Science, technology, innovation, and digitalization

by Khaled El-Sayed and Maged Ghoneima

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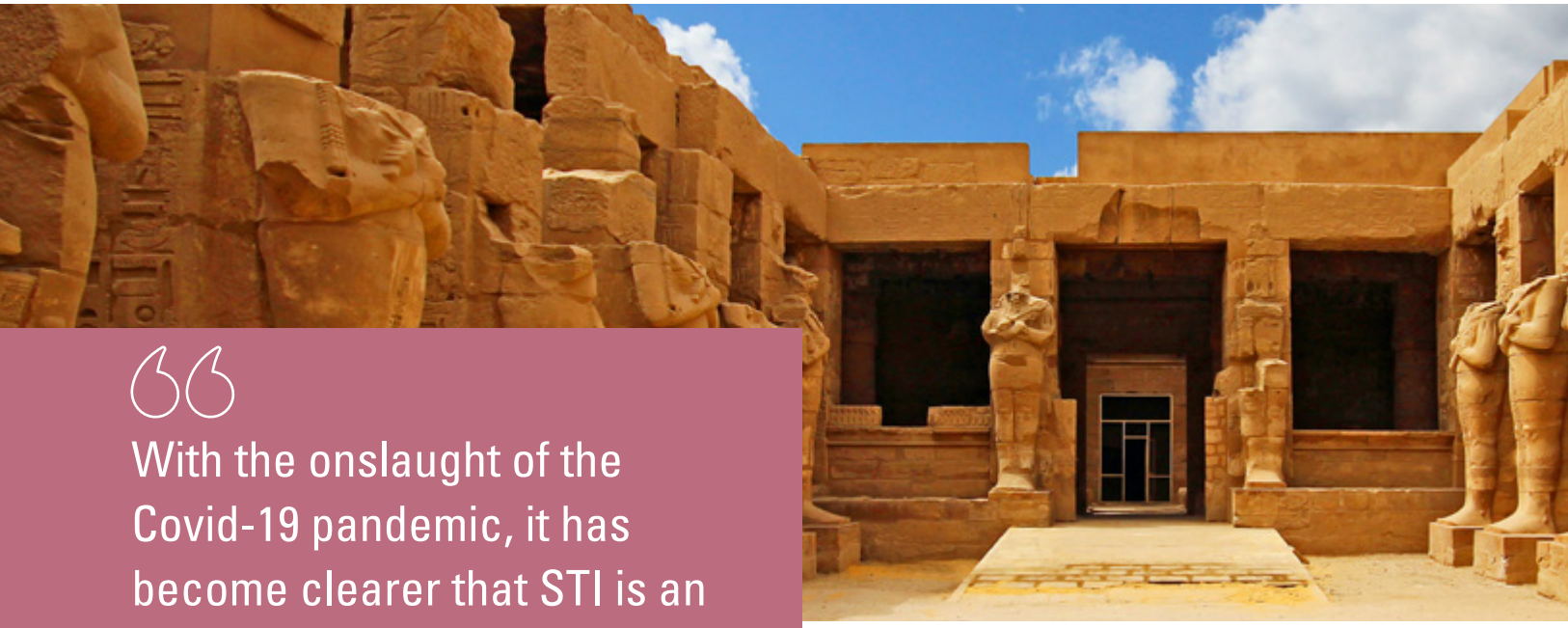
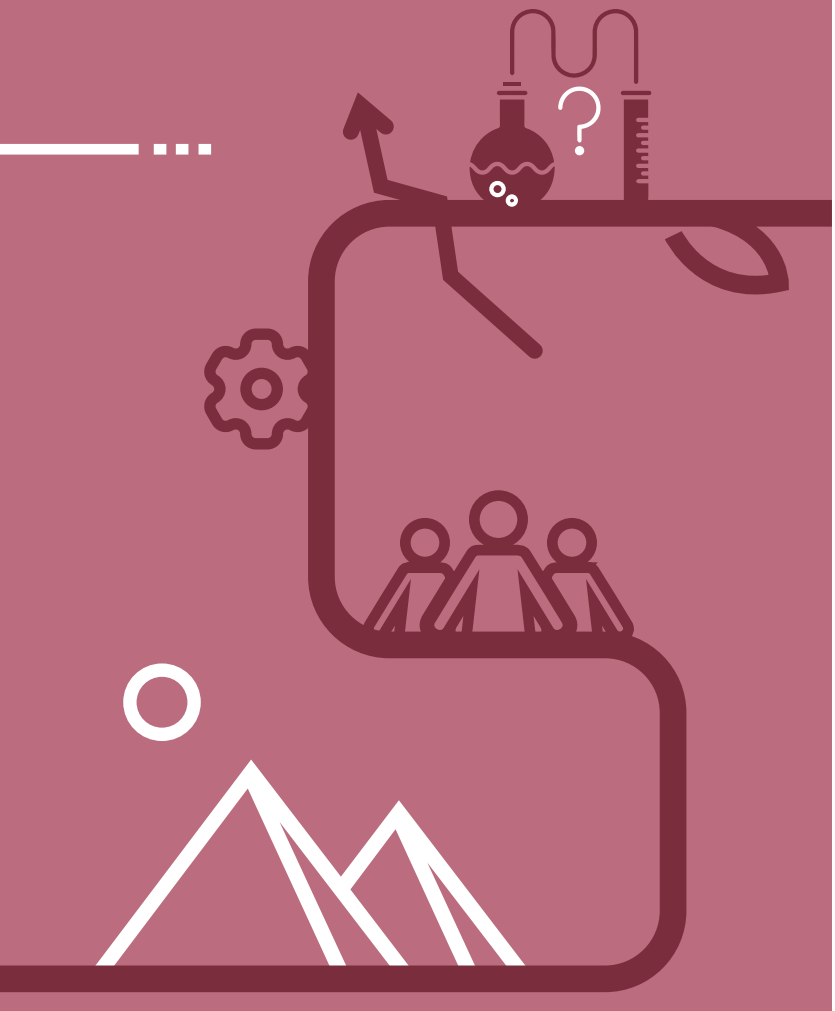


> With the onslaught of the Covid-19 pandemic, it has become clearer that STI is an essential tool for achieving the SDGs and is instrumental in building resilient societies.



Background

The role of science, technology and innovation (STI) has long been recognized as essential to achieving sustainable development. In fact, one of the shortfalls of the Millennium Development Goals (MDGs) was their limited emphasis on the role of STI in meeting their targets. Conversely, of the 169 targets of the 2030 Agenda, 48 directly relate to STI, with technological innovation also having a notable role to play in relation to the remaining targets. The Third International Conference on Financing for Development in 2015 recognized STI as one of its seven action areas stating that "appropriate incentives, […] harnessing the potential of science, technology and innovation, closing technology gaps and scaling up capacity-building at all levels are essential for the shift towards sustainable development and poverty eradication".[1] With the global onslaught of the COVID-19 pandemic, it has become clearer that STI is an essential tool for achieving the SDGs and is instrumental in building resilient societies and reducing the likelihood of shock.

This is particularly true for developing nations, which already struggle to provide clear linkages between STI and the SDGS. They also face a unique set of challenges that require tailored and urgent interventions, including a lack of adequate funding, insufficient government commitment, unequal access to data and knowledge, inadequate ICT infrastructure, the need for further inclusion of marginalized and resource-constrained groups, and the importance of fostering frugal innovation.[2]

Egypt explicitly recognizes the role of STI and digitalization (STI+D) in achieving sustainable development at the national level. This is reflected in the Egypt Vision 2030, the most recent version of which identifies technology and innovation, digital transformation and data accessibility as enablers for achieving its goals. In its 2021 VNR, Egypt recognized the digital divide as one of the most pressing challenges facing the country in its efforts to achieve sustainable development. It also identifies information technology and digital transformation as a major catalyst for future national development endeavours.[3] ICT was selected in the second phase of the structural reform programme as one of three priority sectors for the coming four years, along with agriculture and manufacturing. Several national strategies and plans have been put into action that focus on unlocking the potential of STI+D to accelerate development efforts in Egypt.

This chapter discusses national efforts to embrace STI+D as a cornerstone of inclusive sustainable development and financing development. Accordingly, it is divided into three parts. Section A is diagnostic in nature, examining the current status of STI+D in Egypt in terms of resources, efforts and outputs. Section B investigates the reasons for the disconnect between the government efforts to advance STI+D and the results, which are lower than they should be. Section C provides policy recommendations to maximize the uptake and use of STI+D in Egypt. It is noteworthy that this chapter does not focus on STI+D in general but rather its use in supporting sustainable development efforts in Egypt, with a particular focus on its role as an area of action for FFD. The chapter should therefore serve as a starting point for a national dialogue on the importance of STI+D and its contribution towards financing and achieving sustainable and inclusive development at the national level.

A. Current status of science, technology, innovation and digitalization in Egypt

While the Third International Conference on Financing for Development does not provide quantitative targets for STI action areas, various indicators can be used to evaluate development in STI at the national level. Key among them is the annual WIPO Global Innovation Index (GII), which

measures the performance of every national economy using seven different STI-related pillars.

Egypt has been undergoing a commendable and relatively steady, if still below target, progression in its overall GII ranking, rising from 107th place (out of 128 countries) in 2016 to 94th place (out of 131 countries) in 2021. The sustainable development strategy of Egypt had originally targeted a global rank of 85th by the year 2020. Table 30 shows its rank in each of the seven GII pillars.

