Digital Dividends

Best Practices and Lessons Learned in ICT Sector Innovation: A Case Study of Israel

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**Acknowledgment**

The purpose of this report is to provide a complete and true picture of the ICT Industry in Israel. We used various sources and quoted those sources where needed. We made sure that the report will meet Samuel Neaman institutional standards for objectivity, evidence, and full response to study requirements.

This report would not have been possible without the work of the following individuals who put a lot of effort into making it come true: Mr. Eliezer Shein; Mrs. Bahina Eidelman; Mrs. Ella Barzani.

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Authors: Dr. Daphne Getz and Dr. Itzhak Goldberg
Executive Summary and Key Findings

- It has been the Israeli government’s explicit goal to position Israel at the core of the knowledge economy. Looking at the origins of the ICT sector\(^1\) in the early 1970s we can see that the process was not fully planned. This case study of Israel ICT sector highlights the important role of the government in the emergence of Israel as a powerhouse of high-tech in information and communications technology, by laying the foundations for private industry to support innovation, and through heavy investment in building the much-needed human capital resource. The main strategic asset is human resources. The quality of human capital is essential to innovation and economic growth. Skilled human resources are the most strategic assets in the knowledge society. The Israeli higher education system, mostly supported by the government, contributed a great deal to the success of Israel in the high-tech arena.

- The role of the government in advancing the economy of the state of Israel provides an excellent showcase for how a well thought-out and efficient government intervention contributed to the establishment of Israel's capability in ICT. In fact as we show in Chapter 2 and throughout this report there is broad agreement as to the major role played by the government in the emergence and development of Israel's vibrant and dynamic high-tech sector of which the ICT industry is an important part.

- Government policies as we describe them in the report helped to release astonishing development of the ICT sector as well as the whole of Israel's high-tech industry. Starting at the end of the 1980s and early 1990s Israel took full advantage of heavy investment in military and defense technology, high educational levels, skilled immigrants that came from Russia, as well as culture of innovation to cultivate the ICT sector to a level that led to the "Start-up Nation".

- The Israeli ICT Ecosystem was gradually built up in the Tel Aviv and Haifa areas, both close to leading academic institutes: Technion – Israel Institute of Technology, and Tel Aviv University. The companies in this ecosystem are export oriented. It was very difficult for the ICT companies to grow because they were far away from their customers in the United States and Europe. So the solution was to move marketing and headquarters out of Israel and establish operations close to their customers. Still, R&D stayed in Israel to take advantage of the human capital. As the ICT sector grew, multinational companies seeking innovative technology bought small startup companies and established local R&D centers. Today there are 298 multinational companies in Israel, with R&D centers, such as IBM, Intel, Apple, Cisco, Motorola and Microsoft to name a few.

- Many of the companies in the ecosystem are software companies. One area which stands out is cybersecurity. Because of the huge damage a cyber-attack could cause, as was witnessed by high-profile cyber-attack victims including eBay, Sony, and many other companies, along with financial institutions, media outlets and

\(^1\) IT & Enterprise Software, Communications, Internet, Semiconductors
government websites, it is no wonder cyber-security businesses abound worldwide. And second only to the United States, Israel provides the most products to fight this costly crime. About 200 Israeli companies specialize in cyber-security, accounting for $3 billion worth of anti-hacking exports in 2013. One-quarter of the world’s venture capital-funded cyber-security startups are Israeli. At the same time, Israel is investing major resources into a comprehensive cyber-security development complex, CyberSpark, in Beersheba. A leading company in the field is Check Point.

- Check Point was the first one with its fire wall solution. Founded in 1993 and now Israel’s biggest high-tech firm, Check Point pioneered FireWall-1 and boasts all Fortune and Global 100 companies as customers for its award-winning ZoneAlarm solutions against hackers, spyware and identity theft.

- In Chapter 4 we describe, in several case studies, how startups have developed within the ICT Ecosystem. One major insight is the fact that all entrepreneurs had a great deal of experience either from their military service or from working in a large company in the industry. They are also very good in networking and fully dedicated and focused on their target. The usually start their company after identifying a real unmet need in the marketplace that need a solution. Check Point and Wix, two of the case studies, are good examples of that approach.

