank/Korea RIAL Team for Jordan, April, pp 6–7.

encourage young enterprise through projects and competitions can also assist in developing a culture of innovation and entrepreneurship from a grassroots level. Studying the experiences of other countries in generating innovative output and creativity can also prove instructive. Opportunities to include the teaching of business and management skills within school and university courses should also be explored.

Other possible strategies include:

- A national awareness campaign in the media;
- Hosting conferences and seminars which address issues of entrepreneurship and innovation;
- An annual 'innovation festival' which brings together stakeholders from across the NIS, as well as guests from across the region and internationally, to discuss new areas of innovation, build networks and encourage greater collaboration and knowledge transfer. This could also provide a vehicle to promote greater awareness and collaboration across the Islamic world, and link into an international innovation festival held every two years, hosted by different OIC member countries.

8.2.4 Reforming and aligning the education system

As discussed above, continued reforms to teaching methods must be implemented in order to transform students into creative and critical thinkers. Greater emphasis should also be placed on elevating the importance of S&T within the school system.

Efforts should be made to overcome the current mismatch of university courses and vocational training with the needs of industry. Reforms to the current content of university courses and vocational training programmes can be best achieved through greater collaboration with the private sector, possibly using alumni and industry associations as initial contact points to coordinate these efforts. Opportunities to include entrepreneurial and business skills within programmes should also be explored, or education deficiency will persist.

A greater number of programmes and competitions at both secondary and tertiary levels should be introduced to encourage young entrepreneurs and to provide them with inspiration, basic business skills and access to mentors. Research institutions, successful entrepreneurs and businesses should be encouraged to support these activities.

School leavers should also be provided with advice that includes not only information on higher education options, but also information on vocational training and apprenticeships, and advice on the career options available to them as school-leavers. At the university level, graduates should be given access to career advice that encourages career choices beyond public sector positions. Current levels of funding to all levels of the education system should be reviewed.

8.2.5 Raising the level of innovative R&D

Incentives should be provided to encourage universities to shift their focus from academic or basic research to problem-solving R&D, and research that seeks to identify new ideas and technologies that will help Jordan develop its competitive advantage. Strategies to achieve this include:

- Changing the focus of academic publications from theoretical research to applied R&D and innovation;
- Revising the basis of academic promotion from publication to meeting a set of key performance indicators that reflect not only publications, but other factors including innovative R&D, and collaboration with industry;
- Increasing funding to universities to enable current heavy teaching loads to be reduced and free up time for faculty to engage in R&D activities;
- Identifying opportunities for increasing levels of expenditure on R&D activities, including increasing allocations for R&D from university budgets (to a recommended 5%), increasing funding made available through the SRSF or alternative programmes, and raising private sector sponsorship;
- Providing financial incentives to encourage greater collaboration between academia and the private sector in joint R&D activities, and in joint projects involving the commercialisation of university-generated R&D output;
- Removing barriers that prevent faculty from gaining financial advantage from commercialising the output of their R&D activities;
- Charging ‘technology transfer centres’ located within universities with the responsibility for identifying university-based R&D that has commercial potential and developing links with industry to facilitate commercialisation processes. This will require that technology transfer centres design a framework for negotiations, licensing, marketing and other processes that need to be addressed to facilitate commercialisation processes.²¹⁵

Strategies should also be developed to raise the awareness in the private sector of publicly funded R&D in universities and R&D institutes. This should help to encourage greater levels of public and private sector collaboration, as well as to promote innovation.

Opportunities to increase private sector investment in R&D should also be explored, including the provision of company tax concessions on R&D expenditures, and soft loans for innovative business ventures to both start-up and established companies undertaking new areas of innovative business development. Further to this, investment should also be encouraged in joint R&D projects within industry clusters, and through joint projects coordinated by industry associations.

²¹⁵ Tee D (2006). *A practical guide to wealth creation—proposals for an innovation policy for Jordan*. Euro-Jordanian Actions for the Development of Enterprise (EJADA), April, p 17.

Strategies should also be implemented to raise the awareness of the benefits to be gained by researchers, entrepreneurs and companies involving customers early in the innovation process in order to assist development activities and ensure there is a market for their innovations. Early customer commitment can even attract investment to support R&D activities.²¹⁶

As well as raising GERD from 0.34% of GDP to the targeted levels in the National Agenda of 1.0% by 2012 and 1.5% by 2015, it is also recommended that in the future more emphasis should be placed on concentrating R&D expenditures to achieve critical mass in priority areas that align with the National Innovation Policy. This compares with the current system whereby R&D expenditure tends to be allocated across a large number of disparate projects. Greater concentration of R&D expenditure, possibly including greater coordination and collaboration across the NIS and especially between researchers, should help Jordan develop specific centres of excellence in the niche areas that it believes it can profitably develop and exploit. Improved coordination and communication across the NIS should make this an achievable goal.