Considering score rather than rank, GII for Egypt has been narrowly fluctuating around an average of 27.5 out of 100 over the past ten years (2011 to 2020), with the lowest score of 24.2 in 2020 and a slight increase to 25.1 in 2021. The 2020 GII states that Egypt is one of eleven economics that were "performing below expectations for their level of development while before they were performing at expectations".[4]

Table 30. Ranking of Egypt in the 2020 Global Innovation Index

GII pillars	Egypt's rank	
	2020	2021
Institutions	115	↑ 114
Human capital and research	90	↓ 93
Infrastructure	99	↑ 92
Market sophistication	106	↑ 96
Business sophistication	103	↓106
Knowledge and technology outputs	65	↓ 70
Creative outputs	101	↓104
Overall	96	↑ 94

Source: Dutta, S. and others, eds. (2020). Global Innovation Index 2020: Who Will Finance Innovation? 13th ed. Geneva: World Intellectual Property Organization. Ithica, New York: Cornell University; Fontainebleau, France: European Institute of Business Administration; Geneva: World Intellectual Property Organization.

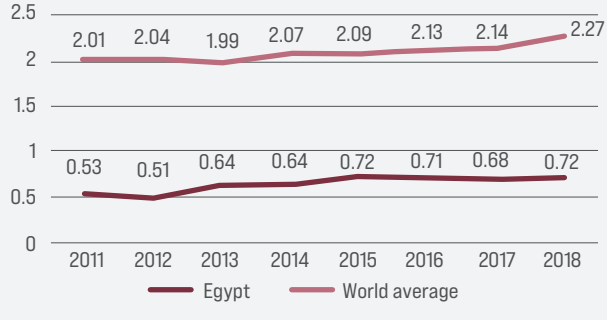
1. Resources dedicated to research and development

As a percentage of GDP, spending on research and development in Egypt has largely been steady over the past decade, remaining at approximately 0.7 per cent of GDP from 2015 to 2018, below the global average of around 2.2 per cent and slightly below the constitutional mandate of 1 per cent.

While expenditures on research and development remain stable but comparatively low, human resources dedicated to research and development in Egypt, such as the number of researchers and technicians, are relatively on par with several comparator countries, as shown in figure 135. While the number of researchers per million inhabitants in Egypt is markedly higher than the average for its income group of lower-middle-income countries, at 267.4 per million, it is still significantly below the 2017 global average of 1,207.1 per million.

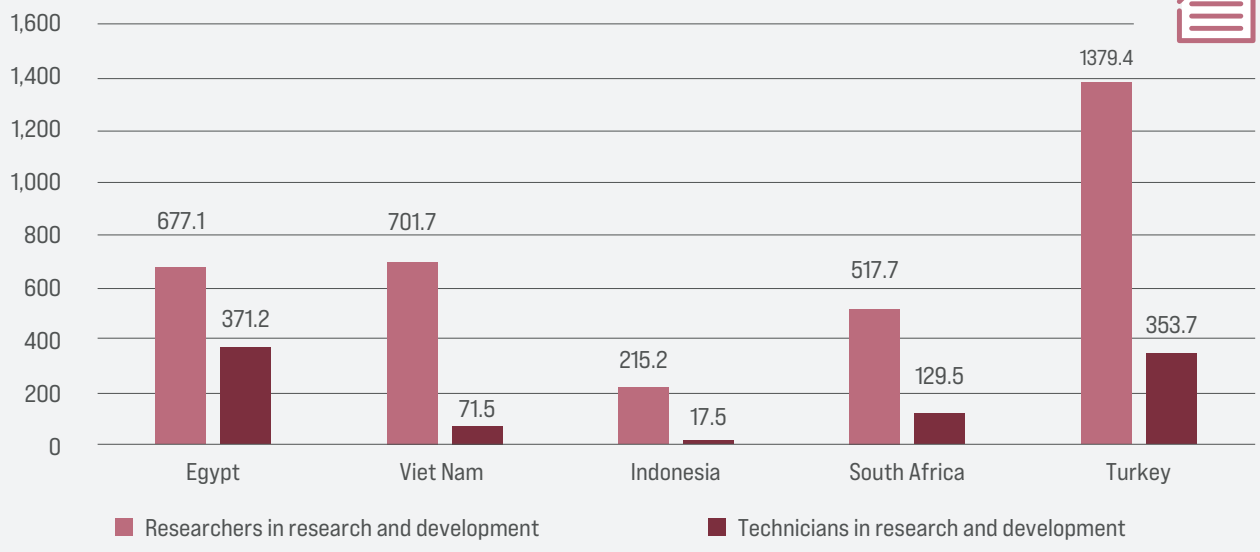
The notably large number of dedicated research and development researchers and technicians could be a result of the numerous public research centres in Egypt, the most prominent of which is the National Research Centre, which is considered the largest multidisciplinary research and development centre in Egypt. It had over 4,800 staff as at March 2021 and is dedicated to research in applied science and technology within the sectors of national priority. The Centre was established in 1956 and is under the purview of the Ministry of Higher Education and Scientific Research. Table 31 shows some of the public centres in Egypt.

Figure 134. Research and development expenditure, as a percentage of gross domestic product



Source: Authors, based on the UNESCO Institute for Statistics using data from the World Bank World Development Indicators database. Available from https://databank.worldbank.org/source/world-development-indicators. Accessed December 2021.

Figure 135. Researchers and technicians in research and development, per million people (2017)



Source: Authors, based on data from the UNESCO Institute for Statistics.

Table 31. Sample of public research and development centres in Egypt

Established in:	Research staff:	Research areas include:
National Research Centre		
1956	4,800	Circuits, cloud computing, automation, satellites, renewable energy
Electronics Research Institute		
1989	215	Circuits, cloud computing, automation, satellites, renewable energy
Theodor Bilharz Research Institute		
1964	482 + (a 300-bed hospital)	Tropical medicine, immunology, biochemistry
National Institute for Oceanography and Fisheries		
1924	558	Sustainable fishing and fish farming, combatting pollutants of the marine environment
Egyptian Petroleum Research Institute		
1974	430	Petrochemicals, efficient use of concentrates, nanotechnology, petroleum replacements
National Research Institute of Astronomy and Geophysics		
1903	321	Exploratory geophysics, earthquake monitoring, astronomy
Agricultural Research Center		
--	--	Precision farming, biotechnology, agriculture production development, GMOs

Source: Authors, based on data from the Council of Research Centers and Institutes, Egypt.

Note: Staff data as at January 2021.

With the exception of the Agricultural Research Center, which is affiliated with the Ministry of Agriculture and Land Reclamation, the rest of the centres in table 31 are under the supervision of the Ministry of Higher Education and Scientific Research, which supervises at least 11 research and development centres and institutes with a combined research staff of over 7,300 researchers and professors. There are also an estimated 13 other research and development centres under different ministries and a plethora of centres affiliated with public universities.[5] For a simple point of reference, the Faculty of Engineering at Cairo University alone has 15 research and development centres.[6]

2. Scientific and technological output

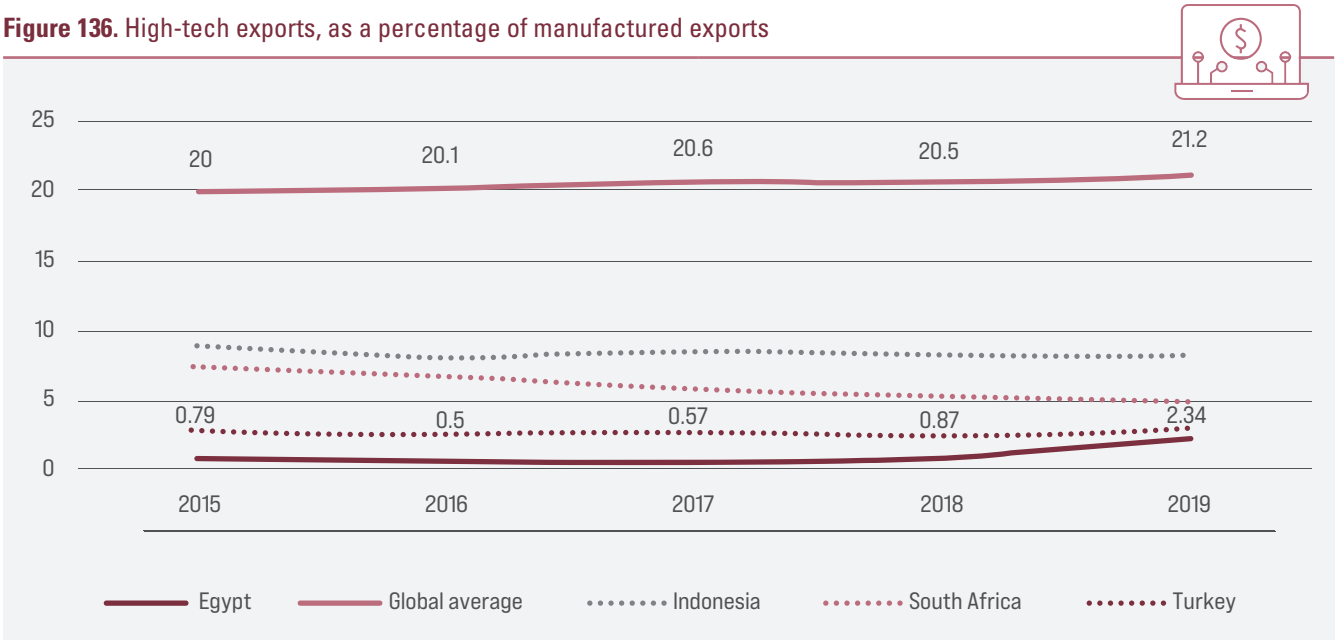
Given the relatively sizeable institutional and human resources dedicated to STI+D and notwithstanding the reduced financial resources, several indicators show the STI+D output of Egypt to be markedly low. Among the seven subindices of the GII, the lowest score for Egypt is usually in the "innovation output" subindices, which measure knowledge and technology outputs such as patents, software spending and ICT service exports, as well as creative outputs such as brand value, the printing and media market and mobile app creation.

Since 2015, high tech exports as a percentage of total exports only edged above the 1 per cent mark in 2019, reaching 2.3 per cent and remaining significantly below the global average of 21.2 per cent. This number is also quite far below the average of 4.7 per cent for the MENA Region.