- As this report is a case study of Israel’s ICT Sector, emerging markets and developing countries could learn a great deal from the lessons that Israeli companies and entrepreneurs have gained. The key to innovation is the capability to establish and cultivate a culture in which young people are not afraid to dare and establish their own startup, given that there is a good and highly capable human capital as well as supporting business environment. Bringing local citizens from abroad (US, Canada, Germany, Australia) who are experienced in the particular industry and Academe could be a good starting point.

- Chapter 5 of the report compares Israel with Singapore. This chapter analyzed the distinctive and generic ingredients that make Israel a “start-up nation”. The objective was to see which of these could be used by other countries in order to build their own high-tech industry. There are basically three key ingredients; Single-minded dedication to engineering; emphasis on world class education, above all excellence in math, as a foundation for educating engineers; and establishment of excellent infrastructures that will support the growth of high-tech industry.

- The closing chapter of the report deals with lessons that emerging markets and developing countries could employ, in order to develop their own ICT sector. An important lesson is to adopt an entrepreneurial focus in order to grow the innovation ecosystem. We also noticed that in Israel the three major drivers behind the high-tech community are strong universities, a vibrant startup community and access to capital. One important lesson for entrepreneurs is the fact that they must know their market and aim at an unmet need. Also an entrepreneur must establish a cohesive team made of smart and knowledgeable people who are dedicated and focused on their target. Through hard work and right networking and mentor they will eventually succeed.
**Snapshot of Israeli ICT 2013**

- Major Engine of Growth

### Israeli Hi-Tech

4,467 ICT Companies

- IT & Enterprise Software: 1,239
- Communications: 1,301
- Internet: 1,599

### Performance 2013

- **GDP of ICT – 11.1%** of the Israeli total business sector GDP
  
  (= NIS 69.5 Billion (c) ≈ $US 19.25 Billion)

- **Amount of capital raised in 2013 by ICT companies**
  $US 1.561 Billion

- **$US 4.25 Billion** spent on R&D in ICT

### ICT Jobs are Everywhere

- Software & Computer Services: 76%
- ICT Trade Industries: 6%
- Manufacturing: 18%

### Export in 2013

- **Export of ICT Sector – 16.4%** of the total goods and services export
  
  (=NIS 56 Billion (c) / $US 15.5 Billion)

### ICT Exits in 2014

- IT & Enterprise Software: $US 1.96 B
- Communications: $US 1.42 B
- Internet: $US 904 M
- Semiconductors: $US 1.4 B

- **Direct Jobs = 185,000** (full-time equivalent)
- **Annual average earnings of ICT workers with 3-5 years of experience:** $US89,000-$US116,000

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(a) Sources: IVC & CBS; Data are for 2013 or the most recent year available
(b) December 2014
(c) At 2011 prices
(d) Israeli High-Tech Exits include M&As and IPOs
1 Background and Sources for the Development of the ICT Sector in Israel

1.1 Historical Background of Israel's Science, Engineering, and Technology Innovation

Since its independence Israel had to fight for its protection. ICT actually evolved from survival and existence needs. Because of that the government invested large sums of money in order to develop solutions for the needs of the Israeli Defense Forces (IDF) for state-of-the-art equipment and capabilities.

When evaluating Israel’s high-tech capabilities and ICT in particular as well as its economic achievements since inception, the important role played by defense and military developments becomes apparent. In particular, defense-related R&D had significant impacts on, as much as it was aided by, Israel’s industrial sector, higher educational system in science and engineering, research community, and the composition of the ICT industry work force.

Security and needs to protect its borders forced Israel to devote a large share of its resources to defense purposes, putting a high priority on the development of modern armed forces with sophisticated military technologies and equipment, and on the ability to develop and supply these capabilities by its own means. Derived demand from this buildup for highly skilled workers, scientists and engineers affected public resources allocated to universities and research institutions, and accordingly the directions that these institutions emphasized as they expanded. The defense manufacturing industry in Israel accounts for a significant share of its industrial capacity, includes some of its largest corporations, and is considered a major worldwide player in some areas of the defense industry.

Multinational Companies account today for a significant part of the research spending in the Israeli industry. This has actually brought in a large sum of FDI (foreign direct investment). Major Corporations like Intel, IBM, Google, Cisco, Motorola, Philips, Apple and many others set up research centers in Israel in order to take advantage of the local talent. Some other research centers were set up as a result of corporate decisions and others were created after the acquisition of Israeli start-ups.

