Policies for the Establishment of an Efficient System of Innovation and Technology Transfer in Egypt
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>4</td>
</tr>
<tr>
<td>1  INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>2  INNOVATION: WHY AND HOW</td>
<td>6</td>
</tr>
<tr>
<td>2.1 INNOVATION AND INNOVATION SYSTEM</td>
<td>7</td>
</tr>
<tr>
<td>2.2 INNOVATION POLICY MATTERS!</td>
<td>8</td>
</tr>
<tr>
<td>2.3 TECHNOLOGY TRANSFER: A KEY INNOVATION DRIVER</td>
<td>10</td>
</tr>
<tr>
<td>2.3.1 Definitions of Technology and Technology Transfer</td>
<td>11</td>
</tr>
<tr>
<td>2.3.2 Types of Technology Transfer</td>
<td>11</td>
</tr>
<tr>
<td>2.3.3 Modes of Technology Transfer</td>
<td>12</td>
</tr>
<tr>
<td>2.3.4 Impact and Effectiveness of Technology Transfer</td>
<td>13</td>
</tr>
<tr>
<td>2.3.5 History of Technology Transfer Policies</td>
<td>13</td>
</tr>
<tr>
<td>3  EGYPT’S INNOVATION SYSTEM AND POLICY</td>
<td>16</td>
</tr>
<tr>
<td>3.1 CURRENT STATUS OF EGYPT’S INNOVATION SYSTEM</td>
<td>16</td>
</tr>
<tr>
<td>3.1.1 Scientific Research Governance &amp; Hierarchical Structure</td>
<td>16</td>
</tr>
<tr>
<td>3.1.2 Technology Transfer and Innovation Centers</td>
<td>18</td>
</tr>
<tr>
<td>3.1.3 Science Parks, Technology Parks &amp; Innovation Clusters</td>
<td>20</td>
</tr>
<tr>
<td>3.1.4 Funding for Scientific Research and Innovation</td>
<td>23</td>
</tr>
<tr>
<td>3.1.5 Support Organizations</td>
<td>24</td>
</tr>
<tr>
<td>3.1.6 IT and Communication Infrastructure</td>
<td>25</td>
</tr>
<tr>
<td>3.1.7 Education and Human Capital</td>
<td>26</td>
</tr>
<tr>
<td>3.1.8 A Holistic Assessment of Innovation in Egypt</td>
<td>30</td>
</tr>
<tr>
<td>3.2 NATIONAL INNOVATION POLICY IN EGYPT</td>
<td>30</td>
</tr>
</tbody>
</table>
3.2.1 IPR Policies .................................................................................................................. 31
3.2.2 Foreign Direct Investment Policies .............................................................................. 33
3.2.3 Human Capital and Education .................................................................................... 34
3.2.4 Domestic Technology Transfer: Academia/Research - Industry Relations .......... 35
3.3 Innovation Policies in Key Government Institutions .................................................... 36

4 THE WAY FORWARD: RECOMMENDATIONS ......................................................... 38
4.1 Institutional Reform: A Policy of Integration ............................................................... 38
4.1.1 Creation of a National Innovation Council and Agency .......................................... 39
4.1.2 Restructuring of Research and Technology Institutions ......................................... 39
4.1.3 Linking TICOs and ETTICs ...................................................................................... 40
4.1.4 Initiation of Export Innovation Clusters ................................................................... 40
4.1.5 Building a Comprehensive Innovation System ......................................................... 41
4.2 Effective Innovation Policies for Growth .................................................................. 42
4.2.1 IP Management and Protection ................................................................................ 43
4.2.2 Technology Transfer ................................................................................................ 44
4.2.3 Education and Human Capital ................................................................................ 45
4.2.4 Physical and ICT Infrastructure ................................................................................ 47
4.2.5 Scientific Research .................................................................................................. 47
4.2.6 Foreign Direct Investment ....................................................................................... 48
4.2.7 Social Innovation ..................................................................................................... 49
4.2.8 Institutional and Public Sector Innovation ............................................................... 50

5 SUMMARY ....................................................................................................................... 52

6 REFERENCES..................................................................................................................... 53
Executive Summary

This study aims at examining the current policies relevant to innovation and technology transfer in Egypt and providing recommendations to update existing policies as well as develop new ones with the objective of enhancing the country innovation system effectiveness and efficiency.

Innovation has been identified by all developed nations and most developing ones as the most important path for sustainable development where innovation has been defined as the transformation of science, technology and know-how into economic value. Building a robust innovation system with an underlying battery of effective innovation policies that span all relevant aspects ranging from Education to scientific research, technology transfer, attraction of Foreign Direct Investment (FDI) etc.. However, there are foundational framework conditions that should be ensured for any innovation system to be effective in creating economic growth and sustainable development. These include enforcement of the rule of law and curbing down corruption should as a top priority objective to achieve economic growth, prosperity and social stability. Like most countries, Egypt has to fully embrace this holistic approach in order to find its way to sustainable development. The current government is putting a lot of effort and investment in implementing mega projects. Although this could be of significant value, it cannot achieve the right impact without adopting innovation and the establishment of an effective National Innovation System (NIS) as the main strategy towards a knowledge society and knowledge economy.

The study will review and analyze existing and planned national and institutional policies relevant to innovation and technology transfer and will compare them to international best practices. Based on this review and comparative analysis, the study will embark on providing recommendations to upgrade existing policies and/or develop new ones and will suggest potential legislations to enforce such policies. While the study will focus on technology transfer and the role of Technology Transfer Offices (TTOs) in playing a significant role towards strengthening the existing innovation system, it will also address the status of policies relevant to all the ingredients of the innovation process and the components of the NIS such as Intellectual Property (IP) rights and IP protection, Scientific Research, Education and Human Capital, R&D funding, start-ups funding, tax incentives, attraction of FDI, and many other aspects of the innovation system. It is to be noted that the highest priority should be given to reforming the national education system and strengthening scientific research in addition to developing a strong technology transfer ecosystem if we want to establish a strong NIS.

This study falls within a bigger project composed of a number of studies in five selected countries (Egypt, Lebanon, Morocco, Tunisia and Oman) aiming at helping these countries to develop their innovation capacity. This project comes at a time where Egypt is striving to build a knowledge-based economy where innovation stands as the main pillar and the main driver of positive economic and societal transformations.
1 Introduction

Coming out of a period of relative instability, Egypt is striving to continue build its national innovation and technology transfer capacity through establishing different components of a comprehensive NIS and developing the right innovation policies, strategies and plans. Although the country does not have a formally ratified innovation policy at the national level which drives towards a unified view of a national innovation system, significant scattered efforts have been undertaken during the past two decades or more to develop different ingredients of such an NIS.

In particular and in direct pertinence to this study, two different networks of technology transfer centers have been established and are currently operational in Egypt. The first network of technology transfer centers has been established by the Ministry of Industry and Foreign Trade (MoIFT) under the name of “Egyptian Technology Transfer and Innovation Centers” (ETTICs). More than a dozen ETTIC exist today with the main objective of supporting Egyptian industrial firms through transfer of new technologies directly from outside Egypt. In addition to technology transfer, ETTICs provide a wide variety of services to Egyptian companies ranging from incubation to technical support to funding facilitation and networking. ETTICs are managed by the Industrial Council for Technology and Innovation (ICTI).

Another network of technology transfer centers has been more recently established within a number of Egyptian Universities through an initiative by the Academy of Scientific Research and Technology (ASRT). These centers are mainly concerned with technology licensing and transfer from Egyptian Universities to the local industry as a first step and potentially to regional and international industries as well. These centers are called Technology, Innovation and Commercialization Centers (TICO) and similar to ETTICs they provide more services than just technology transfer. They support researchers and educate them on issues related to IP rights, IP licensing, IP Protection, technology licensing and transfer as well as all business and legal aspects related to IP and technology commercialization.

In addition to the above two networks of technology transfer, the Egyptian Innovation Ecosystem boasts a large number of players serving innovation and technology transfer from different perspectives and under different organizations. Key players on the government side include the Ministry of Industry and Foreign Trade, the Academy of Scientific Research and Technology, the Ministry of Scientific Research, the Ministry of Communication and Information Technology (MCIT), the IT Industry Development Agency (ITIDA), the Technology Innovation and Entrepreneurship Center (TIEC) and the Science and Technology Development Fund (STDF). Non-governmental organizations and networks concerned with promoting innovation have also emerged and started to play a visible role within the innovation landscape. These include Misr-Elkheir, ECASTI, EITESAL, Endeavour, and several other organizations.

Last but not least, private initiatives and enterprises as well as funding bodies and investors are central to the innovation and entrepreneurship arena and play a major role in supporting...
entrepreneurs, start-ups and established companies. These entities include RISE UP, Flat 6 labs, Technology Development Fund, SAWARI ventures, etc.

Based on the above view, one might think that the Egyptian innovation ecosystem is relatively developed, which is true. However, the above innovation landscape lacks the glue and high level unified vision and policy which can make the above components function together in an efficient and effective manner thus becoming a real NIS.

At this point, it is interesting to make the distinction between the innovation ecosystem and an innovation system. The first refers to the environment including culture, geographical and political aspects, economic and social conditions, etc. in addition to the different ingredients including entities and organizations, policies, laws and physical infrastructure required to have meaningful innovation processes. On the other hand, an innovation system refers to the different actors and the way these different entities and organizations are linked together to produce targeted economic and social outputs when provided with specific inputs in terms of investments and resources. An innovation system is therefore more like an engineering or physical system whose efficiency can be measured in a quantitative manner with objective and measurable KPIs.

As a result of the above discussion this study will try to provide a high level overview of Egypt's national top-level innovation policy and vision of its NIS, if they exist, before diving into institutional and organizational policies relevant to the different players of the innovation ecosystem and different aspects of innovation. Once we understand the current situation of the Egyptian innovation policy, the study will examine the mandates and policies of the different stakeholders of the innovation ecosystem including, but not limited to, technology transfer centers and will provide recommendations for developing new policies or upgrades to the current ones to enhance their performance and to link these different components into an efficient innovation system.

It is to be noted that several studies relevant to innovation have been conducted before. However, most of these studied have confined themselves to a rather limited scope pertinent only to the organizations commissioning such studies such as that conducted by Fraunhofer IPK in 2009 [1] which focused only on ETTICs. In this work, we will try to have a higher level view with the objective of assessing the national innovation system and policies as a whole and trying to identify the gaps and missing links to make this system more effective and efficient.

2 Innovation: Why and How

This section tries to answer several questions. Why innovation? How does innovation happen and how it can be enhanced? What is a National Innovation System? and how can a national innovation policy make this system more effective and efficient?
2.1 Innovation and Innovation Systems

Innovation is the foundation of knowledge-based economies. It is defined as the ability to access, absorb, develop and utilize knowledge and transform it into economic and developmental value. Innovation is therefore wider in scope than scientific research. In fact, scientific research is one component of the innovation process.

Classical linear models assume knowledge to flow in a simple linear manner where the initiator of innovation is scientific research and an increase in scientific inputs will simply lead to an increase of new innovations. In real life, however, innovation originates at different stages of research, development, production and marketing. Innovation is thus the result of interactions between various players in a complex system rather than a simple linear one. This leads us to the definition of an innovation system as a set of interacting organizations from the research, academia and industrial sectors charged with the production, communication, storing and utilization of all elements of specialized knowledge required in the innovation process.

An effective innovation system has well defined components and players that are linked together in robust networks through policies, programs, incentive mechanisms and many other tools to boost synergies and interactions between different actors leading to higher levels of innovation and value generation. The efficiency or performance of an innovation system is a measure of the output of such system in terms of innovations and economic value for a specific input in terms of resources and investments.

Based on the above, the efficiency and performance of an innovation system depend on two main factors:

- The abilities and levels of maturity of different players, including those generating knowledge and know-how, those transforming such knowledge into products and those acting as catalysts.
- The strength of linkages and interaction mechanisms between such players.

Figure 1 depicts a schematic diagram of an innovation system according to [2] with some modification to fit the Egyptian context. We have added also an underlying background circle which represents the environment and framework conditions required for any innovation process. In fact, without the right environment and framework conditions, no significant impact or sustainable growth can take place even in presence of the best policies and state-of-the-art infrastructure. Finally, the diagram also suggests that a strong political will is mandatory to establish the right environment and proper framework conditions.
2.2 Innovation Policy Matters!