Nevertheless, the uptick in 2018 and 2019, as shown in figure 136, signals a positive future outlook, as the downtrend during the period 2015–2017 can be attributed to the increase in other Egyptian manufactured exports, such as refined petroleum products.

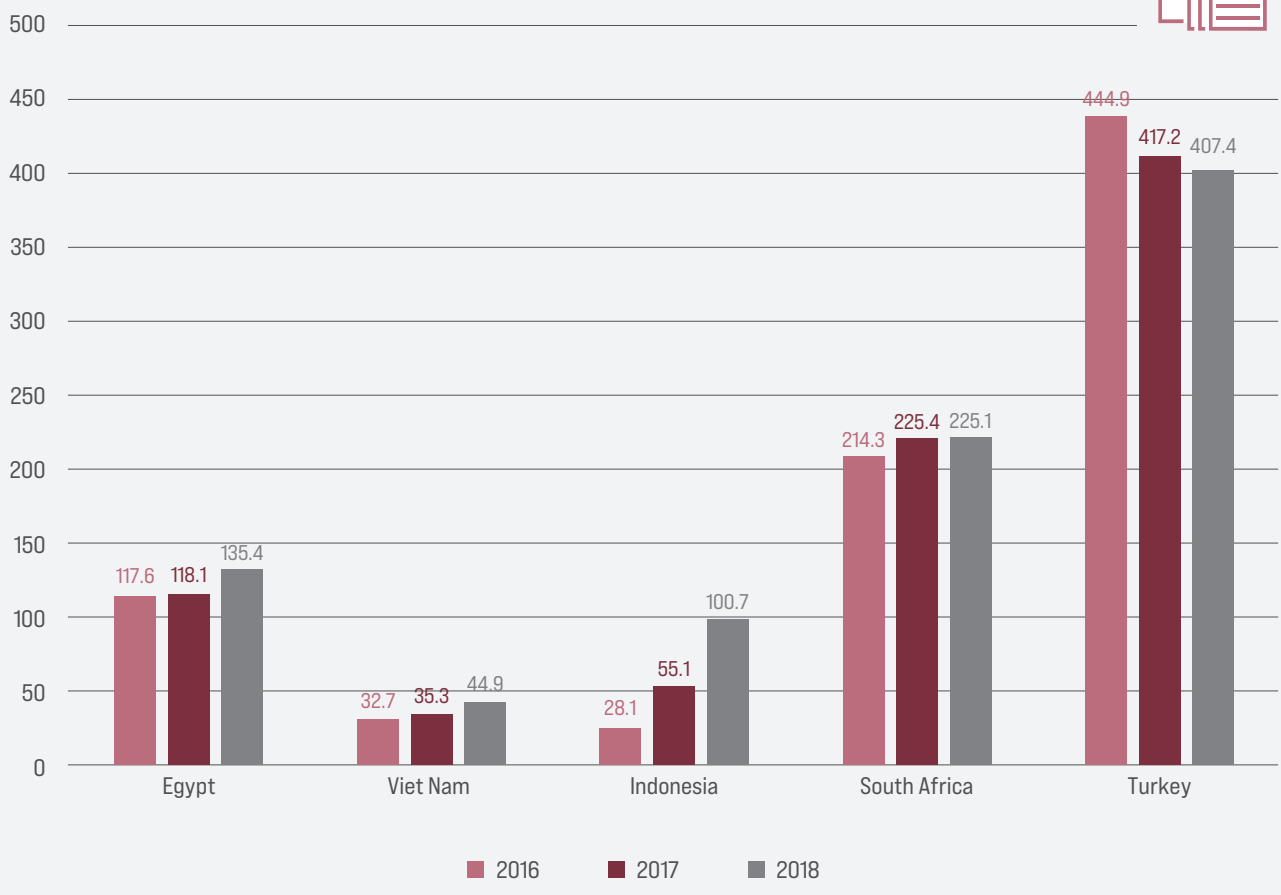
As for knowledge creation, the number of scientific and technical journal articles published per million people in Egypt has historically been higher than the average for Arab States (except in 2017 and 2018) and at an average position in relation to comparator countries (figure 137).

Figure 136. High-tech exports, as a percentage of manufactured exports



Source: Authors, based on data from the UN Comtrade Database.

Figure 137. Scientific and technical journal articles, per million people



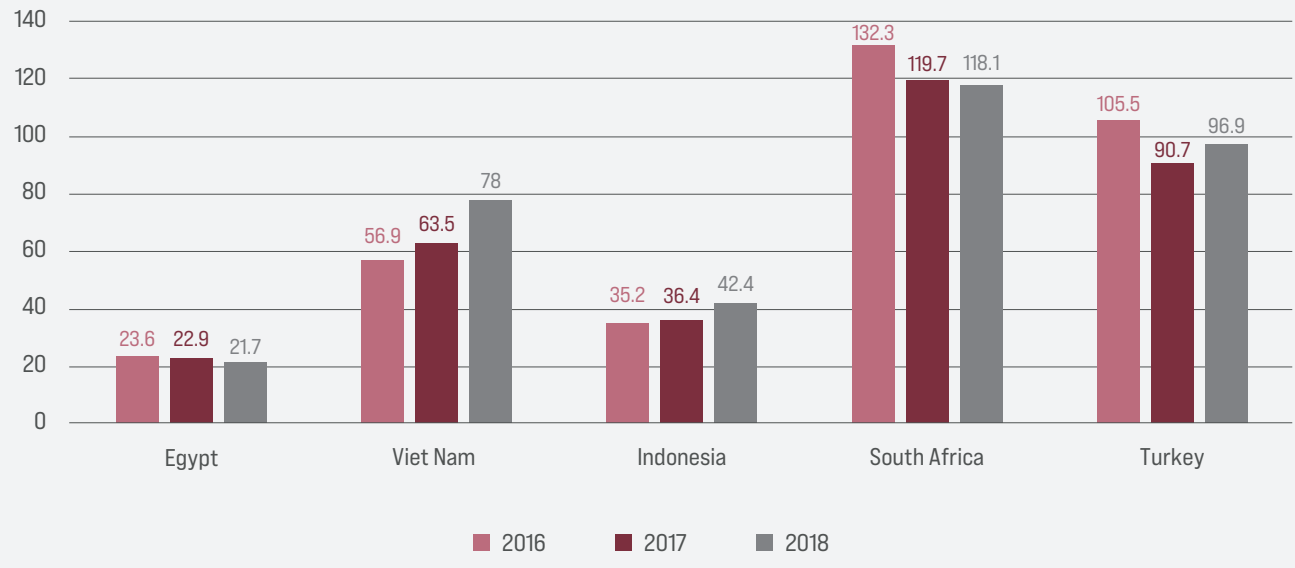
Source: Authors, based on the National Science Foundation, using data from the World Bank World Development Indicators database. Available from https://databank.worldbank.org/source/world-development-indicators. Accessed December 2021.

The Hirsch index ranking of Egypt (cumulative from 1996 to 2019), as measured by Scopus data, puts it at a global rank of forty seventh of 240 countries and regions, ranking below South Africa at thirty third and Turkey at thirty sixth, but it is above Indonesia at fifty seventh and Viet Nam at sixty second. Egypt also shows an average performance in the quality of its science and research output relative to comparator countries.[7]

Over the past few years, there has been a greater emphasis on improving the quality of Egyptian scientific output. One example of this emphasis is at the Kasr Al-Ainy Faculty of Medicine at Cairo University, which used to require a large number of published papers for faculty promotions with little regard to the level of the journals in which they were published. Recently, however, faculty promotion guidelines were modified to allow for fewer published papers on the condition that they are published in journals with a high impact at both the local and international levels.[8]

Although such emphasis on high quality knowledge creation has been noticeable in regard to academic papers and journal articles, patent creation in Egypt paints a less positive picture, as yearly applications averaged 23.6 patents per million people over the ten-year period of 2011–2019, which is quite low compared to the global annual average of 360.5 patents and the annual regional average of 67 patents for the MENA Region (figure 138). Egyptian patent applications have also slightly decreased in absolute value, from 2,279 in 2017 to 2,183 in 2019.

Figure 138. Total patent applications, per million people



Source: Authors, based on data from the World Intellectual Property Organization.

(a) Tertiary education

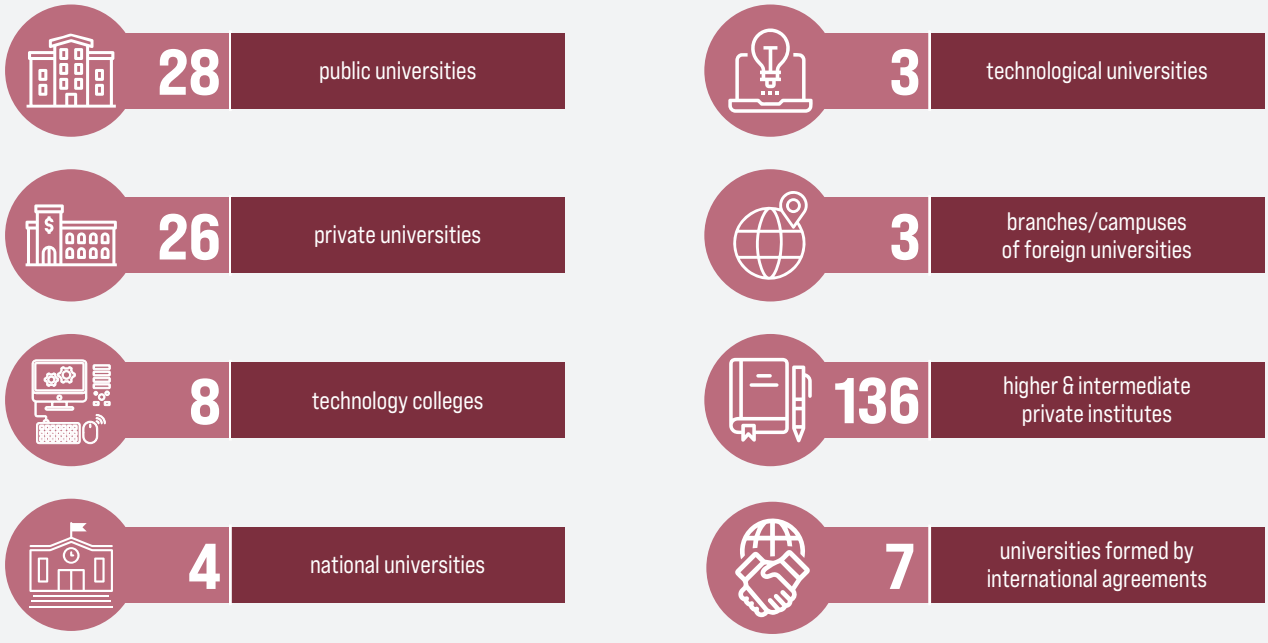
In the Third International Conference on Financing for Development in 2015, United Nations Member States pledged to scale up investment in education in science, technology, engineering and mathematics and to enhance technical, vocational and tertiary education and training.[9] Tertiary school enrolment in Egypt has grown from 26.8 per cent in 2011 to 35.2 per cent in 2017, edging closer to the 2017 global average of 37.9 per cent. Figure 139 shows the number and classification of universities in Egypt.