Due to government incentives and the availability of high level human capital, Israel has turned into an attractive location for R&D operations of leading multinationals. Funding from abroad constitutes today a major portion of Israel's total business
enterprise R&D funding. Recent OECD and Israel CBS data\(^2\) shows that the weight of foreign multinationals investment in the Israeli national expenditure on R&D economy (GERD) stands on at 50.7%, as compared to no more than 25% in other OECD countries (OECD, 2013). Israeli Business invests 45.3% of the total business sector expenditure on R&D.

The capital market and financing of innovation in Israel is an important sector that is very instrumental in the whole buildup of the Israeli ICT as well as the high-tech industry. We will describe the Venture Capital market in Israel and its support together with a network of Angels of the creation of new startups as well as their support for the companies as they develop and grow. The following Picture describes the amount of money raised by VC funds in 2014. It is also estimated that this will reach about $1,200 million in 2015.

![Figure 1: 2014 VC Fund Raising Reaches $914m – Most in 6 Years](image)

Source: IVC Research Center

Today Israel is a small country with a population of 8.309 million as of January 2015\(^3\). The economy grew by 2.6% in 2014. Gross Domestic Product – GDP (at purchasing power parity) per capita, i.e. the purchasing power parity (PPP) value of all final goods and services produced within Israel in current PPP Dollars for the years 2011, 2012, 2013 was $30,193, $31,648 and 32,505 respectively (OECD). This is described in Table 1.

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\(^3\) The Central Bureau of Statistics (Israel), Society & Population - Population & Demography [website]
Table 1: GDP, GDP per Capita, Israel and Selected Countries, US Dollars

<table>
<thead>
<tr>
<th></th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Israel</td>
<td>204,849</td>
<td>219,275</td>
<td>234,391</td>
<td>250,197</td>
<td>261,858</td>
</tr>
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<td>GDP per capita (current PPP $)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Israel</td>
<td>27,379</td>
<td>28,773</td>
<td>30,193</td>
<td>31,648</td>
<td>32,505</td>
</tr>
<tr>
<td>Switzerland</td>
<td>49,553</td>
<td>51,577</td>
<td>54,849</td>
<td>56,388</td>
<td>57,443</td>
</tr>
<tr>
<td>USA</td>
<td>46,930</td>
<td>48,307</td>
<td>49,732</td>
<td>51,435</td>
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</tr>
<tr>
<td>Denmark</td>
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<td>41,812</td>
<td>43,319</td>
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<tr>
<td>Italy</td>
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<td>34,396</td>
<td>35,494</td>
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<tr>
<td>Spain</td>
<td>32,804</td>
<td>32,361</td>
<td>32,678</td>
<td>32,774</td>
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<td>Greece</td>
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<td>Korea</td>
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<td>30,465</td>
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<td>32,022</td>
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<tr>
<td>Portugal</td>
<td>26,217</td>
<td>26,924</td>
<td>26,932</td>
<td>27,204</td>
<td>27,804</td>
</tr>
</tbody>
</table>

Source: OECD

Turning to the export sector, the export of goods and services rose in 2014 by only 0.6% after a 1.5% increase in 2013 and a 0.9% increase the year before\(^4\). Industrial exports excluding diamonds rose in 2014 by 2.4% following a decline the year before of 2.8%. More than 50% of Israel’s export derives from the high-tech and life science industries. GDP in 2013 was $250B and grew by 3.3% in 2014. Israel is ranked 1\(^st\) of all OECD countries by expenditure on R&D (research & development) as percentage of GDP (4.27%), demonstrating innovation, development and creativity. The OECD expenditure on R&D was 2.28% of GDP\(^5\).

In this chapter we will describe the Historical Background of Israel’s Science, Engineering, Technology and Innovation (SETI) that led the country to gain the title "Start-Up Nation".

\(^4\) Economy Grew by 2.6% in 2014, While per Capita Growth Rose by Just 0.7%, Haaretz. (2015, January 1). [website]

\(^5\) Zetelny, I. (2014). The Israeli Hi-Tech Industry. EY Israel. (January) [website]
1.2 Government Policies and Initiatives for the ICT Sector in Israel

The Israeli SETI ecosystem involves the activities of the government, research universities and institutions, medical centers, industry and not-for-profit research organizations. Today, there is no single ‘umbrella type’ organization that coordinates all STI activities and sets the overall policy.