Examining the above figure, the circle in the middle encompasses the different actors of the national innovation system and the links or “connective tissue” between these different players in the circle determine to a great extent the performance of the innovation system if we assume that all players enjoy a certain level of maturity and capacity at what they do. The strength and efficiency of those links depends to a large extent on the national innovation policy and the underlying legislations and institutional innovation policies. The performance of an innovation system is usually measured using instruments such as the so called community innovation survey (CIS) which is a European Union standard that measures the output of innovation with a defined set of quantitative and qualitative indicators [3].

Innovation policy is the combination of government policies from tax, to trade, to human development, to technology that support a nation’s innovation system. These policies can be visualized as a four layer pyramid (see figure 2, [4]); at the base level are key framework conditions such as the rule of law which, transparency and a low level of corruption, ease of doing business, competitive markets, flexible labor markets, the effective protection of property (including intellectual property), and a culture of trust. These framework conditions are
mandatory for success; without them, even the best innovation and industrial policies will not succeed. The next level includes an effective tax, trade, and investment environment designed to establish a globally competitive ecosystem and policies that encourage trade and FDI.

Figure 2: Four-level pyramid for innovation success

At the third level come robust physical and digital infrastructures; a skilled workforce with broad-based general capabilities as well as the specialized skills matching needs of key industries; and robust knowledge creation (e.g., investment in science and technology). However, success requires going to a fourth level that includes effective innovation and productivity policies specifically tailored to a country’s competitive strengths and weaknesses. Policies here include provisions such as R&D tax incentives, support for regional innovation clusters, and support for innovative small businesses.

Establishing the foundation of success requires a strong political will and strong awareness and belief that innovation based on the right framework conditions and policies is the right path for prosperity. This could even represent a fifth foundational layer that could be added at the bottom of the whole pyramid. Most countries often focus on the top of the pyramid because these are often the easiest to implement from a political standpoint (for example, establishing a program to develop a regional innovation cluster seldom faces opposition), while some of the policies at the base of the pyramid require fighting corruption, protecting property and ensuring the rule of law are much more difficult to achieve politically because change challenges entrenched interests in government or the private sector.

Development of a national innovation policy requires very good understanding, via thorough situation analysis, of the current country innovation system. Such an understanding is mandatory to identify points of strength that should be leveraged to boost innovation. It can also help identifying mismatches within the system among different players. Different innovation systems differ in the way in which knowledge flows and linkages are structured among different types of institutions and actors. There are systems in which knowledge flows and interactions occur more easily than in others. Policies and legislations relating to regulations, taxes, financing,
competition and intellectual property can ease or block the various types of interactions and knowledge flows. Consequently, a good national innovation policy based on updated understanding of the national context or system will definitely lead to enhanced innovation and value creation.

An innovation system is not only focused on creating value through transforming knowledge into economical value, however, innovation is also key to addressing critical social and societal problems such as poverty, unemployment, health issues, pollution, energy and corruption. The scope of innovation is therefore much wider than economic success and extends to social and institutional innovation to drive a process of inclusive development of the whole society.

Inclusive social innovations are directed towards the marginalized and the poor thus allowing larger segments of society to benefit from them. Egypt as most emerging countries has a high demand for different types of social innovation targeting the poor, the sick and other categories of the society such as agricultural and bio-technological research, as well as research on specific chronic and widespread diseases.

### 2.3 Technology Transfer: A Key Innovation Driver

Technology transfer is definitely a pivotal driver for innovation since it is one of the most important tools of acquisition and dissemination of know-how. Having defined innovation as the transformation of knowledge and know-how into economic value, it is only natural to think of promoting and developing innovation through acquiring knowledge and know-how as a start. An organization concerned with innovation such as a company or a firm or even an NGO may acquire knowledge and know-how through different potential sources, the most important of which are, education/training and human capital development, scientific research and know-how/technology transfer. Education and human capital development are two very important sources of acquiring and developing knowledge and know-how, however, technology / know-how transfer stands out in the sense that it is not only a source of knowledge and know-how but a means of dissemination and diffusion of knowledge and know-how. Indeed, developing policies and mechanisms to enhance technology transfer will enhance both the acquisition/development as well as the diffusion of know-how and will consequently enhance the efficiency of the innovation process which is highly dependent on the efficiency of knowledge and know-how diffusion and transfer. In addition, technology and know-how transfer could be in many cases a faster means of acquisition of know-how compared to human capacity development and research.

Having identified the above three major sources of knowledge and know-how, one cannot overlook the role of modern Universities within the ecosystem of an innovation system. Indeed, Universities encompass all these three mechanisms of knowledge and know-how generation and dissemination. Modern Universities are major knowledge and technology producer and transfer agents with different vehicles of transfer. Of course, research laboratories are considered as a very important technology producer and transfer agent, however, the vehicles of technology
transfer are somewhat limited compared to Universities who have the distinct characteristic of producing and transferring know-how through human capital.

Before delving into the history of technology transfer and examining its evolution, let us first understand the definitions of technology and technology transfer.

### 2.3.1 Definitions of Technology and Technology Transfer

The unabridged Webster offers three definitions of technology, (1) the science or study of the practical industrial arts; (2) the terms used in a science, technical terminology; and (3) applied science. Defining technology within the context of technology transfer and accurately specifying the transfer object requires a different description of technology. In fact, none of the major works on technology transfer uses any of these definitions of technology [6]. One of the popular definitions of technology within the context of technology transfer describes technology as “processes and products as well as the knowledge of use and application of such products” [7]. In this sense, technology and technology transfer may involve ideas, proofs of concept, and prototypes and their move from research phases or research entities to development and production phases or firms and organizations. This leads us to the definition of technology transfer as “the movement of know-how, technical knowledge, or technology from one organizational setting to another” [6].

### 2.3.2 Types of Technology Transfer

Before the 1980s, most of the work on technology transfer, its policies, effectiveness and impact has been focused on cross-national technology transfer [6]. Such form of foreign technology transfer has been (and probably still is) one of the most important development mechanisms for developing nations and has been primarily one directional from industrialized countries to less developed ones [6]. In recent history and specifically in the 1980s and 90s, many countries and primarily the US have developed policies promoting domestic technology transfer from Universities and government research to domestic industries. For the sake of this work, we will refer to first type of technology transfer as “Foreign Technology Transfer” and for the second one as “Domestic Technology Transfer”. There are other types of technology transfer such as transfer from domestic Universities to international firms and organizations as well as domestic transfer of technology between private sector companies. These types of technology transfer are not of lesser importance within an innovation system, however, they are not regulated by national policies and are mainly market driven.
2.3.3 Modes of Technology Transfer

2.3.3.1 Foreign Technology Transfer

Technology transfer from foreign sources can be done in different ways or through different vehicles; the most commonly known of these vehicles are [8]:

Foreign Direct Investment (FDI) where a multi-national company (MNC) establishes a local affiliate. In this scenario, technology transfer occurs through employed human capital and their movement, collaboration with local companies and potential collaboration with local R&D institutions and Universities.

Joint ventures where MNCs can engage in joint ventures (minority or majority shareholders) for various reasons. One scenario for this to occur would be if the domestic partners are already fairly matured and have established some form of domestically-owned technology. A second reason is based on a risk-sharing motive where the MNC may consider the risk of setting up a local affiliate to be too high.

Technology Licensing where MNCs may consider the target market to be too small or too much unknown to them so that they prefer to license production and sales to a domestic player. Another scenario would be that the technology to be licensed may have a short life span for the MNC to invest in it.

Imports of Machinery and Equipment where the new technologies embodied in these capital goods can produce significant positive spillover effects if the local firms have an adequate knowledge base to learn from them. This form of technology transfer will lead to maintenance activities of such machinery and potentially development of similar machinery or equipment in later stages.

Contracts awarded to MNCs in domestic agencies or sectors and the possibility of having domestic companies providing support and partial implementation of such contracts.

2.3.3.2 Domestic Technology Transfer

Domestic technology transfer from Universities and research institutes to local firms and organizations can happen through various vehicles, the most important of which are:

Technology or IP Licensing where a research group or lab within a University or research institution may license a new technology at any form or level to a company that intends to build a commercial product based on this technology or IP.

Contract Research where a University or research institution may engage in a joint research or development activity with a company to develop a new product or service.
Spin-offs where a University or research lab may spin-out a start-up company with the objective of developing a new product or service based on a new technology or IP developed within the University or research institute.

Human Capital where a University (and potentially some research institutes) embody knowledge and know-how into human capital that will be employed by local firms through education, research, training, workshops, conferences, projects, theses work and many other human capacity development activities.

2.3.4 Impact and Effectiveness of Technology Transfer

It is of utmost importance to be able to measure the impact and effectiveness of technology transfer since it involves an investment of resources, time and money. Consequently, the return on investment in any technology transfer exercise should be measured in terms of its impact and effectiveness which in turn can be looked at through the following criteria:

Market impact. This is measured by quantifying the commercial impact resulting from such technology transfer in terms of revenue, profit, market share, etc..

Economic impact. This is similar to market impact but measured in relation to national or regional economy rather than to a specific company or firm or industrial sector.

Political Reward. This kind of impact is rarely examined in technology transfer related research, however, it exists in practice. This kind of impact may be on the firm level where transfer of a certain technology may lead to reward to the company whether tangible or intangible. In addition, political impact may also be on the national level due to the introduction of a specific technology that may affect the life of the public.

Opportunity Cost. This criterion examines the effectiveness of technology transfer by looking at alternate investment of resources in other technologies or even in different scenarios other than technology transfer.

Human Capital. This criterion measures the impact of technology transfer in developing the scientific and technical skills of human capital.

2.3.5 History of Technology Transfer Policies

Before the 1980s, most technology transfer policies focused on cross-national or foreign technology transfer, especially from industrialized nations to developing countries [6]. The 1980s
witnessed a lot of interest in domestic technology transfer as a significant driver to economical growth. The USA has been a pioneer in this regard where the US congress has passed at least 8 major policy initiatives promoting domestic technology transfer [9, 10]. This has also happened in other countries [11].

This interest in domestic technology transfer was reflected in many ways; at least one journal, the Journal of Technology Transfer, is devoted exclusively to “technology transfer” and several professional organizations include technology transfer in their mission statement. Many Universities and government research institutes around the world have created technology transfer offices and technology transfer became a hot topic appearing in titles of so many books and scholarly articles [6].

In order to better understand the evolution of technology transfer policies, let us examine the case of the US which has been and is still pioneering in technology transfer as a driver for development. As mentioned above, many developed nations have followed suite of the US.

Before the 1980s, the US policy for domestic technology transfer has fallen within what can be called the “mission paradigm” where government-owned research labs and government Universities focused on R&D in service of well-specified missions in which there is a national interest not easily served by private R&D such as defense, energy, public health and other strategic sectors. In this context, government funding agencies retained all rights for any technology developed by Universities and government research labs and gave non-exclusive rights to companies. This has resulted in many scientific publications but very little commercial impact. Since companies didn’t obtain exclusive rights, they were reluctant to invest in product development as competitors could come at a later stage and acquire licenses to develop similar products.

The US congress felt concerned due to the failure of the technology transfer policies and acted aggressively to pass several laws that ushered the US into what is known as the “cooperative paradigm” of technology transfer. The “cooperative technology policy paradigm” features an active role for government research labs and Universities in technology development and transfer.

The main goals of the new policies were to:

- Promote economic development
- Enhance U.S. competitiveness through innovation
- Benefit public by encouraging commercialization of technologies that would otherwise not be developed into products due to lack of incentives

These new policies were implemented through several laws the most important of which are:
The Bayh-Dole act of 1980:
This law stipulated that Universities and research labs should own rights to their own discoveries developed under Federally funded projects. The Bayh-Dole act also emphasized the following [6,12]:

- Universities should collaborate with commercial entities to promote the utilization of inventions arising from federal funding
- University must share commercialization revenues with inventors
- Universities are expected to file patents on inventions they elect to own
- Universities are expected to give licensing preference to small businesses
- The government retains march-in rights (the funding agency may demand full rights back in case of strategic importance of the developed technology)
- University must report back on progress to the funding agency

The Stevenson-Wydler technology innovation act of 1980:
The most important aspect of this act is that it required federal laboratories to have a formal technology transfer program and actively seek opportunities to transfer technology to industry, universities, and state and local governments. This was followed in 1986 by the Federal technology transfer act which made technology transfer the responsibility of every scientist and engineer working in government research labs.