The quality of tertiary education has been a major national issue over the past few decades, with no Egyptian university ranked in the global top 400 of the 2021 Times Higher Education World University Rankings or in the top 600 in its teaching subindex.

Another major issue is the lack of absorptive capacity in the labour market for higher education graduates. University graduates and postgraduate degree holders have consistently had the highest unemployment rates in Egypt, reaching 17.7 per cent in the census held in the first quarter of 2020. This number rises dramatically to 34.7 per cent for female graduates and postgraduate degree holders.[10]

However, the Government of Egypt does not seem oblivious to the challenges in tertiary education and has announced multiple plans and initiatives to address them. One such initiative concerns technological universities, which is one of the commitments in the country's medium-term sustainable development strategy. It encompasses the need for dedicated public institutions for studies in science, technology, engineering, mathematics and rising technologies. The aim of these universities is to bridge the gap between university graduates and the expected future labour demand in key future industries, which is why their curricula are designed to accommodate more practical experience and hands-on learning methods rather than traditional academic teaching. In the academic year 2020/21, three such universities have already begun to receive students, in New Cairo, Beni-Suef and Qena,

Figure 139. Higher education institutions in Egypt



Source: Authors, based on data from the Ministry of Higher Education and Scientific Research, Egypt.

with six more currently under construction. The three established technological universities have programmes in field such as renewable energy, mechatronics, autotronics and ICT, with postgraduate studies also planned in these fields. As they are yet to have graduates, the effectiveness of these technological universities remains to be seen. Nevertheless, they appear to be a step in the right direction, with future foresight and a clear focus on innovation that has arguably been lacking in the Egyptian tertiary education system.

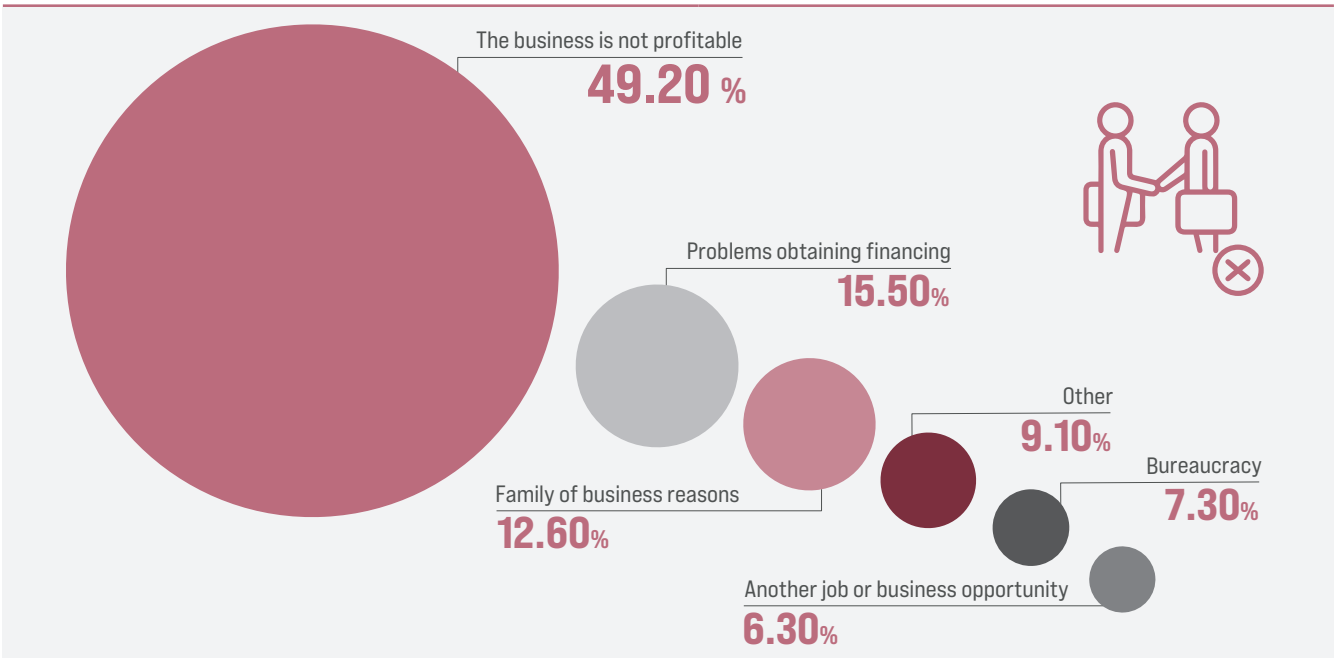
In 2019, an updated version of the National Strategy for Science, Technology and Innovation 2030 was released with some key focus areas to provide universities with greater autonomy in scientific research. The Strategy addresses some key challenges in scientific research, including the restrictions on universities and research centres to produce scientific publications for the purpose of professional promotion, which has caused researchers to be reluctant to enter into contracts with industry to develop the sector through scientific research. The Strategy is also focused on addressing the infrastructure and data challenges faced by researchers within the scientific community.

(b) Entrepreneurship

The latest data on total early-stage entrepreneurial activity by the Global Entrepreneurship Monitor in its Egypt National Report indicate that, as of 2017, around 13.3 per cent of the adult population in Egypt aged 18–64 years were either actively setting up a new business or have a business that is younger than 3.5 years, slightly higher than the global average of 12.3 per cent that same year. There is a similar rise in the overall societal perceptions of and attitude towards entrepreneurship in Egypt, as 75.9 per cent of Egyptians perceive it as a good career choice.

Nevertheless, the country's performance in several entrepreneurship-related indicators seems to run counter to this appetite and high regard for the entrepreneurial spirit.

Figure 140. Reasons for business discontinuation in Egypt (2017 survey)



Source: Global Entrepreneurship Monitor (2018), Global Report 2017/18.

For example, a key factor in the levels of entrepreneurship in Egypt is the lack of alternatives. The Global Entrepreneurship Monitor: Egypt National Report 2017/18 found that 42.7 per cent of entrepreneurs cite necessity owing to the absence of other work alternatives as the reason for opening their businesses, high above the global average of 22.2 per cent.[11]

Business discontinuation is another key challenge in the entrepreneurial scene in Egypt, with a rate of 10.2 per cent in 2017, ranking Egypt first among the 54 countries that participated in the Global Entrepreneurship Monitor Report. Figure 140 shows the reasons for business discontinuation in Egypt.

The Micro, Small and Medium Enterprise Development Agency in Egypt recognizes several key challenges to the business environment and entrepreneurial culture, which include challenges relating to bankruptcy laws; tax burdens, not only in the form of the amount of taxes levied on businesses but also in terms of difficulties with tax calculation and collection; lack of seed capital and general financing challenges; institutional and legislative challenges caused by bureaucracy and corruption; educational and training issues; and structural challenges owing to the majority of micro- and small enterprises preferring the informal sector.[12]

In fact, the economic census of 2017/18 found that the number of formal private sector establishments was 1.76 million, while the number of informal establishments was 1.98 million, a near 1 to 1.13 ratio, concentrated in the "wholesale and retail trade; repair of motor vehicles and motorcycles" sector (59.4 per cent of informal establishments).[13]

As a result of these challenges and the apparent high appetite and societal regard for entrepreneurship, especially among the youth population, a full ecosystem for entrepreneurship and innovation support has begun to emerge in Egypt in recent years.[14] Start-up accelerators, whether fully private (e.g. Flat6Labs), government supported (e.g. Falak Startups) or university affiliated (e.g. AUC Venture Lab), began witnessing growth in number and activity, offering mentorships, advice on business development, seed funding and often follow-up funding.[15] Summits and

marathons that connect start-ups with investors and support organizations have also been experiencing a rise in popularity and participation. Box 5 provides more information on the evolution of the innovation ecosystem in Egypt.

The Egyptian entrepreneurship scene has been diverse in nature since the start of its rapid growth phase in 2010. Between 2010 and 2013, there was a focus on mobile app-based start-ups, with e-commerce taking the lead between 2013 and 2016, followed by fintech from 2017, with logistics and transport becoming more prominent since 2019.

There have also been some regulatory and legal developments supporting innovators, entrepreneurs, researchers and investors, such as Law No. 23 of 2018 on the provision of incentives to STI. This law exempts higher education institutions and scientific research bodies from taxes and customs fees in a bid to incentivize research and promote innovation. Another example is Law No. 72 of 2017, or the new investment law, which removes obstacles to investment, consolidates investment-related regulations that were previously scattered under different laws and offers tax and non-tax incentives.