In 1969 Israel established the Office of the Chief Scientist within the Ministry of Economy in order to help build its high-tech industry. The OCS is the major policy making body outside the university system. Under the OCS are the functional frameworks for funding research and innovation such as the R&D Fund, the Incubator program and the Magnet (consortia) program, but also operative frameworks such as ISERD which manages the Israeli side of FP7, Horizon 2020 and MATIMOP, which manages all international R&D relations including European programs (other than FP7 and Horizon 2020) and bilateral agreements with countries, regions and international corporations.

In Israel government policies towards the supply side (e.g. connectivity, equipment production, higher education and research) and the demand side (e.g. skills development, cybersecurity, and privacy) have dramatic effect on the ICT sector. We will describe those policies as well as the initiatives taken by the government.

The Council for Higher Education (CHE) is the source of statutory authority in the university based research system even though its authority is limited by the universities’ high level of autonomy. Under the CHE there are its Planning and Budgeting Committee (PBC), VATAT, which makes funding decisions, and the Israel Science Foundation, an autonomous body organized as a non-profit organization which is mostly funded by VATAT and is responsible for competitive grants for Israeli scientists.

Israel has pursued progressive liberalization and privatization in its communications and information technology subsector. These reforms have included privatization, with the sale by the Government of its controlling interest in Bezeq, Israel’s incumbent fixed-wire line service provider, in 2005; adoption of a regulatory regime suitable for a multi-operator environment; and competitive local exchange carrier (CLEC) licenses for infrastructure, transmission, data (broadband) and telephony services, a wireless tender carried out in 2010 which led to the entry of two new infrastructure-based operators, and an ongoing process for the development of a wholesale market in fixed communications. Regulatory functions are exercised by the Ministry of Communications and we will describe them in this chapter. The Communications Law empowers the Minister of Communications to enact legislation concerning all relevant telecommunications services and equipment, including technical specifications for telecommunications equipment and type approvals.
On March 2, 2008 the Ministry of Justice submitted a statement on intellectual property protection in Israel to the Office of the United States Trade Representative (USTR) as part of USTR's annual "Special 301" review process. In the submission the Government of Israel defends its intellectual property law regime as adequate, effective, in conformance with all relevant international obligations and requests removal of Israel from any intellectual property "watch list" maintained by USTR under the Special 301 process.

The Government of Israel maintains that its intellectual property law regime, including acquisition, maintenance and enforcement of intellectual property rights, is modern, effective and exceeds uniform minimum standards set forth in multilateral treaties regulating large aspects of intellectual property standards. Intellectual property law provides for monopolies limited in time and scope with respect to, inter alia, inventions, trademarks, and works of copyright, such as computer software, films and recorded music. We will describe the importance of Information Policy and the importance of the law of IPR for the development of the ICT industry in Israel and its relevance and adaptation for developing countries.

### 1.3 Analysis of the ICT Ecosystem for Entrepreneurship in Israel

The Israeli Science, Technology and Innovation ecosystem is the backbone of the ICT Ecosystem. It involves the activities of the government, research universities and institutions, medical centers, the industry and not-for-profit research organizations. As mentioned above there is no single "umbrella type" organization that coordinates all ICT as well as Science, Technology and Innovation activities and sets the overall policy. The main STI policy of the State of Israel is set, formulated and implemented by a relatively small number of organizations. The activity of these organizations with respect to the various stages of the STI policy cycle is described in detail in this chapter. Many of these organizations are involved throughout the entire process.

The main players in Israel's national research and innovation system, responsible for policy-making, formulation and governance, are the Office of the Chief Scientist (OCS) in the Ministry of Economy, responsible for industrial R&D, and the Planning and Budgeting Committee of the Council for Higher Education, responsible for academic R&D. Since 2011, the Ministry of Finance has become much more involved in policy formulation. The involvement of the Finance Ministry has helped in increasing the cooperation and coordination between all entities involved in innovation policy, including the OCS and the Planning and Budgeting Committee. An additional key player is the Ministry of Science, Technology and Space which funds numerous thematic research centers (regional R&D centers) and is also responsible for international scientific cooperation. The National Council for Research and
Development (NCRD) works under the auspices of the Ministry of Science, Technology and Space. It is responsible for devising policy and advising the government.

In this chapter we will elaborate and analyze the various elements of the Israeli ICT Ecosystem for Entrepreneurship. We will show and demonstrate that Israel has a strong innovation and entrepreneurial culture. Israel’s innovation is made up of few ingredients which include among others subjects such as highest gross expenditure on R&D, largest amount of companies listed on NASDAQ outside of North America, highest level of venture capital as share of GDP, etc. How did this success come about will be also explored.