It was then the Federal executive order 12591 that implemented royalty-sharing programs with inventors who were employees of the agency, and cash award programs thus providing incentive to government employees to innovate.

These policies had tremendous impact in terms of technology commercialization and economic growth. Before 1980, US Universities received only 250 patents per year and only 24 Universities were engaged in technology licensing and transfer. By 2005, US Universities engaged in technology transfer amounted to 200 and the number of issued patents for those Universities rose to 3000 per year [12].

In 2008, the Association of University Technology Managers (AUTM) licensing activity survey [12] summarized the impact of domestic technology transfer on the national US economy in the following:

- 648 new commercial products introduced
- 5,039 total license and options executed
- 595 new companies formed
- About 72 percent of new companies formed with the primary place of business in the institution’s home state
- 3,381 startup companies still operating as of the end of FY2008
- $51.47 billion total sponsored research expenditures

One of the most important practices that has been developed within the US technology transfer and innovation ecosystem is to measure the impact of technology transfer. A Federal Interagency working Group (IWGTT) has been established to do so [12]. In addition, each federal research lab is required by statue to prepare and submit an annual report of its technology
transfer activities and their impact according to the following metrics:

- Number of patents filed
- Number of patents granted
- Number of licenses
- Earned royalty income
- Number of licenses terminated for cause
- Other relevant parameters unique to the agency

In the European Union (EU), different countries changed their laws following the US model. Austria, Denmark, Germany, Norway and recently Finland have introduced new legislation to grant universities title to IP resulting from publicly funded research. In Japan and Korea, recent reforms in funding regulations to this effect have been implemented. All these policy trends echo the landmark US Bayh-Dole Act of 1980.

Different European countries have very strong technology transfer systems such as Germany where the Fraunhofer society institutionalises the academia and research collaboration with the industry. The Fraunhofer society is comprised of more than 60 research institutes with the mandate to expedite the development and application of new technologies in German industry. These institutes are structured and funded in such a way that the industry has a say in the kind of projects that are pursued. Nevertheless, these institutes also receive government funding to be able to conduct more advanced/futuristic research that the industry cannot support. It is the policy of these institutes to strike good balance between industry-sponsored research leading to immediate commercial value and advanced research intended to maintain the edge of the German industry in the future.

### 3 Egypt’s Innovation System and Policy

#### 3.1 Current status of Egypt’s Innovation System

The current status of the national innovation system has been the subject of investigation and analysis in a previous study within the framework of this project [5]. However, we will focus in this section on technology transfer centers, science/technology parks and innovation centers and their role within the current structure.

##### 3.1.1 Scientific Research Governance & Hierarchical Structure

The Ministry of Scientific Research has embarked in 2014 on updating its strategy and the organizational structure of the national science and technology system. In 2015, the consolidated ministry of Higher Education and Scientific Research has just recently released the first draft of its Science, Technology and Innovation strategy [13].

This strategy proposed a modified governance and organization structure for science, technology and innovation system, which we regard as an organization structure for science and technology institutions. The main reason for this is that this structure, does not clearly show other parts of
the innovation system beyond science and technology institutions such as ETTICs for example which should have been an integral part of this system as this network of technology transfer centers represents an interesting point of interface to the industry.

One of the major drawbacks of the Egyptian NIS is the lack of an overarching body orchestrating the innovation process and providing national policies for innovation. The above figure shows two high level councils, the Higher Council for Science and Technology (HCST) which has not been functional since 2011 after the January 25\textsuperscript{th} revolution and a more recent specialized advisory council for science and technology affiliated to the presidency. Both councils focus on science, technology and research, however, neither of them is mandated with the development of the National Innovation System and innovation policies in a clear manner.

It is also essential to monitor the effectiveness of the innovation system and the impact of innovation policies in order to determine whether policies have worked and which policies might be most effective. For this, the government needs access to relevant, timely, and reliable statistical information. In this regard, the Egyptian Science, Technology and Innovation Observatory (ESTIO) conducts innovation surveys according to Oslo manual (OECD document titled “The Measurement of Scientific and Technological Activities, Proposed Guidelines for Collecting and Interpreting Technological Innovation Data”, also known as the Oslo Manual, contains guidelines for collecting and using data on industrial innovation). However, these surveys do not link specific policies to specific outputs nor do they measure the evolution of tangible outputs of the national innovation system as a function of specific policies.
The new strategy does suggest reinforcing the Technology Transfer Centers established by ASRT but does not elaborate on how to do that or on how to strengthen linkages between these centers and the industry.

### 3.1.2 Technology Transfer and Innovation Centers

#### 3.1.2.1 Foreign Technology Transfer

The Ministry of Industry and Foreign Trade has established a national Industry Council for Technology and Innovation (ICTI) with a main role to advocate policies, design and implement Technological & Industrial Development plans and programs that aim at enhancing the competitiveness of the Egyptian Industry in global markets. ICTI is the managing and supervising body of the previously mentioned 12 technology transfer and innovation centers (ETTICs) providing a broad range of services to different industrial sectors in 23 governorates in Egypt. Services include: technology transfer and innovation, technical assistance, product testing and development as well as capacity building. Currently each ETTIC works to enable foreign technology transfer and localization within Egyptian industrial firms. ETTICs do not work on transferring technologies from Egyptian Universities and research institutes to the industry.

The centers already established cover the following disciplines:

- Food & Agri-Business
- Mining Industries and Marble production
- Leather & Leather Tanning
- Plastics
- Engineering
- Furniture
- Textile development
- Fashion & Design
- Jewelry and creative industries
- Cleaner Production
- Quality Improvement

It is beyond the scope of this report to provide a full account on the status and impact of these centers however, we have chosen the food and agro industries technology transfer center to give an idea about the activities and impact of such centers on the national food industry. The role of this center is to improve, modernize and develop the Egyptian food industries sector by leading innovation and technological development through transfer of advanced foreign technology. The center has established partnership with AINIA technological center, Spain and has provided technical assistance to more than 20 companies and training services to more than 35 companies. Technology transfer activities have led to the development of two new dairy products in two selected Egyptian SMEs and increasing the shelf life as well as improving quality of several dairy products.

#### 3.1.2.2 Domestic Technology Transfer

The Academy of Scientific Research and Technology (ASRT) has established a network of technology transfer centers (TICOs) in a large number of Egyptian Universities, public and
private, with the mandate of enhancing technology transfer between Egyptian Universities and research institutes on one side and industrial firms on the other side. The initial phase in 2013/2014 involved establishing 28 centers distributed among different Universities in Cairo (17), Alexandria (3), Suez (2), Mansoura (1), Tanta (1), Zagazig (1), Menia (1), Assiut (1) and Qena (1) with a total budget of EGP 18.95 M.

However, before the appearance of such network, several Universities and research institutes had taken the initiative to engage with the industry. This has been also encouraged by several government programs and initiatives supporting cooperative research. The ICT industry has taken the lead in such domain through ITIDA which has launched the Information Technology Academia Collaboration program (ITAC) in 2006 and has been running successfully up till now. The program funds research projects that are jointly proposed and implemented by industry and academia. Although the ITAC program focuses on ICT, the submitted projects have covered issues in a wide spectrum of disciplines such as health, agriculture, energy, transportation, industry, etc., whereas ICT technologies have been deployed in to solve a problem or develop a product in the above domains. Not only has ITAC stimulated collaboration between academia and industry but it has in many cases led to the development of very successful products on the international level.

Another example of programs designed to facilitate and support collaboration between academia and industry are those designed by the STDF. In addition to several programs targeted to support joint research and development between academia and industry, the STDF has launched in 2008 a program called “Faculty to Factory” which funds a project where an expert research or faculty staff spends one year at an industrial firm working on a specific project.

The Academy of Scientific Research and Technology (ASRT) has also played an interesting role in supporting innovation in SMEs through a program called RDI (Research Development and Innovation) funded by the European Union with the objective of stimulating collaboration between academia and industry to produce novel technologies and products. The first round of this program was launched with an initial budget of 11 M€ targeting a wide spectrum of domains including agriculture, energy, nano-technology, medicine, pharmaceuticals, etc. In 2011, a second round of the program has been launched with a budget of 20 M€ after the obvious success of the first round.

Some universities and research centers have started initiatives to engage with the industry. Assiut University has been a pioneer in establishing a technology transfer unit that worked as a private company to solve industry problems and to develop solutions and products in collaboration with local firms or service sectors.

In addition, there is a few research institutes and University research centers or labs that have developed world class industry oriented research and development expertise and have had long track records of working with the local industry. In some cases, successful start-ups have emerged out of such research centers. A very good example of such institutes that have
managed to bridge the gap between academia / research and industry is the Central Metallurgical Institute in Tebeen which has developed solutions and products for the local industry and local service and strategic sectors. For example, this institute has designed and developed train cars for the national railway company as well as specific products for the defense sector. Another example is the Integrated Circuits Laboratory (ICL) at Ain Shams University whose collaboration with the industry has been intensive in the last couple of decades and has led to the emergence of more than a dozen start-ups developing products and chip design services for the international market. One of these companies has developed critical intellectual property for low energy Bluetooth and has been acquired by a world leader in integrated circuits IP. Another company has developed a world class MEMS based spectrometer that has won the best product award at the Photonics West conference/exhibition in 2014. The Egyptian Petroleum Research Institute (EPRI) is another example of industry oriented research centers where advanced technology research is being conducted in areas related to energy generation in addition to research targeted to address all issues related to the national oil industry.

It is not the intent of this section to give and exhaustive account on domestic technology transfer and the collaboration between academia and industry. However, the objective here is to monitor the status of such collaboration and show that there has been a positive change that has happened in the last decade or so. Although this change remains highly unsatisfactory and limited to specific domains mainly in Engineering and ICT, it provides a very good start and living examples for other industries and research centers to follow.

Currently, there seems to be no or minimal coordination between the foreign technology transfer network under ICTI and domestic technology transfer centers initiated by ASRT. Establishing the right coordination and even integration mechanisms between these two networks could be a very strong point of the Egyptian NIS. Each of these two networks represents an interesting point of interface to its respective world, the domestic academic/research world for TICOs and the industrial world for ETTICs. Hence, linking these two networks can be a valuable mechanism to link academia to industry and facilitate synergy between these two worlds. This could be done through a unified council for the two networks providing the overall vision, policies and objectives of technology transfer within the context of the NIS as well as monitoring the operation and outcomes of the combined networks and assess the overall impact of technology transfer according to well defined metrics as outlined in section 2.3.4. In addition, the two networks should be linked on the ground through operational guidelines that ensure the right synergy and strong interaction between academia and research on one hand and industry on the other hand.

### 3.1.3 Science Parks, Technology Parks & Innovation Clusters

It is not the intent of this section to give a detailed overview of the existing science and technology parks and innovations clusters. Again, this has been covered in the first study if this project [5]. This section will focus on making the distinction between different kinds of
agglomerations and the role of each within the NIS of Egypt and how to boost their impact. We will also address, in this section, new plans to create technology parks and Special Economic Zones (SEZ) in different parts of the country.

Science and technology parks refer to physical agglomerations of start-ups, technology companies and firms. In many cases, these agglomerations are built around Universities and they include incubators, accelerators, and other mechanisms of support to tenant companies at different levels. In some cases, the park is reduced to just an incubator incubating a number of start-ups and in other cases the park is just a business park hosting different types of companies and businesses. Egypt has several science and technology parks and incubators that are cited in [5], however, their impact is not significant due to the lack the right ecosystem, policies, incentive and support mechanisms that would eventually transform such agglomerations into an innovation clusters. An innovation cluster is more than just a science/technology park or an incubator; it is a miniature innovation system that is focused onto a specific industry or discipline.

An innovation cluster success is highly dependent on the strength of its “social capital” [14] which refers to the relationships and interactions between its different actors. Such social capital should be promoted through policies that favor building relationships and trust between different actors of the cluster. The close relations among such actors enable smooth and efficient knowledge exchange and more effective collective action. Effective partnerships, consortia, and research or business networks are forms of social capital or more precisely, mechanisms to foster social capital. Table 1 shows the critical success factors for innovations clusters as reported in a study by the UK department of Trade and Industry [14].