Opportunities for greater levels of collaboration in joint R&D projects between universities, R&D institutes and the private sector across the *region* should also be explored, with the umbrella organisation coordinating the NIS tasked with this responsibility. This should include responsibility for identifying common areas of interest that could possibly include the development of new technologies for renewable energies and water management.

8.2.6 Promoting a positive environment for entrepreneurship and business

Job creation and economic growth require the successful commercialisation of new products, services and processes arising from R&D activities. Success in the future will require that Jordan develop a business environment that is more conducive to both innovation and entrepreneurship. Addressing cultural barriers, reforming the education system and promoting greater emphasis on applied R&D activities will help lay the foundations for this environment to grow and evolve.

The implementation of IP laws to protect local innovations is an area that is yet to be adequately tested in Jordan due to the very limited number of cases that have been investigated to date. Moreover, the judiciary and government patent staff currently lack a depth of knowledge, skills and experience in this area.

Regulations and laws at the industry level should also be reviewed. For example, Jordan's telecommunications sector is heavily taxed (estimated to be taxed at over 55% of total revenue), operators are required to pay hefty annual frequency fees, and regulations prevent mobile number portability and local loop unbundling. These issues are currently considered to present significant hurdles

²¹⁶ Kristensen P (2010). *Challenges of being an innovator*. Australian Innovation, 18 November.

to growth in this sector. Extending the Investment Promotion Law to include telecommunications, as well as other sectors, would also help to provide a more business-friendly environment in Jordan.²¹⁷

Ultimately, however, a more stable policy, regulatory and legal environment will be necessary to promote greater certainty for future business investment and growth.

Incubators also provide a valuable mechanism by which to facilitate the transition of innovative ideas into competitive products and services, and in turn lead to job creation. Jordan has several incubators distributed across the Kingdom, with one of the most successful to date being the iPark in Amman. However, more funding is required to establish new incubators. Moreover, training and knowhow should be transferred from already established incubators to ensure that newly established incubators are effectively managed.

An organisation that provides a high profile and accessible interface between entrepreneurs, start-ups and other companies seeking support to develop and commercialise innovative ideas, and other stakeholders within the NIS—including academia, R&D institutes, funding programmes, incubators and investors—would also play a useful function within the NIS. This organisation should ideally be an arm of the umbrella organisation overseeing the entire NIS, and have an in-depth knowledge of the NIS and R&D-based businesses in order to assist entrepreneurs and businesses that lack the knowledge necessary to take the next step down the path to commercialisation. It is unclear at this stage to what extent the recently established Jordan Technology Transfer Offices Network (JTTON) will fulfil this important coordination role.

The National Business Incubation Association (NBIA; see <http://www.nbia.org/>) in the USA, and the Australian Institute of Competitiveness (AIC; see <http://www.ausicom.com/>) provide models that should be investigated for possible adoption in Jordan, albeit on a smaller scale. By way of example, the AIC seeks to:

provide(s) innovation and collaboration services that help organisations grow. Nationally, we work with entrepreneurs, businesses, research organisations and governments to convert ideas or intellectual property into successful business outcomes. Using our networks and experience, we deliver services to achieve that by establishing partnerships, improving skills, and providing commercialisation advice.

The AIC claims that the innovation services it provides to business are worth up to AUS\$240 million per year to the Australian economy in terms of additional turnover, exports and job creation.²¹⁸ The AIC provides a user-friendly website for entrepreneurs and innovators seeking support and assistance, including access to an online 'innovation toolbox' (<http://www.innovationtoolbox.com.au>) that provides the following tools and resources:

217 Based on information provided by Ihab Hinnawi, CEO, Umniah.

218 See AEC Group (2010). *Economic Impact Assessment: AIC Innovation and Collaboration Programs*. AEC Group, Australia.

- An on-line roadmap that introduces innovation across all aspects of the business;
- A directory of innovation programmes and services that support businesses;
- Up-to-date information on events and networking opportunities related to innovation;
- A discussion forum;
- A self-help innovation navigator to guide businesses in identifying appropriate innovation products and services;
- Detailed information of each stage of the “innovation adventure”.

8.2.7 Facilitating access to capital

Opportunities should be explored to strengthen and increase the network of angel investors in Jordan to support entrepreneurs and start-up companies, as well as established companies seeking to develop innovative business opportunities. The umbrella organisation overseeing the NIS should have the ultimate responsibility for coordinating this network, possibly drawing on contacts and expertise available in the larger Jordanian business and financial communities. Introductions to angel investors could be facilitated by the interface organisation discussed in the previous section, as well as through conferences, seminars, industry associations and the annual innovation festival.