According to Frenkel and Maital (2012) and Kon et al. (2014) one of the key factors influencing the high innovation level of the Israeli ICT ecosystem is the unique innovation (social climate) culture (e.g. risk taking, “no-giving up mentality”, and no fear of failure).

1.4 Case Studies of Successful ICT Startups Companies

SNI will study five successful ICT companies in order to examine the whole path they made starting with their startup activity, receiving OCS or Angel support and continuing with VC investment which helped those companies to grow and succeed in the global market.

We have been using the following criteria to choose the proposed companies for profiling.

**Main Sector:** ICT (Israeli company, Foreign R&D Center)

**Subsector:** Information, Communications, Semiconductors, Internet, Software, IT & Enterprise Software.

**Foreign R&D Center:** (Semiconductors, IT & Enterprise Software)

**Status:** Privately held or publicly traded (on NASDAQ, NYSE, TSE, AIM etc.).

**Revenue Growth:**

**Number of Employees:** 1-20, 21-50, 51-200, 200+

Year of Establishment: Before 2012

**OCS Support:** Received OCS Support

The process that we have gone through included selection in accordance with the above parameters. The companies which we had chosen appear on the next page. All data for the selection process was taken from IVC database which SNI was licensed to use.
The following companies were chosen: Wix, Check Point, Silverbyte, Ceragon Networks and Shadow.com.

1.5 Benchmarking and the Distinctive Ingredients that Make Israel a “Start-Up Nation”

We chose to compare Israel ICT with Singapore. In 1982 Israel and Singapore had similar GDP per Capita. In 2012, Singapore GDP per Capita was twice that of Israel and its GDP was 1.31 of Israel. GDP of Israel in 2012 was US$ 249 billion and that of Singapore was US$ 327 billion.

We have chosen Armenia and Poland as the countries where ICT ecosystem ingredients could be replicated and adjusted to their conditions.

1.6 Conclusion and Lessons for the Emerging and Developing Countries

This chapter includes lessons that could be learnt from the analysis of Israel ICT sector performance over the years 1990-2014.

The Israeli innovation ecosystem was created only 25 years ago (around 1990), and this alternative Silicon Valley offers some fascinating new technologies, contributing to improve our lives. There are currently 6,521 high-tech companies and 298 foreign R&D centers in the IVC database. Of those 4,467 are in the ICT sector. These companies and R&D centers are the base frame of the Israeli smart ecosystem.
2 The Role of Government: Government Policies and Initiatives for the ICT sector in Israel

2.1 Introduction

It has been the Israeli government’s explicit goal to position Israel at the center of the knowledge economy. This goal has been achieved through close collaboration between the government and business, with government involvement focused and limited, ready to withdraw as soon as the private sector was able to continue on its own. The government’s readiness to withdraw its intervention has mitigated the risks of government failures such as capture or corruption, which in other countries undermined the transparency of innovation support programs.

The economy has seen rapid growth since the early 1990s. This is in part due to the influx of highly educated Eastern Europeans after the fall of communism in 1989 and increasing foreign investment, especially in the high-tech industry.

This case study highlights the important role of the government in the emergence of Israel as a high-tech power, encouraging and supporting the capacity of the private sector to compete in international markets. Significant components of government action have taken the form of:

- Heavy investment in education, reinforced by large-scale immigration to provide the necessary human capital,
- Effective investment incentives favoring foreign investors to build industrial momentum,
- Investment in R&D as a proportion of GDP (4.4% in 2008 and 4.2% in 2013) higher than that of any other industrialized country,
- Incubator and venture capital programs to convert research into cutting edge businesses,
- Heavy investment in defense technologies.

Alongside these helpful interventions, providing a backdrop for the development of information and communication technologies, Israel has also made important strides in laying the foundation for macroeconomic stability. Not only has inflation fallen sharply from the runaway levels seen in the mid-1980s, but wide-ranging reforms have been put in place aimed at reducing the scale of the public sector and the role of the

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state in the allocation of resources, and, more generally, at supporting the modernization of the economy.

This chapter will outline the role of the Israeli government in supporting ICT development, and the influence of education, culture, immigration, and security issues on Israel’s achievements. This is followed by a detailed discussion of the role of government in investment and R&D, and the relationship between the ICT sector and Israel’s overall economy.