<table>
<thead>
<tr>
<th>Cluster Success Factor</th>
<th>Approximate Percentage Identifying Each Factor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Networking and partnership</td>
<td>78</td>
</tr>
<tr>
<td>Innovation technology</td>
<td>75</td>
</tr>
<tr>
<td>Human capital</td>
<td>73</td>
</tr>
<tr>
<td>Physical infrastructure</td>
<td>42</td>
</tr>
<tr>
<td>Presence of large firms</td>
<td>40</td>
</tr>
<tr>
<td>Enterprise and entrepreneurialism</td>
<td>38</td>
</tr>
<tr>
<td>Access to finance</td>
<td>35</td>
</tr>
<tr>
<td>Specialization</td>
<td>29</td>
</tr>
<tr>
<td>Access to markets</td>
<td>27</td>
</tr>
<tr>
<td>Access to business support services</td>
<td>25</td>
</tr>
<tr>
<td>Competition</td>
<td>21</td>
</tr>
<tr>
<td>Access to information</td>
<td>20</td>
</tr>
<tr>
<td>Communications</td>
<td>15</td>
</tr>
<tr>
<td>Leadership</td>
<td>13</td>
</tr>
<tr>
<td>Virtual aspects/ICT</td>
<td>11</td>
</tr>
<tr>
<td>External economic impact</td>
<td>8</td>
</tr>
</tbody>
</table>

It is quite clear that the 3 top success factors are very close to each other in terms of percentages and are highly differentiated compared to the rest. An interesting observation is that
two of these three factors represent inputs to the innovation cluster (or system) or pools of knowledge and expertise (Human capital, Innovation technology) and the third factor represents the mechanisms (Networking and partnership) that allow sharing of the first two and synergy that creates economic value.

A good example of an innovation cluster in Egypt is the Communication and Information Technology (CIT) sector. This sector has succeeded in creating a real innovation cluster whose scope and definition extend beyond the physical agglomeration of firms and organizations within the Smart Village and Maadi technology parks. The main characteristic of this cluster is the existence of all the elements of the innovation process starting with ITIDA which is playing a significant role in the development of this industry by developing the vision, strategies, action plans and programs to incentivize innovation and NGOs such as EITESAL (biggest ICT NGO in Egypt) which is partnering with ITIDA in developing policies, strategies and action plans in addition to providing services to support its member companies. Such policies, programs and incentive mechanisms provide the foundation for strong interaction and synergy between different actors within the innovation cluster leading to an efficient and effective innovation process within this sector. In fact, the Ministry of Communication and Information Technology (MCIT) and ITIDA have gone beyond this and have taken the initiative in facilitating the creation of missing actors such as dedicated VCs, incubators, and other kinds of entities required for the innovation process even including a highly successful education and training institute, ITI, which has played a significant role in upgrading the level of graduate students and help them bridge the gap between their educational level and that required by the market.

The Industry Council for Technology and Innovation (ICTI) and before its creation the Industry Modernization Center (IMC) are playing an equivalent role for developing other industrial sectors. However, they have not succeeded with the same degree in creating clear and strong innovation clusters as is the case with the CIT sector.

Ironically, Egypt has quite a large number of established industrial clusters that are much older, more mature and bigger in size than the CIT sector and that could be transformed into innovation clusters by introducing the right science, technology and knowledge component to such clusters and putting in place the right mix of policies, programs and incentive mechanisms tailored to each industry.

In fact, the ICTI should focus in its mission of developing innovation clusters on existing industrial clusters which could be a low hanging fruit rather than establishing new industries. The innovation centers (ETTICs) launched under its umbrella could play a significant role in creating such innovation clusters.

Finally, the MCIT has launched a new plan supported by the Presidency to establish 7 technology parks in different governorates. The first two of these parks will be established in 2016 in Assiut and Borg El-Arab city. These parks will benefit from the presence of strong local Universities such Assiut University and Egypt-Japan University for Science and Technology (E-JUST) in Borg El-Arab. In fact, MCIT is partnering with TUS Holdings (the biggest Chinese
holding firm specialized in establishing and running science and technology parks) to establish and operate these science and technology parks and to attract foreign companies from China and other countries to establish development and innovation centers in these parks.

In addition, the agreement between MCIT and TUS Holdings involves support from TUS Holdings to attract Chinese manufacturing companies to open up factories in special economic zones in Beni-Suif and the Suez Canal region.

3.1.4 Funding for Scientific Research and Innovation

Funding for research and innovation should not be characterized only by the amounts of funding available but more by the quality of such funding. The term “quality” here refers to the terms and conditions associated with the funding and the support provided by the funding agency. In fact, several funding bodies and programs do exist and are available for research groups, individuals and industrial firms. Moreover, some of these programs are generous in the amount of funding they can allocate for a specific project or proposal. However, in many cases, the funding is associated with stringent bureaucratic requirements on how the money should be spent which limit its usefulness. In other cases, the funding body imposes severe conditions on the ownership of the resulting outcomes or IP of the project. The STDF for example maintains majority ownership of the resulting IP and research outcomes of the projects it funds. This drives private innovative companies and even some University and research centers staffs to avoid approaching STDF for funding. This has been the main problem rectified by the Bayh-Dole act of 1980 and following legislation in the US.

In addition, some government funding bodies do not fund private sector firms or organizations unless they put letters of guaranties against the funds they receive which is beyond the ability of most creative young start-ups who wish to receive government funding.

The ITAC program is one of the most flexible and efficient programs supporting innovation, however its scope is limited to ICT industry and the amount of funding is also limited compared to the STDF for example. Moreover, the ITAC has recently adopted a new policy requiring firms to return back a significant percentage of the funds they received once they start commercializing their products.

Venture capital funding has started to be available in Egypt and has grown quite well in the last decade. Several VC funds, angel investors and private equity groups are listed in [5]. However, most of these funds are relatively small and can only offer small amounts of funding. In addition, only a few of these funds and firms are tech savvy and understand very well new and emerging industries and markets. In fact, most of these funds focus on IT related opportunities in social media, e-commerce, mobile applications, etc. while not so many can engage with opportunities based on emerging advanced technologies.
### 3.1.5 Support Organizations

This section is dedicated to supporting agencies playing a catalyst role within the innovation system. This includes chambers of commerce, NGOs, business alliances, semi-governmental organizations, etc. The innovation ecosystem in Egypt has recently been enriched by organizations that are more sophisticated than traditional chambers of commerce or business alliances. Endeavor is one of those organizations that has emerged only a few years ago. Endeavor is an international network established to support entrepreneurship and innovation in developing countries. It provides entrepreneurs and start-ups with a large portfolio of services and valuable support mechanisms ranging from linking such companies to a very large network of international expert consultants, advisors and investors to offering excellent opportunities of development to entrepreneurs. Endeavor focuses on high impact entrepreneurs and companies.

Another example of business alliances is EITESAL, which is an alliance of Hi-Tech companies working in the fields of electronics, software development and telecommunications. EITESAL has more than 400 companies to which it offers a wide portfolio of services supporting innovation, entrepreneurship and access to international markets. For example, most recently, EITESAL has launched a program to support SMEs developing their business in China through a network of satellite business development offices funded by EITESAL.

Misr El-Khair is another example of organizations supporting innovation and entrepreneurship. In fact, Misr El-Khair also supports scientific research and students through different types of grants. In addition, Misr El-Khair is one of the few organizations which focuses on social innovation.

Examples of think tanks working on developing strategies and policies for the future and collaborating with the government are ECASTI and ITT. ECASTI is an acronym for The Egyptian Center for the Advancement of Science, Technology and Innovation (ECASTI); it is a policy think tank that produces reports, policy briefings, and position statements on issues related to Science, Technology, and Innovation (STI) and their impact on socio-economic development in Egypt. ECASTI has participated into the development of the recent strategy of the Ministry of Higher Education and Scientific Research. Whereas ITT stands for The Egyptian ICT Think Tank which is a non-profit group of independent volunteered Egyptian experts in the ICT domain and influential ICT users, brought together to develop ideas and suggest initiatives for the sake of the advancement of the ICT sector in Egypt.

These are only examples or recently emerging organizations that play a very important role in the Egyptian innovation ecosystem. However, most of them operate under the law governing social and charitable organizations and under the umbrella of the Ministry of Social Solidarity. This imposes several restrictions and bureaucratic measures that hinder the flexible and smooth operation of such organizations and make the founders and executive staff of such organizations fall under the threat of aggressive legal penalties in many cases.
3.1.6 IT and Communication Infrastructure

Ensuring widespread access to broadband and fostering the development and supporting the adoption of next-generation digital infrastructure is key for innovation. The innovation index framework considers ICT infrastructure as one of the main pillars required to sustain innovation. Low cost ICT services foster inclusion and integrate innovation across different layers of the society. In fact, since innovation relies primarily on the diffusion of knowledge, no significant innovation can happen without a developed ICT infrastructure. According to the world bank, an increase in broadband penetration by 10% will lead to an increase in GDP by 1.38% [15].

Developing the ICT infrastructure has been an important part of Egypt’s national development strategy for the past decade. The Government has been developing a framework to move the country into the information age, through promoting partnerships of public, private, civil society and multilateral stakeholders. The NTRA has put forward in 2011 a national plan “e-Misr” that aims at the diffusion of Broadband services in Egypt by fostering the supply (Networks) and demand (Services) sides through a mixture of regulatory and investment packages.

In 2013-14, the updated MCIT strategy has set new broadband penetration goals as follows:

- Increasing fixed broadband penetration from 14% in 2013/14 to 40% in 2020/21
- Increasing USB broadband penetration from 4.49% in 2013/14 to 15% in 2020/21
- Increasing mobile broadband penetration from 22.61% in 2013/14 to 44.4% in 2020/21

Figure 4, shows that Egypt is lagging many other Arab countries in internet speeds due to lagging broadband penetration.

Figure 4: Download speeds and latency for Egypt and other countries (source: MCIT)
However, the ICT infrastructure is not only about broadband and mobile penetration, more important is building the foundation for a digital economy and even for a digital society. The transformation to a digital economy is measured by what is termed “Digitization score” [16]. An increase in the digitization score by 10% will lead to an increase in the innovation index ranking by 6 points and will lead to an increase in GDP per capita by 0.5% [17].

![Digitization Score Diagram](image)

**Figure 5: Digitization situation of 150 countries including Egypt**

As can be seen from figure 5, Egypt is still among countries that are lagging in the transformation to digital economy. The updated MCIT strategy has set forward an objective to develop a national and secured digital platform to facilitate the digital transformation of Egypt’s economy and the whole society. This platform will be built to access knowledge and services using simple and affordable means anywhere and anytime for all citizens. This means putting more services and more content in terms of knowledge and information online and encouraging people to use such services and alleviating their privacy and security concerns when doing business online.

### 3.1.7 Education and Human Capital

Drivers for innovation and Economic growth as well as improvement in the overall quality of life of a particular country have been studied and investigated by a large number of economists. According to Theodore W. Schultz [18] the main reasons behind positive economic growth and high quality of life are, knowledge, information, ideas, skills, and health of individuals. Building human capital through education is an important determinant of quality of life, potential earnings
Researchers and policy makers stress the importance of education for economic growth and all studies have indicated that what matters is not the quantity of education but the quality of that education [19].

Egypt is the most populous country in the Middle East, and the third most populous in Africa with an average annual growth rate of 2.2% in the period 2011-2015 compared to 1.4% for Morocco and 1.2% for Lebanon for the same period. Such growth has proved an enormous challenge for Egypt's education system which has suffered a lot of deterioration in the last 3-4 decades mainly due to the rapid growth in the number of students and policies that cater for quantity rather than quality. Around one third of Egypt's population is under 15 years old, and around 50% between under 24 years old [20]. Average class sizes are 44 in public primary schools, close to 40 in secondary schools [20], and the average ratio of pupils to teachers in primary schools is among the highest in the region.

With more than 17 million students, 821 thousand teacher and 40 thousand school, the Egyptian education system is one of the largest in the world and the largest in MENA (Middle East North African Countries) [21]. The Egyptian education system is divided into Al-Azharite system (Islamic school) and a secular system. The first is supervised by ALAZHAR while the secular system is divides into public and private, Arabic, language and religious schools, 90.2 percent of all students in Egypt are included in the public and private education sectors (83 percent and 7.2 percent, respectively) [22]. All are under the supervision of the ministry of education which makes this system highly centralized.

In addition to the regular academic track in secondary schools, the Egyptian system offers another track; the technical or vocational track. The former typically leads to university while the vocational track leads to technical and vocational institutes. Around 63% of those leaving basic education enter the vocational track mostly as a result of their lower test scores.