Box 5. Examples from the innovation ecosystem in Egypt

1. Government side:

- 2010: The Technology Innovation and Entrepreneurship Center was created by the Ministry of Communications and Information Technology to spark and motivate entrepreneurship across Egypt.
- 2017: The Ministry of Planning and Economic Development started the Rowad 2030 project, which in turn created nine university incubators.
- 2018: The Central Bank of Egypt launched the NilePreneurs initiative, piloted at Nile University and since expanded to four other universities.
- 2018: The Ministry of International Cooperation created Falak Startups, now one of the country's top incubators.
- Legal infrastructure: Law No. 152 of 2020.

2. University side:

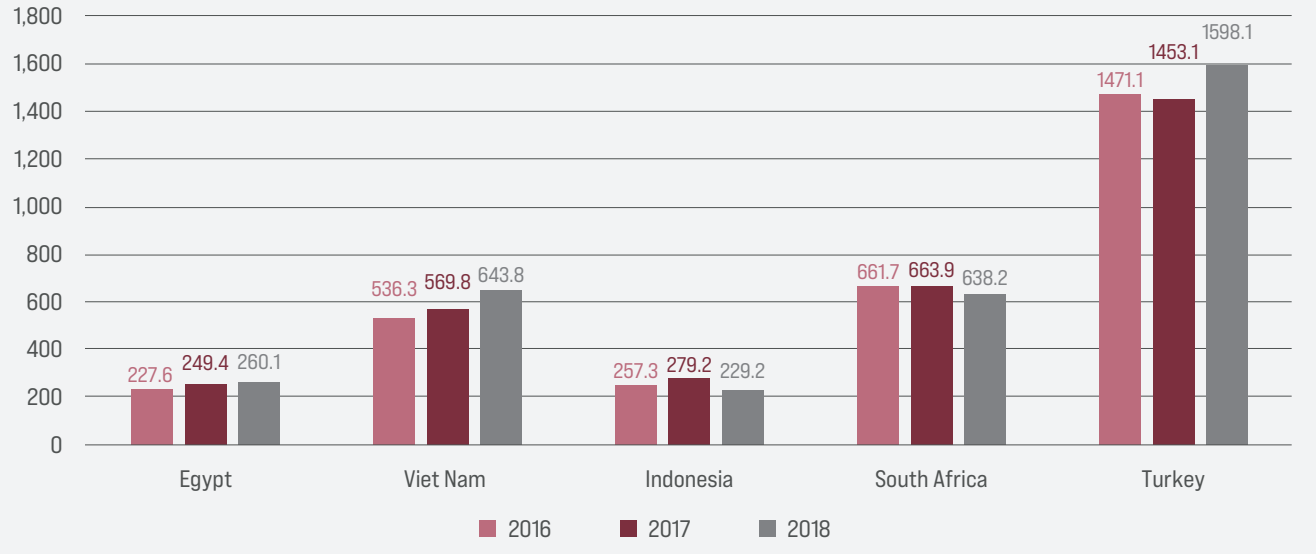
- The American University in Cairo Venture Lab was the first university-based accelerator in Egypt offering support programmes to early-stage innovation start-ups.
- Ain Shams University Innovation Hub (iHub) was launched in 2012 with over 150 industry partners, which enabled it to offer a variety of programmes for entrepreneurs.
- Hemma by Assiut University, in cooperation with the European Commission, is the first incubator in Upper Egypt with a high impact in the region.

3. Private sector side:

- Accelerators such as Flat6Labs Cairo and Kamelizer.
- Angel investment networks such as Cairo Angels, Alex Angels, Nile Angels and Egyptian Business Angel Network.
- Venture capital firms such as Sawari Ventures (2010), Endure Capital, Pride Capital and Algebra Ventures.
- Specialized venture capital firms and accelerators such as EdVentures (2017, specializing in education) and Ghabbour Auto (focusing on the automotive industry and fintech).
- Fairs and summits such as the RiseUp Summit and Techne Summit, both of which connect innovators with funders and professionals.

Source: Ghoneima, M. and others (2020). The Evolution of the Egyptian Innovation and Entrepreneurship Ecosystem.

Figure 141. Total trademark applications, per million people



Source: Authors, based on data from the World Intellectual Property Organization.

More policies are still needed, however, to reduce the hurdles faced by researchers, entrepreneurs and investors to further boost the growth of the start-up scene and commercialize more of the research and development outputs generated by research laboratories and institutions. This is clear, especially considering that, despite the growth of this support ecosystem for entrepreneurship and innovation, the number of trademark applications in Egypt (figure 141) remains lower than several comparator countries, despite its steady rise in recent years.

It is worth mentioning that this chapter is focused on entrepreneurship in its capacity as a vessel for STI+D. Chapter 6 provides a better in-depth assessment of topics such as foreign direct investment and the broader role of entrepreneurship and business in FFD.

(c) International cooperation in science, technology, innovation and digitalization

Another key characteristic of the STI+D scene in Egypt is the contributions and support of international and intergovernmental actors. These contributions include financial and technical assistance targeting business innovation, capacity-building for young people, support for increasing technological output, knowledge-sharing and supporting key sectors in need of innovation.[16]

In terms of financial contributions, according to the 2021 VNR of Egypt, Goal 9 on industry, innovation, and infrastructure was most linked to STI+D and received 22.3 per cent ($ 5.7 billion) of total ODA received by Egypt in 2020, making it the second most funded SDG by ODA, after Goal 7 on affordable and clean energy.[17] Chapter 12 elaborates further on overall international development cooperation.

(d) Digitalization as a national priority

(i) Access, connectivity and affordability

As previously mentioned, digital transformation is actively promoted as a national priority for Egypt. Internet accessibility has improved, with the proportion of individuals in Egypt using the Internet increasing from 41.3 per cent in 2015/16 to 57.3 per cent in 2019/20, according to a survey by the Ministry of Communications and Information Technology. The survey also showed an increase

in connectivity with mobile Internet subscriptions, which increased from 28.7 per cent in 2016 to 52.4 per cent in 2020, and asymmetric digital subscriber lines (ADSL), which increased from 4.4 per cent to 8.8 per cent over the same period.[18] Affordability has largely stayed the same, as measured by the Affordability Drivers Index of the Alliance for Affordable Internet, which has described Egypt as having affordable Internet, with a global rank of 36 out of the 72 countries measured in 2020. Although its ranking has stayed the same, its score on the Affordability Drivers Index improved from to 45.1 in 2017 to 54.2 in 2020 out of a potential score of 100.[19]

(ii) E-government

The digitalization of public services is also currently a notable priority for the Government in its aims for efficiency and better governance. A pilot version of "Digital Egypt", the platform for online government services, was launched in July 2020. According to the Ministry of Communications and Information Technology, the platform included 34 digitized government services, including notarizations, court services and driving and vehicle licensing, with various e-payment methods. A total of 550 government services are planned to be on the Digital Egypt platform by 2023.[20] The platform is just one of five outlets that the Government is using to provide access to digital public services, the rest of which include mobile applications, call centres, citizen service centres and post offices, which have experienced a noticeable upgrade in the number and quality of the services they provide over the past three years.

(iii) E-payments

The digitalization of public services is matched by a push towards electronic payments and a decreased reliance on cash. One example of this was the joint national campaign of CBE and the Federation of Egyptian Banks in the second half of 2020 to increase awareness and improve access to e-payments. The campaign included the distribution of 100,000 points of sale to retail vendors and merchants, the cost of which would be covered by CBE.

This transition to e-payments was reflected in the notable growth of electronic transactions handled by banks in Egypt, which reached one billion transactions and saw a near 49 per cent increase in value in the 2020/21 financial year compared to the previous year, according to statements by the CBE Assistant Governor. Over the same period, Internet banking transfers increased by 70 per cent and transactions through mobile wallets more than tripled, increasing by 226 per cent.

(iv) Digital legal infrastructure

The Government is also working on improving the legal infrastructure pertaining to digitalization and digital security. A key recent development was an amendment to the executive regulations of the e-signature law by the Ministry of Communications and Information Technology in 2020, which resolved a major regulatory challenge. This followed the introduction of several other critical digital infrastructure laws, such as the law against cybercrime and information technology crimes in 2018 and the law on personal data protection in July 2020, which is modelled on the acclaimed European Union General Data Protection Regulation.[21]

(v) Digital Egypt as a comprehensive plan

The Ministry of Communications and Information Technology oversees the entire Digital Egypt plan, which is intended to lay the foundation for the transformation of Egypt to a digital society. The plan has three areas of focus:

- Digital transformation: digitizing government services through the dedicated platform and other channels, as mentioned above.
- Digital skills and jobs: providing training programmes and initiatives in various ICT fields to expand the skills pool.
- Digital innovation: integrating advanced technologies such as artificial intelligence,

promoting entrepreneurship and establishing an applied innovation centre.

Digital Egypt also recognizes the importance of developing the ICT infrastructure as a prerequisite for achieving any of the plan's goals, specifically by improving the quality of Internet services; however, there is no mention of improving accessibility or affordability. The plan also mentions the development of a supporting legislative framework as a priority, naming cybercrime, consumer protection, intellectual property and e-signature laws as examples of the steps taken towards the creation of a supportive regulatory environment for the sector.[22]

B. Challenges

As can be seen from the previous section, STI+D is in no way dormant in Egypt. Improvements in the tertiary education system are progressing, the national entrepreneurship ecosystem is growing and digitalization is at the forefront of major national strategies. While many developing countries suffer from insufficient government commitment to STI as trade-offs are made in favour of other development domains, this is thankfully not the case with the Egyptian Government.

Nevertheless, there remain systemic issues with the STI+D landscape in Egypt that prevent greater strides in related international indices such as the GII. Otherwise, the original 2020 target would have been achieved.