Other initiatives aimed at encouraging lending to entrepreneurs and SMEs that could be explored include investigating opportunities to provide greater incentives and government support to banks and other financial institutions extending finance to these groups. For example, regulatory changes reducing the reserve requirements for lending to entrepreneurs and SMEs, possibly through providing some form of government guarantee for approved borrowers (and lenders), could promote greater access to capital for these groups. Branches specialising in SME finance could also be established.

Appendix 1.

The Atlas of Islamic-World Science and Innovation

This country case study is part of the Atlas of Islamic-World Science and Innovation project.

This exciting project aims to explore the changing landscape of science and innovation across a diverse selection of countries with large Muslim populations in the Middle East, Africa and Asia. Looking in detail at economically and geographically diverse countries, including Malaysia, Egypt, Jordan, Indonesia and Senegal, the project charts the delicate interplay between science, innovation, culture and politics. The project also aims to explore and promote new opportunities for partnership and exchange.

The Atlas is a unique partnership between organisations from across the Islamic world, Europe and internationally. Jointly managed by the Royal Society and SESRIC (the lead statistical agency of the OIC), the project is overseen by a Joint Management Team of all the project partners, which is chaired by Professor İhsanoğlu, Secretary-General of the OIC. Project partners include the British Council, the International Development Research Centre of Canada, Nature, COMSTECH (the OIC's Standing Committee on Scientific and Technological Cooperation), Qatar Foundation, the Islamic Development Bank and the Islamic Educational, Scientific and Cultural Organisation (ISESCO). In March 2007, the project was endorsed by all the Kings and Heads of State of the OIC in Dakar, Senegal, reflecting the importance of this project to senior figures across the Islamic world.

Each country case study consists of an independent and authoritative assessment of how capabilities are changing, and an analysis of the opportunities for and barriers to further progress. It does not aspire to be a comprehensive analysis of every sector, but will map key trends and consider the role of international best practices at the country level.

Every report is jointly authored by an experienced international analyst of national science and innovation systems and an in-country researcher, ideally placed in a recognised or emerging centre of excellence within the country of focus. By working closely with national research partners, national governments, universities and other stakeholders throughout the process, the hope is that the findings will be taken forward and used by the countries to strengthen their innovation systems. By bringing together such a wide range of stakeholders, the aim is to identify new opportunities for collaboration and partnership between scientists, policy makers, the private sector and the non-government sector in the Islamic world and elsewhere.

At the conclusion of this project, an overview report will be produced which will highlight commonalities and differences between the countries, and draw conclusions about the prospects for science and innovation across the Islamic world.

For more information about the Atlas of Islamic-World Science and Innovation project, please see either <http://www.aiwsi.org> or <http://www.royalsociety.org/aiwsi> or email info@aiwsi.org or aiwsi@royalsociety.org.

Appendix 2.

List of individuals interviewed

HE Khaled Anis Irani, former Minister of Environment and Minister of Energy and Mineral Resources, Jordan

HE Dr Khaled Elshuraydeh, Secretary General, Higher Council for Science and Technology (HCST)

HE Maysoun Al Zoubi, Secretary General, Ministry of Water and Irrigation

Dr Taher H. Kanaan, Managing Director, Jordan Center for Policy Research & Dialogue

Dr Radi A. Tarawneh, Secretary General, Ministry of Agriculture, Jordan

Professor Dr Hisham Ghassib, former President, Princess Sumaya University of Technology

Mr Nart Hameed, Chief of Staff, El Hassan Science City, Jordan

Mr David Tee, former Technical Assistance Team, Team Leader, Support to Research and Technological Development (SRTD), Jordan

Mr Mohammad Shahbaz, President, Jordan Badia Research and Development Centre

Dr Omar Al Jarrah, Vice President, Jordan University for Science and Technology (JUST)

Dr Hashem Sabbagh, Chairman/Board of Directors, Oxford Schools, Jordan

Mr Jawad Al-Hamad, Director, Middle East Studies Center, Jordan

Professor Dr Amer Salman, Director of Water and Environmental Research Center, University of Jordan

Dr Fawzi Al-Hammouri, CEO and General Manager, Consultant Paediatrician and Endocrinologist, The Specialty Hospital, Jordan

Eng. Riyad M. Al-Khatib, Director of Industry Support Directorate (JUMP), and Mr Eman F. Issa, Senior Manager, Jordan Services Modernisation Programme, Jordan Enterprise Development Corporation

Ms Reham Gharbiyeh, CEO, Al Urdonia, Lil Ebda, Jordan Innovation Centre

Ms Penelope A. Shihab, General Manager, and Dr Khaled Al-Qaoud, R&D Manager, Monojo, Jordan Company for Antibody Production

Ms Amal Al-Sadi, Wireless Software Department Manager, and Mr Adi Al-Nashashibi, Wireless Software Department Telecom/VAS Engineer, Eskadenia Software