According to the Ministry of Higher Education, the number of students entering higher education (universities and higher technical colleges) is around 2.5 million students in 2011. The ministry forecasts this number to be around 3.9 million students by 2021. This makes the density of students in higher education institutions very high. Big Universities like Cairo and Ain Shams Universities host close to 250,000 students in their different colleges. This large number of students highly impacts the quality of education of these institutions.

As a direct result of the deteriorating quality of education of governmental schools and higher education institutions, private tutoring has become very widely spread among students both in pre-University education as well as among higher education students but to a lesser extent.

Due to the limited number of places in higher education specially practical colleges such as science, medicine and engineering which have more limited places due to the nature of education which requires practical sessions in labs, hospitals and workshops and due to the higher cost of private tutoring for such practical disciplines, students have gradually fled science
and math section in secondary education to the arts and literature section. In fact, an interesting thesis [23] has studied the major influential factors affecting students’ scholastic achievement in Egypt and has found this to be the socio-economic status of the students’ families whereas the school influence was found to be much less. This has been attributed to the high cost of private tutoring indicated above.

The table below shows the evolution of distribution of secondary school students among the two sections in recent years [24].

<table>
<thead>
<tr>
<th>Year</th>
<th>Science &amp; Math (%)</th>
<th>Arts &amp; Literature (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>45.4</td>
<td>54.5</td>
</tr>
<tr>
<td>2003</td>
<td>30.3</td>
<td>69.7</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>71</td>
</tr>
<tr>
<td>2012</td>
<td>30</td>
<td>70</td>
</tr>
</tbody>
</table>

Another major problem of the education system in Egypt is the low wages of educators specially school teachers. This drives such teachers more and more to increase their income by providing private tutoring. Salaries of University professors have been increased but not to the level that would make them completely focused on their jobs. Many of those professors seek to increase their income either through side consulting jobs or producing teaching material that they sell to their students or taking long leaves at other regional Universities especially in Gulf countries. All this represents a major problem that affects the quality of education in schools and higher education in Egypt.

The above two problems of high students’ densities and low educator’s wages have rendered the public education system in Egypt ineffective and year after year, the quality of graduates coming out of the system and joining it as educators has significantly deteriorated.

The Ministry of education has recently promised to increase the wages of school teachers. In addition, it has undertaken an initiative to upgrade the standard of educators through a establishing a new cadre for school teachers and linking their pay to their level within this cadre. In order to go up this new cadre, teachers have to upgrade their skills and experience levels through self-learning and have to pass special exams in order to go from one level to a higher one within this new cadre. This has faced a lot of resistance from school teachers themselves and has not yet been widely applied.

Another initiative that has been undertaken by the ministry of education is the establishment of STEM schools. According to the US President Barak Obama, “The jobs of the future are STEM jobs”. Even in the United States, the President’s Council of Advisors on Science and Technology (PCAST) estimates there will be one million fewer STEM college graduates over the next decade than U.S. industries will need [25]. The new US innovation policy recommends maintaining a strong investment in STEM education and increasing coordination of Federal investments. The
US President’s 2016 Budget maintains a strong priority for STEM education by requesting $3 billion, an increase of 3.8 percent over the 2015 enacted level [25].

The first STEM School in Egypt was opened in the fall of 2011 and the implementation of its second STEM School was achieved in the fall of 2012. Both schools were designated for the gifted and talented high school aged Egyptian youth. Several months ago, the ministry of education has inaugurated three more STEM schools. These schools have been established in collaboration with the USAID program and in accordance to the American STEM system which adopts project-based learning rather than traditional education. The ministry of education has contracted “World Learning” (which is an international NGO working in more than 60 countries to advance human development) to provide curriculum and professional development. These schools have been funded by Misr El-Kheir Foundation and ExxonMobil. Other contributors to the STEM School Program are the Academy of Scientific Research in Egypt, The British University (BUE), Cairo University, the American University in Cairo (AUC), The British Council, and Dr. Ahmed Zewail, Egyptian Nobel Prize Winner [24].

The Technical and Vocational Education and Training (TVET) system on the other hand is highly complex and highly fragmented. Basic technical and vocational education is provided through the Ministry of Education (about 1929 technical and vocational schools) and the Ministry of Higher Education (47 Middle Technical Institutes/Technical Colleges). Other ministries involved in technical and vocational education include ministries of Industry and Foreign Trade, Housing, Manpower and Migration, Agriculture, Health and Population, Culture, Tourism, Transportation, Electricity and Energy, Civil Aviation, Defense, Interior, Irrigation, Finance, Local Development, Endowment (Awkat) and Social Solidarity. There are other governmental and para-governmental agencies that work on technical education such as, but are not limited to, the Supreme Council for Human Resources Development (SCHRHD), the National Authority for Quality Assurance and Accreditation in Education (NAQAAE), the sectoral Training Councils (Industrial, Building and Construction, Tourism) and the Social Fund for Development (SFD) [26].

The vocational education system focuses on 3 main disciplines, industrial, agricultural and commercial vocational education. In general, education provided by most vocational training institutions is characterized by its low quality and by a high mismatch compared with market requirements.

One of the most successful experiences in vocational training in Egypt has been the Mubarak-Kohl Program which has become a best practice. The program started in 1994 as a result of a partnership between the Egyptian and German governments. The Egyptian government currently fully funds and owns the German Technical Cooperation unit (GTZ) which previously ran the program. The program currently boasts 76 technical secondary schools in 22 governorates. More than 1,900 companies accommodate and train students. There have been 20,000 graduates (13% of them female) [26].
Finally, one of the worst problems Egypt is currently facing is brain drain to the US, Canada, and other countries. This could be attributed to a myriad of issues ranging from the lack of infrastructure and environment for research and innovation to financial reasons as well as issues related to the political, social and economical status of the country. In this regard, the government has not done any effort to stop or limit such brain drain. However, there are some programs targeted to establish links between Egyptian expatriates and local research institutes or Universities such as the United Nations TOKTEN program (Transfer of Knowledge Through Expatriate Nationals) implemented through the ASRT as well as programs designed by the STDF to encourage young researchers and scientists to return back to Egypt after finishing their studies abroad. However, such programs have very limited impact on limiting or reversing the brain drain. A study that has been conducted before the January 2011 revolution has ranked Egypt highest among 10 Arab countries in terms of brain drain [20]. This study estimated that around one third of Egyptian researchers who go to conduct graduate studies abroad don’t come back to Egypt after finishing their studies. This ratio is likely to be much higher now.

3.1.8 A Holistic Assessment of Innovation in Egypt

Having examined the different components of Egypt's innovation system it is important to know how does Egypt rank in terms of the effectiveness of its innovation system. Although the Egyptian innovation ecosystem is rich in terms of ingredients and actors, the effectiveness of the system is not good since the Global Innovation (GII) index (report 2015 report [4] ranks Egypt 110/141. In addition, the Global Competitiveness Index (GCI) 2014/15 report [27] ranks Egypt as 119/144. The GCI report cites the main issues for doing business in Egypt as follows:

- Policy instability
- Government instability
- Access to financing
- Foreign currency regulations
- Corruption

This highlights violations of some framework conditions for innovation as well as problems with policies and regulations. It is therefore obvious that having a rich innovation ecosystem in terms of actors is not sufficient. An effective innovation system is only possible by having the right framework conditions and an efficient connective tissue that connects the different actors which is the result of the right policies and programmes.

3.2 National Innovation Policy in Egypt

The focus of innovation policies for developing countries such as Egypt differs from that of policies in more advanced economies. Emphasis should be placed on reaching international R&D funding levels as much as on providing the right framework conditions that stimulate a process of innovation and knowledge diffusion: political stability and supportive institutions; good and widespread technical and tertiary education, reliable and widespread basic infrastructure,
excellent protection of intellectual property rights, and stronger links and interaction between publicly funded research institutes and private companies. It is more fundamental to focus on the later rather than aiming to achieve high target levels of R&D/GDP ratios comparable to those of industrialized countries. In fact, such targets will never be achieved in absence of the favorable framework conditions highlighted above.

According to the World Economic Forum Global Competitiveness report for 2014/2015 [27], the most problematic factor for doing business in Egypt is “policy instability”. Until recently, Egypt did not have a formal national strategy for innovation. However, this year has witnessed the launch of a national sustainable development strategy with a long-term vision [28]. This vision has set forward the country objectives in terms of innovation and has provided the foundation for a National Strategy for Science, Technology and Innovation that has been just finalized during the drafting of this report.

“According to Egypt’s vision, the government is committed to continue supporting a market, competitive, diversified, knowledge-based, and private-sector led economy, characterized by a stable macroeconomic environment, sustainable inclusive growth, maximizing value added, and generating adequate and productive job opportunities. By 2030, the Egyptian economy will be an active player in the world economy, capable of adjusting to international developments and well positioned to join the ranks of the world’s medium-income countries.”

The above statement, which is an excerpt from the sustainable strategy document itself, outlines the foundation of not only a knowledge-based economy but a knowledge society as a whole. The main KPIs to achieve the above goals are:

- Achieve economic growth rate of 7 percent on average
- Raise investment rate to 30 percent on average
- Increase the contribution of services to GDP to 70 percent
- Raise the contribution of exports to 25 percent of the growth rate
- Reduce Unemployment Rate to 5 percent

As far as innovation is concerned, the strategic vision stipulates the establishment of a national innovation system based on a high quality institutional and legal infrastructure for scientific research, technology and innovation, and skilled human resources.

The strategic vision also aims at establishing an efficient administrative system. This is considered as another major pillar for sustainable development. By 2030, Egypt’s administrative system is to become efficient and flexible; highly capable of maximizing the use of its resources and providing high quality services using technological mechanisms and applying a clear and transparent governmental regulatory system that is applied fairly and effectively contributing to economic growth.

### 3.2.1 IPR Policies

Protecting proprietary knowledge, know-how and intellectual property is at the heart of company valuation. Intangible assets such as IP, trade secrets and know-how are driving market
capitalizations. An innovation system has to provide effective means of asset management and protection and enable companies to protect their know-how and IP portfolios.

Egypt has made significant progress in improving its IPR protection system through its revised law 82/2002 which reflects the major provisions of the Trade-Related aspects of Intellectual Property Rights (TRIPs) Agreement and the establishment of economic courts through Law 120/2008.

However and despite these efforts, Egypt currently lags behind many countries in the Middle East and North Africa region in terms of IPR protection. The World Economic Forum’s Global Competitiveness Report 2014/2015 ranks Egypt in terms of protection of intellectual property at the 110th place, down from the 58th the year 2009/2010. This significant ranking deterioration is due to several factors. The US-Egypt Business Council (USEBC) has conducted an assessment of the IPR protection in Egypt [29] and found that counterfeit of pharmaceutical products and consumer goods to be significant. According to their report, the Egyptian Customs Authority has not been sufficiently effective in curbing the entry of such products into the market nor in interdicting illicit goods that are transiting Egypt. In addition to a lack of enforcement, customs officials are not adequately empowered with the proper legal authority to prevent and interdict illicit goods in transit through Egypt.

The Egyptian economy is characterized by having a large percentage of informal economic activities which are not regulated, controlled, taxed or protected. Some of the products coming out of this sector may be good or even innovative but, in general, these products do not conform with any quality standards and are much lower in cost and price than quality products. It is very important to funnel such activities within the formal economy otherwise they become a threat to innovation.

Counterfeit products are often sold on the black market at cheaper prices with no quality assurance. This undermines efforts of companies who want to develop novel and high quality products. Further protection and enforcement against counterfeits for public health and safety are required.

Furthermore, the judicial system in Egypt is very slow. Cases related to counterfeit products drag out for years in the court system. Several companies have identified the problem of illicit trafficking of commercial goods affecting their brand products, including, luxury goods, textiles, consumer electronics, apparel, and household products. Smuggling not only impacts businesses and their ability to innovate, but also affects national security and public health.

In addition, confidentiality of information still needs to be better enforced. As an example, the report has found that Egypt still needs to adopt measures to protect data submitted to obtain marketing approval for pharmaceutical products.
The report has also found that the Egyptian government’s price control system for pharmaceutical products references 36 countries and determines the government’s pricing by identifying the lowest price out of all the countries and then reduces Egypt’s price by 10%. This type of price control system negatively impacts the pharmaceutical industry’s ability to develop and introduce innovative products to all markets, including Egypt. In fact, such pricing system encourages or results in significant local counterfeiting activity in order to meet such stringent pricing and make good profit margins.