1. The financing environment

One of the more obvious and unsurprising systemic issues is the lack of adequate funding, as spending on research and development remained stable over a decade at around 0.7 per cent of GDP, as indicated in figure 134. This falls somewhat short of the constitutional mandate of 1 per cent, with minimal contribution to this funding from industry.[23]

The size of available funding may not be the most significant hurdle; this may instead be the allocation mechanism for the existing funding. The majority of available institutional financing for public research and development in Egypt is usually absorbed by higher education establishments rather than research institutions. Furthermore, funding is usually allocated based on traditional approaches rather than needs assessments, performance evaluations or alignment with national priorities.[24]

As for funding for private sector innovation, the problem concerns accessibility more than availability. As previously mentioned, the Micro, Small and Medium Enterprise Development Agency already recognizes the lack of seed funding and other financing challenges as one of the major issues facing entrepreneurship in Egypt. The rise of the entrepreneurship and innovation support ecosystem of start-up accelerators and venture capital contributes to bridging the availability gap to some extent. Some national efforts also target microfinancing to support local enterprises.[25] Nevertheless, difficulties in accessing funding remain as creditors, particularly banks, tend to avoid the risk presented by young and untested innovative endeavours. For example, while CBE has mandated that banks increase financing for MSMEs from 20 per cent to 25 per cent of their credit portfolio, most local commercial banks only approve loans for start-ups three years after their establishment.[26]

2. The pandemic-induced dichotomy

The COVID-19 pandemic seemed to highlight, if not aggravate, further systemic issues, while at the same time having a catalytic effect on STI+D efforts, thereby underlining its crucial nature.

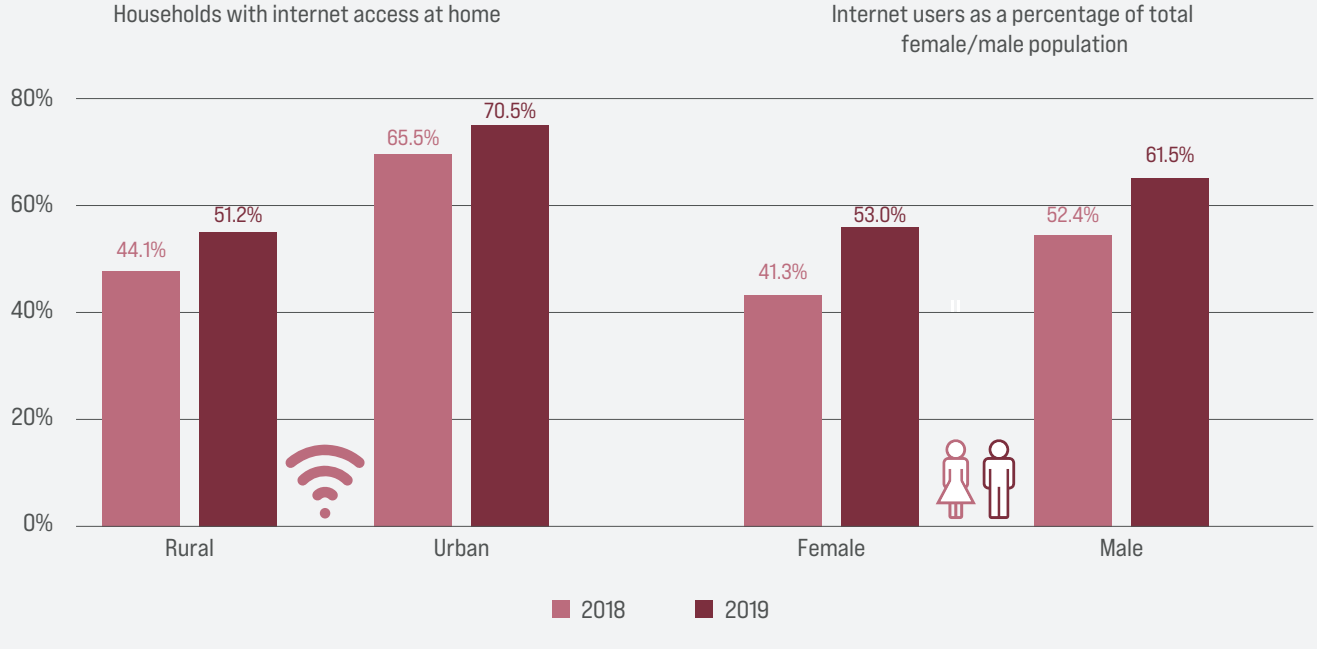
From early in the pandemic, when policymakers around the world were beginning to instate lockdowns and preventive protocols, it was becoming increasingly clear that there was a double-edged effect of COVID-19 on STI+D activities. On the one hand, sources of funding were expected to dry up, halting venture investments and entrepreneurship, while on the other hand, reliance on STI had never been higher than in efforts to pull the world out of the crisis caused by the pandemic.[27]

According to the Global Startup Ecosystem Report 2020, pandemic lockdowns led to dried-up capital, with total venture capital funding decreasing dramatically across continents. The fundraising process was disrupted even when funding remained. The drop in global demand led to drops in revenue, which varied by sector and in turn led to increased layoffs at start-ups.[28]

On the other hand, the pandemic resulted in accelerated digitization efforts, the appearance of a global opportunity and demand for innovation in various fields, a rise in the need for reliable and affordable access to ICT infrastructure and the prioritization of international scientific cooperation.[29]

The dichotomous dynamic of drainage in general resources available to STI+D versus the urgent need for the deployment of STI+D outputs has manifested itself in various ways in Egypt during the pandemic. For instance, one could easily understand from Section B that the momentum of decisions and developments changed during 2020, with an accelerated pace towards digitalization efforts and a transfer to the digital economy.

Figure 142. Digital divide in Egypt



Source: Authors, based on data from the Digital Development Dashboard of the International Telecommunication Union. Available from www.itu.int/en/ITU-D/Statistics/Dashboards/Pages/Digital-Development.aspx. Accessed December 2021.

This acceleration often had fortunate, if unintended, consequences. A noteworthy example of such consequences is the Government's support grant for irregular work during the pandemic. In March 2020, at the start of partial lockdowns in Egypt, among the many decisions taken to strengthen social safety nets for the most vulnerable groups was a monthly support grant of LE 500 for irregular workers such as carpenters, mechanics, builders, fishers and other craftspeople, as well as on-demand or seasonal workers. To apply for the grant, applicants had to enter their data into a form on the website of the Ministry of Manpower and Immigration. This included some personal and contact information, geographical location, income situation, occupational details and whether they had social insurance with an employer. The latter was a proxy question to avoid asking if they had formal employment or were working informally. About a year later, and as a result of this support scheme, the Government had managed to collect data for over 6.1 million Egyptian irregular workers (2.6 million of whom qualified for the grant), which can be used in the future to improve the targeting of social support schemes or to guide private investments.[30] Even if the data are not comprehensive, a data set that would previously have been tedious and expensive to gather was obtained much more easily because of COVID-19, although under devastating human conditions. Furthermore, the data set enabled the disbursement of the grant to be fully digitized at the local level, linking the applicants with their nearest post office and sending them directions via text message to collect their grant.

At the same time, the pandemic was also found to have had harmful unintended consequences relating to digital technologies, such as deepening the digital divide and increasing the spread of misinformation.

(a) The digital divide

The digital divide, as previously mentioned, is already recognized in the 2021 VNR of Egypt as one of the key challenges facing the country's development efforts. The report cites an urban-rural divide in computer ownership and Internet access in households and a male-female divide in Internet usage and smartphone ownership (figure 142).[31]

Unfortunately, the pandemic only served to highlight the extent of the divide. As the Government sought to address this challenge during lockdown by ensuring access to e-learning, increasing the use of e-payments and enhancing international gateways, key challenges emerged that required innovative solutions.[32] For instance, the inequitable access to the Internet meant that a significant proportion of school students did not have access to the education materials provided on successful online platforms such as the Egyptian Knowledge Bank, which was used during school closures to host national curricula and online exams on its platform.[33] This led to the Ministry of Education and Technical Education launching a nationwide television channel called "Madrasatona", meaning "our school", that airs lessons by teachers in different subjects in the Egyptian national curriculum for most school grades. Madrasatona has since been expanded to two television channels, one for primary schooling and another for older students.

(b) The spread of misinformation

Egypt is developing into a more online society, with social media penetration levels rising to 49 million active social media users as at January 2021 (a 16.7 per cent year-on-year increase from 2020), as reported by Kepios. This represents both an opportunity and a challenge to society. According to the GWI Global Report, Egyptians spend around 7 hours and 36 minutes online per day, of which 3 hours and 6 minutes are spent using social media. A wealth of information is being absorbed daily. The realm of misinformation presents a global challenge, and there is still no solution in sight.