Secretary General, Ministry of Social Development

Mr Farhan Kalaldehy, Executive Director, Queen Rania Centre for Entrepreneurship

Dr Issa Batarseh, President, Princess Sumaya University of Technology (PSUT)

Dr Wesam Rabadi, former Director, iPark

Eng. Omar Hamarneh, CEO, El Hassan Science City

Professor Nasri J. Rabadi, former Director General, Scientific Research Support Fund, Ministry of Higher Education

Dr Maher H. Al-Mahrouq, General Manager, and Dr Hatem Halawani, Chairman, Board of Directors, Jordan Chamber of Commerce

Eng. Saad Abu Hammour, Secretary General, Jordan Valley Authority, Ministry of Water & Irrigation

Dr Moayad Samman, former Chairman and CEO, King Abdullah II Design & Development Bureau (KADDB)

Dr Tareq Al-Hadid, former Executive Director of External Affairs, Assistant to the President for International Cooperation and Government Liaison, RSS

Dr Eshaq Shishani, Executive Director of Scientific Affairs, RSS

Eng. Nizar Al-Halasa, former Director, IRADA, Royal Scientific Society

Dr Mohammad A Jitan, PhD Irrigation and Water Management, Project Coordinator, National Center for Agricultural Research & Extension

Mr Samih T. Darwazah, Chairman, Hikma (Pharmaceuticals)

Mr Michael F. Sayegh, President, National Paints

Mr Laith Zraikat, Chief Product Officer and Co-Founder, Jeeran

Mr Zeid F. Kouksi, Founder, Talasim

Mr Muhannad A. Tasaq, CEO, MXD—Mixed Dimensions

Mr Ahmad M. Al-Sheibani, Business Developer, Minerets Tech

Dr Nader M. Atmeh, General Manager, and Mr Hassan N. Atmeh, Managing Partner, Kleenwash—Waterless Wax & Carwash

Dr Ahmad Al-Ghazawi, President and CEO, Triumpharma

Mr Amjad Swais, Director of Operations, Rubicon

Mr Darwish M. Al Khalili, Vice Chairman, MEC (Middle East Complex for Engineering, Electronics & Heavy Industries plc)

Dr Usama M. Fayyad, Executive Chairman, Oasis 500

Mr Abdelmajeed (Abed) Shamlawi, CEO, Information Technology Association, Jordan (Int@j)

Mr Zaid Ayoub, Managing Partner, New Energy Company

Dr Mohammad Jafari, Business Development Department, The Jordan Pharmaceutical Manufacturing Company plc

Dr Yousef Abdulla, Faculty for Factory Programme, University of Jordan

Ms Sophie Gerard, Amman Technology Center Director, Orange (Jordan Telecom Group)

Dr Khaldoon Tabaza, Partner, Riyada Venture

Dr Wajih M. Owais, President, Jordan University of Science and Technology
Founder, Jordan Roll, Jordan Innovation Centre, Irbid

Mr Hisham Al Affouri, Founder, Edom, Jordan Innovation Centre, Irbid

Eng. Mohammad Abu Gheyab, Production Director, and Eng. Jamal Amira, Technical Manager, Arab Potash Company plc

Mr Nabil Ismail, Member, Board of Directors, Chemical Sector, Jordan Chamber of Industry

Ms Amal Ismail, Target Chemicals

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Eng. Mohammed Abu Afifa, Jordan Engineers Association

Mr Haitham Abu Assi, Quality Assurance Manager, Jordan New Cables, MESC Group

Dr Adnan A. Badwan, General Director, The Jordan Pharmaceutical Manufacturing Company plc

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Mr Samer Sabbagh, Fund Manager, National Fund for Enterprise Support

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- Professor Atta ur-Rahman FRS, former Coordinator General, COMSTECH

From a dearth of natural resources, water scarcity and the aridity of much of its geography to its position in a historically turbulent geopolitical region, Jordan is a place where to survive and prosper requires considerable effort. Unlike many of its oil-rich neighbours, Jordan has limited natural resources. As a result, Jordan's future prosperity depends upon its ability to harness its human capital and relatively young population to support future economic growth. The development of a national 'ecosystem' that stimulates science, technology and innovation (STI) offers Jordan an excellent opportunity to ensure future economic development and the welfare of its citizens. This report analyses the state of STI in Jordan, and provides an assessment of how effectively the existing national innovation system (NIS) develops and supports the country's innovative capabilities.

The research for this report was conducted as part of a multi-partner project entitled *the Atlas of Islamic World Science and Innovation*. Bringing together partners from across the Islamic world, Europe and North America, the Atlas project is exploring the changing landscape of science and innovation across a diverse selection of countries with large Muslim populations.

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