In addition, the market authorization process for new medicines is still lengthy despite the intention of various ministerial decisions to reduce the registration period.

As far as internet piracy, the Egyptian law currently has insufficient disciplines for dealing with piracy of IP-related products and services. This problem is more and more exacerbated with Internet penetration. Egypt does not aggressively enforce entertainment and business software IP rights. This severely undermines the growth of Egypt’s IT sector.

Another major problem related to IP rights protection is the lack of technology transfer policies at the institution level in most Egyptian research centers and Universities. Only less than a handful of Universities have developed their own IP right and technology transfer policies. This severely impacts the transfer of IP and know-how from research and academia to the industry. This is a major roadblock facing innovation which mainly relies on the transfer of knowledge and know-how to the industry.

### 3.2.2 Foreign Direct Investment Policies

Before the revolution of January 25th, 2011, Egypt was a very attractive destination for FDI in the Middle East. Between 2000 and 2008, foreign direct investment (FDI) grew from $509.4 million a year to $13.2 billion a year. The dynamic economic growth (=7% before the revolution), Egypt's strategic location, low labor and government reforms aimed at lowering barriers to entry and privatization have all led to driving FDI up. The UN Conference on Trade and Development's World Investment Report 2010 ranked Egypt first among North African countries in its ability to attract FDI [20].

However, FDI decreased following the global economic crisis and the of 2011. FDI flows declined in the fiscal year 2012-2013, and then increased quite significantly in 2013-2014 (USD 10.8 billion of inflows). In March 2015, Egypt hosted a conference aimed at attracting new FDI (with a target of USD 12 billion) and The World Bank indicated that significant progress has been made in terms of protecting minority investors and in recovering security.

FDI is coming back to Egypt drawn by the government’s economic, legislative and regulatory reforms. According to the IMF, prospects for economic growth have risen to near 4% in 2014-15 due to overhauls, including cuts to fuel subsidies and attempts to fix persistent government budget deficits. The government put a freeze on capital gains tax to push investment forward. A
new civil service law has also been passed aiming at decreasing bureaucracy and increasing efficiency by changing the criteria of evaluating performance and promotions in accordance with skills and qualifications rather than seniority and years of service.

The country is currently developing massive infrastructure projects, such as the expansion of the Suez Canal, and the launch of an associated industrial and logistics hub that will encourage growth in the Suez Canal development axis.

According to the UNCTAD 2014 World Investment Report, Egypt is one of the top five African countries in terms of attracting FDI which comes mainly from the EU, the United States and the Arab countries. The UK is the largest investor in Egypt. FDI is concentrated in the oil sector, followed by the construction, telecommunications, financial services and health care sectors.

The government has established special economic zones that operate under a special law. Special economic zones enjoy autonomy since they are governed by an independent general authority which means they are relatively free from bureaucracy. In addition, projects inside such zones are exempted from sales taxes and customs fees and are subject to a flat rate corporate income tax of only 10%. One of such zones is in the Suez Canal development axis whereas several others are targeted mainly in Upper Egypt for development by private investors. Land in industrial zones in Upper Egypt is offered free of charge.

Some government measures that have been put in place to restrict companies from transferring more than US$ 100,000 out of Egypt without a valid commercial purpose, original documentation, and approval by the Central Bank of Egypt have been reported by investors to have a negative impact on industrial and trade activities which could negatively affect in-flow of FDI. Another negative factor is fluctuating policies and legislation. For example, corporate tax in SEZs has been increased from its original 10% to 20% which had a negative impact on investors who had made their business plans and investment decisions based on the initial tax level.

However, there are two main reasons that stand in the way of large scale FDI and sustainable economic growth. The first is Egypt’s regulatory environment, which makes it difficult for entrepreneurs to start businesses and create jobs. For example, it takes several months to get a construction permit in Egypt and it could several years in court to enforce a contract or agreement. The second is corruption, which drives away serious investments and would eventually hinder economic growth and confine any gains to a minority of elites.

3.2.3 Human Capital and Education

Section 3.1.7 has given an account of the status of Human Capital and education in Egypt. The current section will give an overview of new policy trends targeted to preserve human capital and to enhance the quality of education and human resources development.

One the major changes that has happened in the last two years is the creation of the Presidential council Education and Scientific Research among other presidential councils. This council has
conducted an exhaustive study in order to formulate a new law for higher education that is intended to resolve chronic issues of the higher education system in Egypt and lead to a significant boost in the performance of this system and the quality of its output. The new proposed law is still in the very early draft phase. The main proposed changes are rationalizing the free University education system such that University education becomes free of charge only for students performing above a certain level. In addition, Faculty staff should be hired based on hiring requests and on renewable contractual basis depending upon their performance.

Another initiative that has already been launched by the presidential council is a new “Egyptian Knowledge Bank” which is a huge knowledge database accessible not only by researchers and academics but by everyone and is populated with a wide spectrum of books, publications, periodicals, journals, magazines, etc. This project is intended to support students, researchers and academics in their work and also to raise the knowledge and cultural level of the whole society. This knowledge bank is claimed by the presidential council to be the biggest digital library in the world.

The ministry of education is launching a new strategy, however, the detailed plans are not really clear and strategic objectives seem to be very generic and high level.

Finally, it is to be emphasized that human capital is the primary input for any innovation system and the quality of education is one of the most important factors in determining the quality of the available human capital. In fact, most countries increasingly recognize talent as a vital source of competitive advantage and thus have made education and training a core component of their innovation strategies.

Egypt does not have until now clear strategies, policies and plans to uplift its education system from its highly negative situation. Nor does the government has any significant strategies, policies or plans to limit or reverse the huge brain drain the country is suffering from. This remains to be one of the biggest areas of development to create an effective national innovation system.

### 3.2.4 Domestic Technology Transfer: Academia/Research - Industry Relations

The relation between academia and research on one side and industry on the other side has been governed for long time by the lack of policies that incentivize research staff and university faculty to conduct research and development in collaboration with the local industry and a lack of confidence in local R&D abilities shown by industrial firms. In fact, according to the current law that governs the promotion of University and research centers staff, they are only incentivized for publications in journals and conferences without any regard to the value of such publications to the local communities or to the country.
In addition, the current laws do not provide financial incentive to faculty staff and research personnel for conducting research and transferring know-how and technology to the industry in a formal manner under the umbrella of their home institutions. This is due to the lack of IP and technology transfer policies in most government Universities and R&D centers. As mentioned earlier, technology transfer policies in developed countries have evolved to allow financial benefit to research and faculty staff of government institutions through royalty-sharing with their home organizations as well as having equity ownership in spin-off companies in an official manner.

In Egypt, however, industrial firms resort in many cases to University or research centers staff on an individual basis as experts to help them solve problems that face them in development and production. In other cases, some faculty or research staff have succeeded to establish their own companies based on technologies or IP developed during their work or coming out of theses work of their graduate students without regard to the rights of their Universities or institutions since such institutions don’t have specific technology or IP licensing policies and they don’t monitor such events.

As mentioned before, the ICT industry has taken the lead in such domain through ITIDA which has launched the Information Technology Academia Collaboration program (ITAC) in 2006 and has been running successfully up till now. However, the ITAC program has recently modified its funding policy requiring funded companies to return part of the funds they have received once they have successfully commercialized their products.

As previously mentioned, ASRT has also launched a few years ago a network of technology transfer offices in a large number of Egyptian Universities. In addition to facilitating technology transfer, these offices have the mandate to stimulate their host institutions to develop policies for technology and IP licensing and to educate staff members on issues related to technology commercialization and IP rights management and protection.

Some universities and research centers have started initiatives to incentivize their staff to work with the local industry. In 2009 Mansoura University decided to allocate an annual fund of EGP 2M to fund scientists working with the industry.

Finally, one of the most negative aspects related to technology transfer in Egypt is the funding policy of the STDF which is the major governmental funding agency in Egypt. According to the STDF’s internal policy, the STDF retains majority ownership rights to IP and technologies developed under projects funded by the STDF. This is a situation similar to what has been prevailing in the US and other countries before the Bayh-Dole act of 1980 which had very negative influence on the impact of technology transfer on economic growth.

### 3.3 Innovation Policies in Key Government Institutions

The three key ministries actively involved in developing policies and programs for innovation are The ministry of Higher Education and Scientific Research (MoHESR), The Ministry of...
Communications and Information Technology (MCIT) and the Ministry of Industry and Foreign Trade (MoIFT).

The MoHESR has just released a new strategy for Science, Technology and Innovation [6]. This strategy has been developed taking into account the national strategy for sustainable development “Egypt's Vision 2030”. One of the main pillars of the new strategy is to update the higher education and scientific research laws based on new policies that have been outlined in the new strategy.

The new policy updates cover rules and guidelines for promoting research and faculty staff in different education and research institutes, new policies for IPR protection and management, policies and laws linking incentives and funding to performance KPIs of personnel and organizations, new laws to obligate governorates to have their local science and technology councils linking Universities and research institutes on one hand to the community and industry on the other hand, new law to encourage private sector firms to assign part of their profits to research and development, incentive mechanisms for research and faculty staff based on their research outcomes and achievements, new policy to enable professors and research to establish their own companies and work for such companies for limited periods of time, and many other policies and laws targeted to promote innovation and technology transfer.

In addition, the new strategy stipulates changes in curricula to include educational programs and courses on entrepreneurship, professional ethics, intellectual property management, and promoting innovation culture and close collaboration with the industry and local communities.

Finally, the new strategy includes developing new standards for scientific research ethics and new mechanisms to promote and enforce such standards.

The MoIFT on the other hand maintains its policy of developing and expanding its network of technology transfer centers (ETTICs) through its Industrial Council for Technology and Innovation (ICTI). However, there is no clear plan for more integration and synergy with other components within the national innovation system, in particular TICOs.

Finally the MCIT has recently developed a strategy for innovation and entrepreneurship as one of 20 strategic pillars of the whole MCIT strategy. The vision of the innovation and entrepreneurship strategy pillar is “Providing a framework for developing a critical mass of innovation driven entrepreneurial startups to act as a driver for high level value jobs creation, attracting FDI, finding innovative solutions to Egypt's socio economic problems and contributing to the economic value added in Egypt”.

The above vision is to be achieved through the following programs and mechanisms:

- Capacity Building through Education and Training
- Developing Innovation Clusters
- Establishing and Growing Angel and VC Funding
- Establishing Outreach and Partnership Programs
- Promoting Social Innovation and Entrepreneurship
- Developing Innovation and IPR Management Systems in SMEs
In addition to the above, there are other strategic pillars that directly serve innovation such as the “e-Signature”, “Broadband”, “Digital Society” and “Technology Parks” strategy pillars which all contribute to building the physical infrastructure necessary for innovation. In this regard, MCIT has put the following strategic objectives:

- Activate and promote the use of e-Signature technology nationwide deploying the digital identity which will be the cornerstone of the digital society.

- Implement a national Broadband plan that aims at the diffusion of Broadband services in Egypt by fostering the supply (Networks) and demand (Services) sides through a mixture of regulatory and investment packages. The objective is to increase households fixed Broadband coverage to 90%. Moreover it is targeted to reach 90% population mobile coverage through 4G or 5G.

- Building an ICT ecosystem that helps realize the digital society and supports the enhancement of the efficiency and transparency of internal government operations and the ubiquitous availability of quality e-services to all citizens and businesses. A national digital platform will be developed to ensure the seamless integration among different governmental systems and databases as well as the openness to beneficial services that private business might offer.

- Establish the needed technology parks ecosystem to create a distinctive atmosphere to encourage investment and strengthen the global position of Egypt worldwide and raise its competitiveness & exports, also to support community and economic development in the Governorates. The objective is to develop 7 technology parks across different regions of Egypt with 2 parks to be launched in 2016.

Finally, the MCIT strategy addresses human development by playing a catalyst and enabler role in improving the human capital that would help to further position Egypt as an ICT hub. This is achieved through several mechanisms, the most important of which is to build and manage an e-delivery platform for capacity building and establish a coordination center for ICT skills development.