This issue has been highlighted over the past decade but came into focus following the 2016 elections in the United States, where social media was seen as a powerful tool to spread

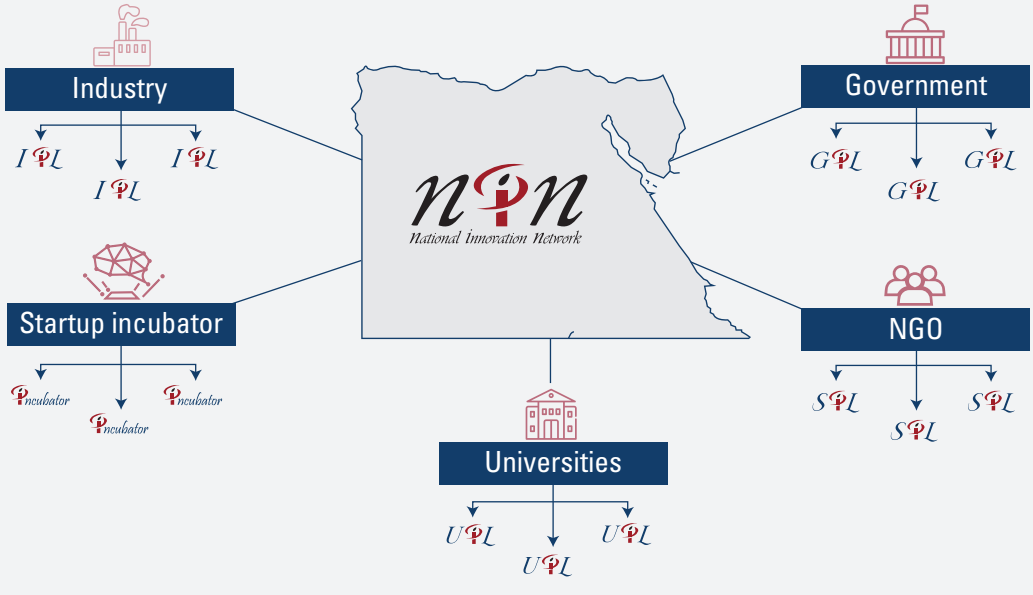
misinformation that could cause long-term harm to societies. Building on the changes caused by COVID-19, on 2 February 2020, the World Health Organization (WHO) warned of an "infodemic", stating that: "The 2019-nCoV outbreak and response has been accompanied by a massive 'infodemic'—an over-abundance of information, some accurate and some not—that makes it hard for people to find trustworthy sources and reliable guidance when they need it".[34] This massive surge of misinformation has the potential to undermine the effectiveness of public health measures.

Misinformation costs money and sometimes lives. In that sense, misinformation can have a negative impact on FFD, as it reduces the effectiveness of public measures and may spread false information, alienating stakeholders from the development process. One of the main pillars of achieving the SDGs is a collaborative approach between the Government, the private sector and civil society, a bond that becomes fragile with the increase of misinformation.

The challenge in today's world is the ease of access to tools to spread misinformation and disinformation. This is true for anyone who wants to exploit a situation to achieve their own agenda, including, in some cases, government agencies. The Bruno Kessler Foundation launched the COVID-19 Infodemics Observatory in early 2020 to understand the impact of the infodemic on a global scale. With regards to Egypt, the Observatory analysed over 890,000 public social media posts in the period between January 2020 and September 2021 and concluded that Egypt belongs in the medium/high category of the dynamic Infodemic Risk Index. This means that Egyptians have a 58.3 per cent chance of interacting or resharing potentially misinformative content.

It is noteworthy that Egypt has taken several measures to curb the effects of misinformation, including a Facebook page for the Egyptian Cabinet that provides daily debriefs of government efforts, as well as a COVID-19 policy tracker launched by the Ministry of Planning and Economic Development to inform citizens of all policy measures taken by the Government to contain and mitigate the effects of the pandemic. The Ministry of Health and Population also launched an automated response service on WhatsApp to provide accurate information about COVID-19 and answer frequently asked questions.

Figure 143. Proposed scheme for the National Innovation Network



Source: Authors, based on 2020 data from the Ministry of Higher Education and Scientific Research, Egypt.

Though the risk of misinformation may seem to be very complex, it boils down to restoring trust in public institutions. To a great extent, this can be achieved through transparency and collaboration; Governments must lead by example in using technology to disseminate information to ensure that no misrepresentation takes place. Effective communication methods between public institutions and the general population need to be implemented to eliminate or reduce the void that will undoubtedly be filled with misinformation.

3. The need for improved linkages and uptakes

Even before the onslaught of the pandemic and aside from the obvious need for enhanced funding mechanisms, there appears to be a systemic gap; the momentum of STI+D activity and institutional support in Egypt was not being reflected in knowledge, innovative and high-tech outputs. For instance, as previously mentioned, in comparison to similar countries, Egypt is underperforming in high-tech exports as a percentage of total exports, the number of patents and the number of trademarks per million inhabitants.

In other words, there seem to be weak linkages between innovation inputs and innovation outputs, and even weaker linkages between knowledge creation and knowledge utilization. According to a 2013 survey of 3,000 firms in Egypt, most are not likely to partner in research and development activities with universities and research institutions and only 1 per cent benefited from public research and innovation programmes.[35]

This is more generally confirmed by the performance of Egypt in the GII. Although the country has improved its overall rank, it has been experiencing a steady decline in the innovation output subindex over the past three years. Egypt has dropped in this subindex, which measures creative, knowledge and technology outputs, from seventy ninth place in 2018 to eighty sixth place in 2021, the same three years in which there was a significant push in digital-related regulatory reforms and digitalization efforts.

Weak enforcement of intellectual property rights and the lengthy wait to obtain a patent are among the regulations that further hinder the uptake of STI in the Egyptian economy. Regulatory challenges appear to be caused more by bureaucracy and enforcement issues than by legal infrastructure issues. There is also a mismatch between what is needed and what is being offered.

Egypt must pivot towards a knowledge-based economy in order to be able to satisfy its needs, continue to play its regional leadership role and contribute more to the global economy. To do so, fictitious barriers or gaps between market sectors and knowledge creators need to be eliminated, allowing for increased dialogue and collaboration and, ultimately, better linkages between inputs and outputs. One of the keys is to have better communication and data exchange. This allows service providers to have a better understanding of those seeking their services and thereby provide more appropriate and innovative services. For this to happen, each entity or group of entities must have a focal point in charge of their communication and innovation system.

This has led to the National Innovation Network, which is currently being considered by the Ministry of Higher Education and Scientific Research, in collaboration with several other ministries. Each of these focal points will be an innovation laboratory connected to others in the proposed Network, as shown in figure 143.

The National Innovation Network connects different sets of innovation laboratories and hubs across universities, community centres, society centres and industry clusters that would communicate, exchange data and

services, collaborate and share success stories. The Network would also have an Innovation Academy to provide the necessary capacity-building, as identified through the activities of the innovation laboratories within the Network.

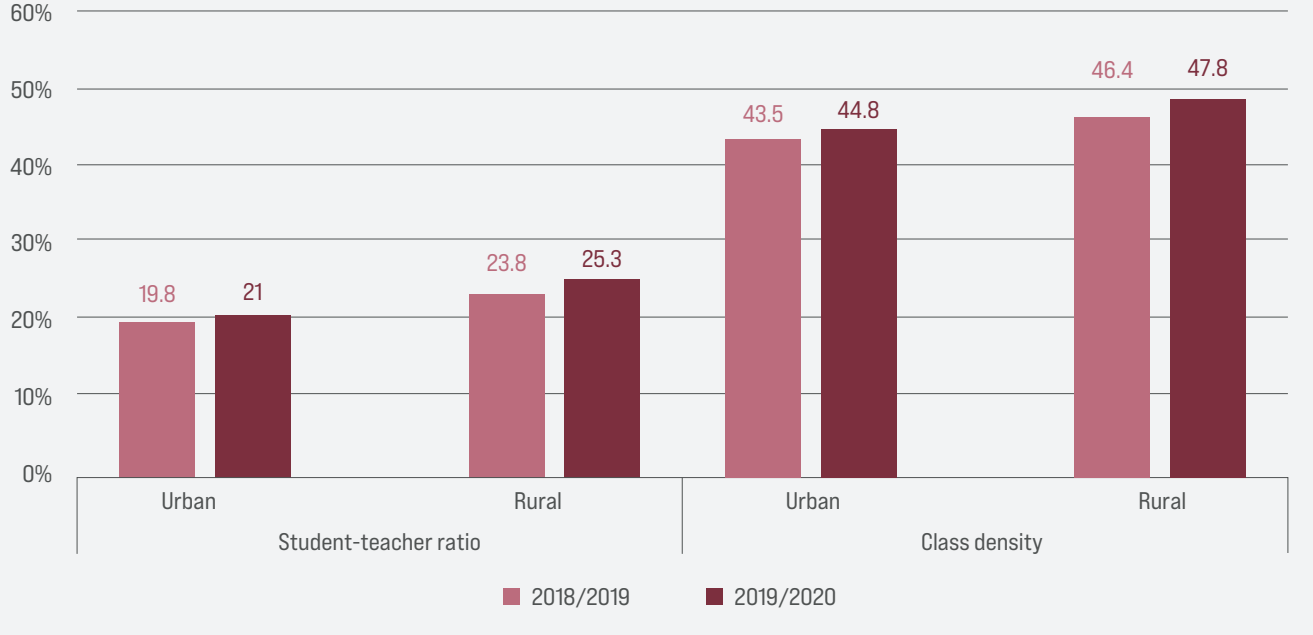
University innovation laboratories will be central to knowledge creation with improved linkages between and within universities. Social innovation laboratories would cater to different local communities and societies, running at local, neighbourhood and urban levels, with the support of NGOs and other societal support groups. Government innovation laboratories will be created at the ministerial level as an alternative vehicle for policymaking by involving a diverse set of key stakeholders participate in the design of public policies. These will include policymakers, civil leaders, practitioners, academics, non-profit organizations and social innovators. Industry innovation laboratories can be located in sectorial chambers or industrial unions with the aim of enhancing cross-sectoral dialogue and fostering new ideas.

4. The implications of low-quality primary education

There remains an even more fundamental systemic challenge preventing STI+D reaching its full potential in both society and economy, which is that Egypt faces grave challenges in the quality of primary and preparatory education (i.e. grades 1 to 9).

Home to over 24 million school students, Egypt has the largest school system in the Middle East. While great strides have been made in achieving near universality in enrolment rates, completion rates and gender parity in primary education, the majority of students barely meet the low international benchmarks in reading, mathematics and science. Based on the 2019 Trends in International Mathematics and Science Study, of the 39 countries studied, Egypt ranked thirty second for the mathematics achievements of grade 8 students and thirty seventh for the science achievements of grade 8 students, with over half the students not exceeding the low international benchmark.[36]

Figure 144. Class density and student-teacher ratios in Egypt



Source: Authors, based on data from the Ministry of Education and Technical Education, Egypt.

The monumental strain on resources has also not been kind to the learning environment, especially in public schools, leading to high class densities and high student-teacher ratios (figure 144), as well the underdevelopment of school facilities. The halting of proper upgrades of curricula and teaching methods, coupled with low compensation and capacity development for teachers, is naturally reflected in reliance on old-fashioned teaching methods focused on rote memorization for exams that do not employ critical thinking or practical skills, let alone the skills needed for competing in the modern global economy.

This is clearly a fundamental issue that has grown over the years to become a heavy burden that Egypt must carry in any STI+D-related activity. This is to a great extent being addressed in the new Education 2.0 reform programme that has been led by the Ministry of Education and Technical Education since 2018. The programm is aimed at reforming examination and assessment methods, developing school curricula, introducing the heavy use of technology in the classroom (which requires major upgrades to schools' digital infrastructure) and improving professional development and capacity-building for teachers. While the impact of such reforms on innovation outputs will unfortunately likely require a generation to be realized, it is a vital and much needed step in the right direction towards activating the potential of STI+D in Egypt.

C. Conclusion and policy recommendations

The Government of Egypt faces a unique set of challenges in developing STI+D in the country and providing clear linkages with the national sustainable development strategy in a manner that ensures that no one is left behind. As challenging as it may seem, this leaves room for opportunities and for the potential to make progress as a developing country that has a clear will to achieve inclusive development.

Sustainable development begins with sustainable planning and policymaking. In recent years, Egypt has experienced significant improvement in this area, but there are still many challenges that need to be addressed. A one-government approach is often absent, except for initiatives adopted at the presidential level. This set of initiatives, no more than a handful at the moment, have the full force of the Egyptian Government and para-government agencies behind them, enabling them to make great strides in a very short time. There are many examples of this, such as the "100 million health initiative", which managed to nearly eliminate the hepatitis C virus in Egypt in just over two years, although the country had been battling the disease for many years. Despite most odds, Egypt is proof that where there is a will there is a way. That is not to say that there is no will to implement STI+D in Egypt, but rather that there should perhaps be greater efforts in this arena to sustain government efforts.

Most of the national efforts mentioned in this chapter follow a basic pattern that highlights the wishes and hopes of the Government, despite the lack of clear mechanisms on financing, enforcement, evaluation, key performance indicators and clearly defined milestones and targets. It is imperative, therefore, that more time is invested in planning and impact analysis, as well as evidence-based policymaking to be able to make best use of the scarce resources.

Enabling a proper STI+D ecosystem would significantly benefit Egypt in two respects:

1. Increasing the efficiency of government services, improving governance and reducing corruption, which improves the inclusivity of government services and better enables them to serve grass-roots communities and include these communities in the development process.

2. Being able to identify and foster talents early and provide them with a tailored education and the means to innovate could allow creative solutions for localized issues to prosper, thereby decreasing the country's dependence on foreign knowledge and reducing the national "brain drain".

While the authors of this chapter may seem to suggest that STI+D ought to become a part of a presidential plan or at least have the highest possible levels of coordination with the country's leadership, the idea is in no way a sustainable one. Empowering national Government and local governorates should always be at the top of the agenda. Nevertheless, leadership from the top could be more effective in cases when greater focus, collaboration and impetus is needed if such a method is only followed until it is phased out by an appropriate body of governance.

A national scientific body might enable clear targets to be set for research and development in collaboration with the private sector and academia and share its results with the technology facilitation mechanism. This would be essential to reaching evidence-based decisions on which technologies to adopt, as science and technology are rarely straightforward and most technologies do not serve certain goals without negatively affecting others. Trade-offs must be made in accordance with policy priorities; however, these trade-offs must be made by taking the science into consideration, rather than just policies or economics.

While this chapter discusses and elaborates on the National Innovation Network, it is also noteworthy that this is merely a step to be built on towards the solution and not a panacea.

Entrepreneurship is often referred to as the domain that contributes the most to innovation, yet the growing trend for investment is to be able to make money quickly without taking note of the long-term solution. Research and development can therefore end up being kept to a minimum. Following trends in innovation or localizing solutions might be useful, but it will only take Egypt so far and will restrict progress towards homegrown solutions. This will always be the case as long as there is a heavy reliance on venture capital and investment banks to finance SMEs. It is essential to create a strong means of financing research in collaboration with the private sector and science and technology-oriented policymakers. Its goal should be to enable the research and development of long-term solutions that may be less financially beneficial in the short term but will have a greater long-term impact or address strategic issues that may not always appeal to traditional investors.

The ultimate goal should be to mainstream STI+D as an easily accessible enabling tool in the country's various productive domains. While the national strategies mentioned in this chapter present the policy efforts being made to reach this goal to a certain extent, further effort is needed to address systemic constraints that, if removed, would release the organic potential of STI and prevent technological and innovative progress from being dependent on certain entities but rather embed it in the Egyptian economy.

Based on the discussion in this chapter, the following recommendations can be considered in the area of STI+D:

- Improve the linkages between national developmental priorities and public and private research and development by offering various incentives to researchers and innovators in general, as well as incentives targeting the country's current priorities. It is also critical to ensure that knowledge creation is linked to knowledge utilization, a key factor in activating the role of STI in FFD, which requires strong engagement with the various stakeholders, particularly in the private sector.

- Continue the current path of digital transformation for government services while improving the quality, accessibility and inclusivity of digital infrastructure, pooling resources through public-private partnership projects in digitalization and ensuring good governance and monitoring and evaluation.

- Enhance the primary and preparatory education curricula by introducing STI-enabling subjects such as scientific methods, scientific concepts, research methods and basic ICT skills. In general, addressing the quality of primary education is critical to the long-term success of any national STI plans. While the current Education 2.0 plan is a strong first step, adding key STI-enabling school subjects to curricula has the potential to positively impact the country's overall innovative outputs.

- Set and activate an overarching national innovation strategy while ensuring its sustainable operationalization by setting measurable targets and enforcement mechanisms. Partnerships should be ensured by engaging relevant stakeholders, particularly the private sector, and local communities. The strategy should also address systemic issues such as the availability of risk financing and how to bridge the digital divide and improve the necessary legal infrastructure.

Endnotes

1. International Conference on Financing for Development, 2015.
2. United Nations Technical Support Team, 2013; Adenle and others, 2020.
3. Ministry of Planning and Economic Development, Egypt, 2021a.
4. Dutta and others, 2020.
5. Micro, Small and Medium Enterprise Development Agency working paper, February 2020, provided by the Ministry of Planning and Economic Development, Egypt.
6. Cairo University, n.d.
7. The Hirsch index or H-index is an author-level metric that measures both the productivity (publications) and the apparent scientific impact (citations) of a scholar.
8. Based on interview with Hanan Amer, Professor of Neurology, Kasr Al-Ainy Faculty of Medicine, Cairo University, on 28 February 2021.
9. International Conference on Financing for Development, 2015, para. 119.
10. Central Agency for Public Mobilization and Statistics, Egypt, 2020a.
11. Ismail and others, 2018. Survey sample of 2,521 individuals and 51 national experts.
12. From a Micro, Small and Medium Enterprise Development Agency working paper, February 2020, provided by the Ministry of Planning and Economic Development, Egypt.
13. Central Agency for Public Mobilization and Statistics, Egypt, 2020b.
14. Ghoneima and others, 2020.
15. It is worth noting that while most accelerators in Egypt are open to many sectors, tech start-ups are normally favoured with accelerators that have specific programmes for fintech companies.
16. See for example: the European Union-Egypt STI Cooperation Portal showcasing joint STI activity (http://www.stip.eg.net/); the 2020–2025 Country Development Cooperation Strategy for Egypt of the United States Agency for International Development, mentioning digitization as a key area for technical assistance (https://www.usaid.gov/sites/default/files/documents/CDCS-Egypt-December-2025.pdf); the Agricultural Innovation Project in rural Egypt of the German Agency for International Cooperation (https://www.giz.de/en/worldwide/92509.html); the Chinese-Egyptian Research Fund's call for innovative and technological research projects (https://stdf.eg/web/download/387587); and the newly launched UNDP Egypt Accelerator Laboratory (https://www.eg.undp.org/content/egypt/en/home/presscenter/pressreleases/2021/catalyzing-sustainable-development-through-the-undp-egypt-accele.html).
17. Ministry of Planning and Economic Development, Egypt, 2021a.
18. Ministry of Communications and Information Technology, Egypt, 2021.
19. Alliance for Affordable Internet, 2020.
20. Ministry of Communications and Information Technology, Egypt, 2020a.
21. Sylla and others, 2020.
22. Ministry of Communications and Information Technology, Egypt, 2020b.
23. Economic and Social Commission for Western Asia, 2017. The constitutional mandate for spending on higher education is 2 per cent of GDP.
24. Economic and Social Commission for Western Asia, 2017.
25. According to the Assistant Governor of the Central Bank of Egypt, the country's microfinance portfolio was worth approximately LE 47 billion as at December 2020.
26. Ministry of Planning and Economic Development, Egypt, 2021a.
27. Gauthier and others, 2020.
28. Startup Genome and Global Entrepreneurship Network, 2020.
29. Caldwell and Krishna, 2020; Gann and Dodgson, 2020; United Nations, 2020.
30. Numbers are according to the Advisor to the Minister of Planning and Economic Development, Egypt, quoted in Akhbar Al-Youm on 4 March 2021. Available from: https://akhbarelyom.com/news/newdetails/3283064/ (in Arabic).
31. Ministry of Planning and Economic Development, Egypt, 2021a.
32. Enterprise, 2020.
33. The central e-platform for educational resources and tools for educators, launched in 2016.
34. World Health Organization, 2020.
35. Economic and Social Commission for Western Asia, 2017.
36. The international benchmark is defined for mathematics as having "some knowledge of whole numbers and basic graphs" and for science as showing "limited understanding of scientific concepts and limited knowledge of foundational science facts" (Mullis and others, 2020).