4 The Way Forward: Recommendations

4.1 Institutional Reform : A Policy of Integration

As discussed earlier, developing a national policy for innovation requires closely examining the country’s existing innovation system and proposing recommendations or policies related to the structure of the system itself and its focus or scope before embarking on developing policies related to boosting the performance of the system itself. This section will focus on policy recommendations related to the structure of the innovation system whereas section 4.2 will focus on policies related to boosting the performance of the system.
Egypt’s innovation system is characterized by fragmentation of key innovation responsibilities across different ministries or agencies with little or no coordination. This has very adverse effects on the effectiveness of the whole innovation system. This is true for innovation responsibilities related to goals, strategies, policies and plans as well as to research and development. In this regard, we believe the way forward should take into account the following recommendations.

4.1.1 Creation of a National Innovation Council and Agency

Some countries have created innovation ministries like the “Science, Technology and Innovation ministry in Malaysia. However, this approach rarely proves successful as such ministry always remains surrounded by other more powerful ministries.

Instead, crosscutting innovation councils reporting directly to, or chaired by, top-level government officials such as the prime minister and supported by innovation agencies have been very successful as in Georgia, Kenya, Malaysia, Thailand and Vietnam [4]. The involvement of key innovation and innovation policy actors in this council, including successful national innovators and entrepreneurs living abroad is critical. The council should articulate visions, policies and strategies for innovation, whereas the innovation agency should have the mandate of translating high level visions and strategies in plans and programs in coordination with other governmental and non-governmental bodies as well as funding those plans and programs. In addition, these agencies work to promote to help firms develop their innovation capacity, especially manufacturers and SMEs, increase productivity by adopting best practices as well as best processes and technologies, training firms and entrepreneurs on innovation skills and competencies, promoting knowledge/technology transfer from universities and labs to the private sector, and helping link domestic firms into global supply chains.

Funding of the innovation agency could come from industrial firms above a certain size in terms of annual revenues by providing 1% of their annual profits to the agency.

4.1.2 Restructuring of Research and Technology Institutions

Again, the science, research and technology ecosystem in Egypt is characterized by fragmentation and disintegration. Research centers, institutes and labs are isolated and rarely collaborate even if they work in relevant fields. In many cases such entities don’t even know much about the capabilities, resources and activities of other entities, which hinders possibilities of collaboration and dissemination of knowledge.

Transforming such Science and Research ecosystem into a more integrated one is key for the establishment of an effective NIS. Mega structures such as the National Research Center and even Zewail City should be spread over the country in integrated networks. For example, the NRC and other government labs such as the Electronics Research Institutes (ERI), should have affiliate labs in different Universities across the country. Such affiliate labs will have University staff resources as well as institute resources working together and receive budgets from their
Universities as well as from institute. The strategy and research activities will be defined according to a national plan coordinated by government institutes and whose objectives are inline with the country’s priorities. This will create effective networks in different disciplines working in harmony and integration as part of the national innovation system specially that University staff represent a very big critical mass (accounting for the majority of research personnel in Egypt) which is not efficiently integrated within the scientific research community. This is the model of the French National Scientific Research Center (CNRS).

4.1.3 Linking TICOs and ETTICs

One of the main points of strength in Egypt’s innovation ecosystem is the presence of two networks of technology transfer centers. Even if such centers are not mature enough, the mere existence of such two networks is an advantage. It is very important to develop TICOs and ETTICs and integrate them into one network with tight coordination and collaboration between them. Enforcing a tight relationship between these two networks of tech transfer centers will provide a unique foundation for an efficient and effective NIS that could be a very strong feature of Egypt’s innovation system. The idea is not only to link those centers on the operational level to support innovation but also through regular executive review meetings to update the vision and strategy and to monitor progress. One of the most important objectives of such integration is to link each ETTIC into one network with a number of centers of excellence of relevant expertise in different Universities through the respective TICOs of such Universities.

4.1.4 Initiation of Export Innovation Clusters

Innovation is a crucial driving force of advanced world economies in the sense that it is regarded as the main driving factor behind competitiveness and productivity. Michael Porter has produced a series of work on the relationship between clustering and innovation. In his early work [30], he defined clusters as “geographical concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries and associated institutions (for example universities, standards agencies, and trade associations) in particular fields that compete but also cooperate.

In his more recent work, Porter [31] argued that it is primarily export oriented clusters that drive prosperity. Exporting clusters contribute to raising the standard of living of a community much more than those purely serving local markets. This has changed the concept of a cluster as being a localized agglomeration of entities since export clusters tend to have both national and international linkages than to be based on purely local connections.

Consequently, Egypt’s cluster strategy should focus on policies to create export oriented clusters. In fact, the ICT community in Egypt is a good example of such a cluster where there is localized agglomeration to a certain extent, however, the main strategy was to create an export oriented ICT industry. In this regard, several actions should be adopted with different clusters to incentivize and enable exports:
- Transform traditional industry agglomerations into innovation clusters by developing programs that link them with centers of excellence and knowledge generation centers
- Promotion of clusters’ social capital through programs favoring and encouraging creation of networks, consortia, research and business partnerships and networks.
- Incentivize exports through export rebate programs or export based tax incentives
- Support business development and marketing activities of clusters to enable them to access international markets
- Develop offset programs to obligate international suppliers/providers in governmental contracts to allocate a percentage of their contracts to local clusters
- Demand pull or creation by public procurement
- Enable development and manufacturing capabilities of clusters to operate according to world class quality standards and helping firms to acquire certification of relevant standards
- Take advantage of regional and Arab markets

### 4.1.5 Building a Comprehensive Innovation System

To build a successful and effective innovation system that can have a significant positive impact on a country’s economy it has to do two major things:

- **Focus on innovation in all industries.** Establishing an inclusive and integrated productivity and innovation capacity of all of a country’s sectors is more important and will lead to better results than developing a few industries based on advanced technologies and state-of-the-art scientific research. This means fostering existing domestic innovation capabilities including in traditional sectors such as agriculture, food, textile, energy. Therefore, building an innovation system is not about launching mega cities of advanced R&D or innovation parks in state-of-the-art technologies, it is rather about transforming existing industries into successful innovation clusters. This does not mean not entering into new and advanced technology fields but rather adopting a balanced mix between the two.

- **Support all types and phases of innovation.** An innovation system and the associated policies should not only focus on all industries, it should also address all points of the innovation value chain. For the reality is that innovations can arise at any specific point in the development process which starts with product definition then R&D, production, and marketing, sales and even the consumer use model of the product. Yet one of the biggest mistakes to define innovation too narrowly, focusing mainly on developing and manufacturing processes of high-tech products.
It is to be noted that the existence of an overarching national innovation council supported by a national innovation agency is the only way to enforce a policy of mainstreaming science, technology, and innovation across all sectors of the economy.

### 4.2 Effective Innovation Policies for Growth

Providing recommendations for new or updated innovation policies require a close examination of Egypt’s NIS and its current policies and addressing all levels of the four-layer pyramid of Figure 2. As discussed earlier, the most difficult level to address is the bottom one which relates to framework conditions. Addressing this level requires a very strong political will at the highest level of the country. This implies putting in place policies and legislation to fight corruption and to ensure the rule of law and protection of property including intellectual property. This also requires maintaining stable policies and legislation specially those related to the investment world and doing business in the country. Frequent changes of tax laws, incentive mechanisms and investment policies will undermine all efforts to promote attraction of FDI and innovation.

In fact, Padilla-Pérez and Gaudin [32] identify the lack of political will to support innovation policies and frequent institutional changes and lack of long-term planning as the top 2 among 8 barriers of innovation in Central America (same barriers are likely to apply to many developing economies including Egypt). The remaining 6 barriers are: modest government support for STI; insufficient enforcement of institutions to promote innovations, such as intellectual property rights and competition; lack of coordination among government agencies and policies; a lack of absorptive capacity and weak educational system; difficulties in financing STI; and a lack of policy evaluations. Addressing all level of the four layer pyramid require a look at the framework of the global innovation index (see Figure 6) which allows a more detailed a look at the different factors affecting the innovation process.

![Figure 6: Framework of the Global Innovation Index [4]](image)
The remaining sections will provide policy recommendations related to the most important aspects of innovation from the perspective of Egypt’s national innovation system.

4.2.1 IP Management and Protection

As mentioned earlier, despite efforts by the government in the last decade or more to improve the situation of IP management and protection, Egypt’s ranking has significantly dropped in the recent years. In order to foster better capacity for innovation, technology transfer and ability to attract FDI, several avenues must be pursued for IP management and protection.

Enforcing IP rights and fighting local and smuggled counterfeit products should be strongly emphasized through policies, laws, increasing public awareness, and highly aggressive enforcement of the law.

- Empowering customs agents with the proper legal authority to prevent and interdict illicit goods in transit through Egypt.
- Conducting awareness and training workshops for customs agents on counterfeit and illicit products
- Providing incentives for customs agents to capture and interdict illicit products
- Increasing legal penalties for those involved in trafficking and distribution of counterfeit products.
- Launching regular campaigns to capture illicit products on the market.
- Launching regular campaigns to capture pirated software
- Increasing legal penalties for entertainment and business software piracy and aggressively enforcing such penalties
- Empowering IPR enforcers by providing training to judiciary and other enforcement agencies
- Establishing programs to subsidize certain categories of software for start-ups and entrepreneurs as well as for research and education purposes.
- Putting objectives to enhance the efficiency of the judicial system especially economic courts in order to significantly cut down the litigation time
- Enforcing confidentiality of information in governmental agencies by adopting measures to protect data submitted to obtain license approvals or marketing approvals for certain products.
- Adopt a new price control system for pharmaceutical products in a way to improve pharmaceutical industry’s ability to develop and introduce innovative products to the markets.
- Establishing a more efficient system and procedure for market authorization process for new medicines especially those having FDA approval. In fact, Egypt has signed an international agreement to limit the registration time of FDA approved drugs to 120 days.
- Restructuring of the patent registration office into an autonomous agency and build
human capacity towards building administrative and legal capacities to support IP and knowledge-based businesses, facilitate access to knowledge and information and facilitate a smooth and online patent application process.

- Establishing a new body, agency or ministry to harmonize IP management strategies, policies and laws across different disciplines and to manage IP protection

### 4.2.2 Technology Transfer

Promoting technology transfer and industry-academia collaboration should be one of the highest priority actions as a cornerstone for any innovation system. This should be achieved through a four dimension approach. These 4 dimensions are:

1. **Mission.** This involves a paradigm change where technology transfer should become a central part of the “mission” of Universities and government research institutes.

2. **Empowerment.** This requires providing Universities with the right legal infrastructure and the right resources to be able to succeed in their mission.

3. **Accountability.** This is very important as it requires a significant change in the management system and methodology of most Universities and research institutes where top management becomes accountable for achieving clear technology transfer objectives and should report on quarterly basis on the achievement of such objectives. This also involves accountability of research staff in achieving technology transfer goals of the institution and the reflection of their performance in this regard on their career promotion and financial reward.

4. **Reward.** Where there is accountability, there should be reward. This involves reward to institutions as well as personnel based on their success in achieving their goals.

The following recommendations are targeted to promote technology transfer based on the above four-dimension approach.

Redefining the role and mission of Universities and research institutes as major agents of technology transfer. This should also emphasize accountability where such institutions have to report on their technology transfer activities as well as on the utilization of funds in this regard.

Establishing IP and technology licensing and transfer policies at the institution level in all Egyptian research centers and Universities.

- Expand and develop TICOs network to include all relevant Egyptian Universities and research institutes
- Strengthen TICOs by enabling them to attract high caliber staff through incentives and rewards to TICOs staff as well as promotion of their career based on their activities and achievements within TICOs.

Establish policies and systems in universities and research institutions to ensure all innovation, patents, and industry related activities pass through official channels to preserve the rights of the home organization.
Vesting the IP rights of government-funded research with the university or research institution and their staff.

Drive towards a new management system at Universities and research institutes with clear accountability of management staff as to achieving clear technology transfer strategies, goals and targets. Accountability should trickle down to individual staff members where their performance and financial compensation and reward becomes clearly affected by their performance in terms of technology transfer. Incentivize universities that participate in the innovation process through IP licensing and technology transfer.

- Introduce policies and legislation to allow universities, academics and research staff to establish and manage start-ups and own equity in them
- Change promotion policy of academics and research staff to credit them for technology transfer and industry collaboration activities as well as patents
- Providing funding for universities to establish incubators and technology parks
- Encouraging Universities to specialize and build on their strengths in terms of research and technology.
- Encouraging universities and government research institutes to conduct technology marketing and commercialization activities including presentations at conferences, workshops and exhibitions targeted to the industry and organization of such events.

4.2.3 Education and Human Capital

This section provides recommendations to enhance human capital through education, cultural change, brain drain containment / reversal and leveraging Egyptian expats.

4.2.3.1 Strengthening elementary education

- Build more schools to reduce the density of students in classes to international standards
- Support STEM education by establishing STEM schools across Egypt.
- Encourage, companies, investors, professionals, foundations, and nonprofits to build STEM schools and support STEM education through tax incentives and credits
- Training teachers and administrators to use technology in the classroom and guiding students through critical thinking and analysis.
- Enhance salaries and benefits of educators
- Launch programs to develop skills of educators and teachers in teaching methodologies using new technologies and in innovation and entrepreneurship practices.
- Adopt policies to incentivize good schools and good teachers who foster innovation and entrepreneurship and link salaries of educators to their performance.
4.2.3.2  Foster a culture of innovation

- Adopt policy to foster a culture of entrepreneurship and teaching business and entrepreneurship principles at both the high school and college levels because entrepreneurship is more than just talent.
- Create a can-do culture where the students in high schools and universities feel able to experiment, innovate and “make mistakes”.
- Encourage development of educational software and educational content for all levels of education.
- Incentivize students to enroll in science and mathematics section at the secondary school level.
- Launch presidential sponsored events which celebrates student winners of math, science, and robotics competitions to be attended by the president.
- Launch innovation competitions or fairs where students and adults accessing the tools and skills necessary to design and make just about anything can showcase their innovations.

4.2.3.3  Reforming the university education system

- Launch a new system for University admission where students would sit entrance exams in the discipline they were hoping to study at university, in addition to sitting the nationwide exam, and the scores from both will count as well as their performance at secondary school.
- Establish new guidelines for membership of promotion committees of University and research institutions staff that emphasize innovation and industry related experience rather than pure academic background.
- Adopt policies linking funding of universities to their performance KPIs in education, research and innovation within their communities.
- Adopt strategies to enhance PhD education through new schemes of doctoral research that promote industrial research through performing research in a real-time industry environment.

4.2.3.4  Technical and vocational education and training

- Employer engagement in workforce development should be promoted and institutionalized through appropriate legislation. For example, the establishment of sector-based Enterprise TVET Partnerships (ETPs), company-based technical schools and civil society led training initiatives should be supported institutionally and financially.
- The promotion of close inter-linkages between TVET providers and employers, regardless whether the TVET providers are publicly or privately funded.
- Expand developing employer-driven packages of training and training related in TVET institutions.
- Develop an integrated system for quality assurance and certification of TVET.
• Create more technical, industrial and vocational education training institutions; and move to business friendly educational programmes.

It is to be noted that many of the recommendations related to TVET have been highlighted in earlier reports such as the Policy Brief related to TVET [16] and Egypt's Human Development report [23].

4.2.3.5 Leverage Egyptian expats

• Change the government and public mindset as to their perception of the value of Egyptian expatriates as a source of hard currency to recognize them as a valuable human capital asset that needs to be leveraged and reintegrated back in their home country.

Establish mechanisms and programs to attract and fund foreign expats to establish start-ups in Egypt, work in existing Egyptian companies, Universities and research institutes.

4.2.4 Physical and ICT Infrastructure

Proper physical and ICT infrastructure is crucial for an effective innovation system and for efficient implementation of government policies. For example, it is very difficult to curb down corruption and to speed up different government processes without good proliferation of e-government services. Also, it is impossible to grow on-line activities whether administrative or business with proper infrastructure for e-signature. In this regard, the following recommendations are of high priority:

• Provide seed funding to Universities to establish incubators and innovation parks
• Develop, announce and implement a plan to establish special economic zones across Egypt for manufacturing, packaging and services activities
• Keep the price of capital ICT and technology goods imports low through low customs and sales taxes on such goods
• Incentivize development of local content requirements for capital goods and ICT goods again through lower taxes
• Promote the development of advanced wireless telecommunications networks and high-speed broadband networks and ensure their availability in different regions across Egypt at affordable prices
• Promote development of digital infrastructure in the form of a range of ICT applications, from intelligent transportation systems and mobile payments to health IT, digital signatures, and e-government.

4.2.5 Scientific Research

This section provides recommendation to enhance the quality of scientific research and to link it to the community and to industry. The following are the main recommendations in this regard:
Introduce policies for highly rewarding applied research and applied patents with validated industry impact through financial awards.

Adopt policies to link graduation project and all graduate studies degrees theses to industrial and community problems.

Implement modified funding policies of research and innovative start-up and industrial firms with less bureaucratic constraints.

Strengthening R&D in Universities and Research Centers

Increase government spending on R&D programs and grants

Adopt policies and legislation supporting research in private sector companies, such as tax credit for R&D, deduction of R&D and patent costs from tax and export rebate can be excellent tools to support and encourage R&D within private sector companies.

Introduce new flexible procurement laws for Universities and research institutes and allowing direct procurement of equipment and materials from outside the country.

Implement policies to support small and medium-sized enterprises (SMEs) through programmes to help those SMEs boost their innovation capacity.

Adopt policies and legislation to allow Universities, research institutes and their personnel to establish, manage (2 years leave for personnel without being penalized in their career) and own equity in technology companies based on their research outcomes.

Introduce new laws to exempt Universities and research institutes from tax on IP and technology licensing and to exempt technology start-ups from taxes on revenue for 5 years following inception.

Assessment of the local content of a product has to take into account intangible R&D and design component. This will stimulate companies to increase their indigenous product development.

4.2.6 Foreign Direct Investment

The most important factors that facilitate the growth of FDI are related to framework conditions followed by policies and incentive programs. Making the right framework conditions prevail is highly dependent on a strong political will and strong awareness at all government levels of the importance of making this happen. Figure 7 is a replication of Figure 2 with an added fifth foundational layer dedicated to political will and government awareness of the importance of innovation to the sustained development of the country.
Based on the above, the most important recommendations required to promote the attraction of FDI are:

- Ensure the rule of law.
- Enhance the effectiveness of the judicial system to ensure swift court proceedings and ruling specially in economic courts.
- Launch a strong campaign to curb down corruption in all government activities specially related to investors.
- Ensure stability of government policies and legislation especially those related to investment.
- Respect the initial law of SEZs by returning corporate tax to its initial 10% value.
- Leverage international bids through an offset program that ensures international bidders would subcontract a significant part of the bid to local suppliers or resort to establishing local development and/or manufacturing operations.
- Adopt policies to limit regulations related to firm downsizing, closure and bankruptcy for if entrepreneurs/investors cannot easily close or downsize businesses and if investors cannot obtain reasonable capital recovery rates, the incentive for investment is greatly reduced.
- Adopt policies, systems and regulations to ensure ease of starting a business compared to world standards.
- Speeding up the implementation of electronic government to substantially reduce the need for dealing with bureaucracy.
- Build state-of-the-art infrastructure in innovation parks and SEZs to attract FDI.
- Ease restrictions on foreign currency transfer and international procurement.

4.2.7 Social Innovation

Fighting poverty as well as social issues that have emerged in the last decades and that are associated with increased population and unemployment in slum residential areas as well poor rural areas especially in upper Egypt, is crucial for maintaining social and political stability and sustained development. Innovation is the best approach to solve such problems and to guarantee proper education, healthcare and adequate jobs for everyone. According the national human development report [33], Egypt is way behind other middle income countries, let alone emerging economies, in raising basic standards of health, nutrition and education of the most vulnerable members of its population, namely children and youth.

In this regard, innovation is defined as the use of knowledge and know-how to create social developmental value. Among the most important recommendations are:
• Adopt policies and deploy new educational methodologies and systems as well as cultural plans and campaigns through different media outlets and different cultural authorities and organizations to develop the right culture based on accepting and respecting others irrespective of their religious beliefs, social background, race, color and gender.
• Fund studies to identify social problems and prioritize them in terms of their importance and severity and propose solutions to them.
• Encourage the development of centers of excellence, think tanks and NGOs concerned with social innovation in specific poor and slum areas as well as rural areas specially on upper Egypt.
• Provide seed funding for micro-credit projects and programs supporting value creation and entrepreneurship inside poor and slum areas as well as rural areas specially in upper Egypt.
• Develop programs to incentivize and reward social innovation addressing poverty and other social problems.
• Develop policies and plans to provide quality education to everyone. Education is the main defensive action against intergenerational transmission of poverty.
• Adopt policies to curb down corruption at all levels
• Adopt crowd sourcing approaches for solving national and social problems
• Adopt policies to ensure equitable wealth distribution such as adopting new systems for subsidies that ensure they reach the needy rather than everyone.
• Adopt policies to stop migration from rural areas to slum areas in big cities accompanied with programs to develop such rural areas.
• Fight leakage from the basic education system preferably via the targeting of rural poor who have been shown to have the highest rates of attrition from the school system.
• Allocate “Project Lands” to youth in Upper Egypt along the desert corridor adjacent to the Nile Valley (Zaheer Sahrawi) to engage in housing projects, as well as SMEs that cater for goods and services for the urbanizing communities of Egypt’s southern region [33].
• Adopt severe measures to enforce the law against sexual harassment
• Develop a monitoring, evaluation and accountability framework for gender equality policies, procedures, processes as well the degree of enforcement of related laws.

4.2.8 Institutional and Public Sector Innovation

There is no doubt that Egyptian governmental and public-sector institutions are in direct need for innovation to address accumulated issues over the past decades that have led to decreased efficiency and crippled performance.

In fact, without reforming these institutions, the ability of the private sector and that of the whole country to innovate will be hindered. The main challenge here will be to build on the current institutions more than creating new ones. Therefore, institutional innovation is needed both to
increase the efficiency of government bodies and to create a better environment for innovation for the private sector and the civil society.

It is beyond the scope of this study to provide recommendations targeting comprehensive reform of the Egyptian bureaucratic system, however, we will try to list below some recommendations that may contribute to making this system more efficient and effective:

- Adopt policies of paying for results rather than paying for inputs when it comes to funding companies.
- Adopt private-sector best practices for active recruiting of top talent into government.
- Tapping the creativity of the people through crowd sourcing to solve problems using public rewards.
- Bring entrepreneurs and world-class experts into government institutions.
- Expand on-line services deployment across different government departments and organizations and adopt best practices for designing, building, and deploying such services.
- Institutions may be ‘hard’ formal ones such as laws and regulations, or they may be ‘soft’ informal ones, characterized by rules shaping social behavior. The latter may exist in a society even when legally binding rules are not in place.
- Promote a very clear new agenda for a rigorous anti-corruption campaign involving swift, transparent and public application of the law.
- Decrease points of contact between citizens and government in order to get rid of the widely spread corruption in services provided to the citizens.
5 Summary

Innovation has been identified by all developed countries and most developing ones to be the major path towards economic growth, sustainable development and social stability. Egypt has not fully embraced this vision; in fact, recent years have witnessed some regression in the awareness of the government and its commitment towards creating an efficient and comprehensive innovation system. It seems that the current government is focusing on mega projects as a tool to lift up the country’s economic position. Although such projects could be beneficial to the country’s economy, they cannot be see as a holistic approach for sustainable development and prosperity.

This report focuses on new policy recommendations to promote innovation with special emphasis on IP and technology transfer as a corner stone for innovation. However, the report has also adopted a holistic approach by addressing policies related to innovation in other areas since innovation is an integrated process that cannot be reduced to the generation, protection and management of knowledge and technology.

One of the most important areas of focus of this study has been education and human capital development which is regarded as one of the most important inputs to the innovation process and the main pillar of any innovation system. A comprehensive upgrade of the national education system is not only crucial for innovation but also for eradication of poverty and maintaining social and political stability of the country as well as sustainable development.

The report has also touched on other pillars and inputs of the innovation system and provided policy recommendations for some of them such as scientific research, funding for research and entrepreneurship, attraction of foreign direct investment as well as social and institutional innovation.

However, building an effective innovation system that ensures economic growth, sustainable development and social stability is highly dependent on several framework conditions such as culture and the rule of law. In this regard it is paramount to adopt an aggressive agenda to enforce the rule of law and eradicate corruption as a primary condition for a successful innovation system. Otherwise, all other efforts including putting in place the best policies and physical infrastructure will not yield significant results.

Finally, government awareness of the importance of putting in place proper innovation policies and the right innovation system as well as strong political will that translates into having the president himself championing these efforts are mandatory for success.

It is extremely important for Egypt to make innovation and the development of a robust innovation system as its top priority national objective.
6 References

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