2.2 The Role of Government in Achieving Global Competitiveness

As a general-purpose technology, ICT holds the potential of transforming economies and societies. The various components of ICT can help address some of the most pressing issues of our time and support inclusive growth. In fact over the past 25 years we could see that information and communication technologies (ICTs) were becoming more powerful, more accessible, and more widespread. Furthermore, they were playing a key role in enhancing competitiveness, enabling development, and bringing progress to all levels of society.

By observing the economic progress over the past 15 years (2000-2015) we could see that ICT technologies and products provide a lot of evidence of these advances. Countries such as the Republic of Korea, Finland, Israel, Estonia, Armenia and Poland have based their national competitiveness on ICT products and services. The Israeli government realized early on that the information and communication technologies could become a growth engine for the economy. Consequently through the adaption of some incentive laws, supporting the creation of VC funds and the establishment of the OCS within the Ministry of Economy it supported the building of that sector and the creation of an ICT Ecosystem.

The spread of ICTs have also had wide societal impact, especially on less-privileged segments of society. For example, farmers in developing countries have benefited from new ICT services such as real-time information about commodity prices and weather, sensors that inform about soil and field conditions, and from the ease of money transfers. The effectiveness of governments has increased as a result of their ability to provide citizen-centric online services and to involve citizens in governance. ICTs have become key enablers of business and employment creation, and of productivity growth. For these reasons, ICTs have significant potential for supporting inclusive growth as well as increasing the competitiveness of the economy.

8 The Networked Readiness Index 2015: Taking the Pulse of the ICT revolution. World Economic Forum [website]
In 2014 Israel retained the 27th position in the Global Competitiveness Index Report, the same it occupied in 2013 GCI. The country’s main strengths remain in its world-class capacity for innovation (3rd), which rests on innovative businesses that benefit from the presence of world’s class research institutions (3rd), support by the government through public procurement policies (9th), and a favorable financial environment for start-ups (availability of venture capital is assessed at 9th place).

Table 2 describes the network readiness and global competitiveness ranking of Israel over the last three years.

Table 2: Network Readiness and Global Competitiveness for Israel

<table>
<thead>
<tr>
<th>Network Readiness Index</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NRI 2015 Rank</td>
<td>NRI 2014 Rank</td>
</tr>
<tr>
<td></td>
<td>(percentiles out of 148)</td>
<td>(percentiles out of 144)</td>
</tr>
<tr>
<td></td>
<td>21 (14.2%)</td>
<td>15 (10.4%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Global Competitiveness Index</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(percentiles out of 144)</td>
<td>(percentiles out of 148)</td>
</tr>
<tr>
<td></td>
<td>27 (18.8%)</td>
<td>27 (18.2%)</td>
</tr>
</tbody>
</table>

Source: World Economic Forum

Israel’s program from its start in the 1970s, has been particularly geared towards “sector-neutrality”, meaning that the government did not "pick winners" (Trajtenberg, Goldberg et al). The case of the Incubator Program, which we describe later, is an excellent illustration of such an approach, since it has provided, and still provides today, financing and support to ventures in the early pre-seed stage, when the funding gap could prevent many of them from moving forward from the idea phase to the project phase that is attractive to private investors or VCs.

The market-friendly nature of government intervention in Israel has resulted in considerable flexibility and dynamism. Thus, permitting specific policies and instruments to evolve over the years, and adapt to what were perceived as the most pressing needs of the time. An example is the array of programs put in place by the

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government to encourage R&D at different points along the life of a project over the past years since 1990.

It was also market considerations (export to international markets) which led Israeli policymakers to concentrate on innovation and R&D. Israel lacks natural resources. Consequently the government realized very soon that Israeli comparative advantage resided in its qualified human capital rather than in its relatively scarce natural resources and land. The national market was too small and very limited to sustain national industries and the political situation prevented selling to neighboring countries. Therefore, the target inevitably had to be the international market, requiring a focus on innovative products which could be sold to the international markets. These unfavorable structural parameters—market size and the adverse political geography including the geopolitical environment—served as catalysts to spur the development of an industry which ultimately would not depend for its success on these two factors.

To conclude this we would like to refer to Bloomberg's 2015 ranking of the world’s 50 most innovative countries\textsuperscript{10}. Israel has been ranked number five overall on this year’s Bloomberg Innovation Index, which is an annual ranking of countries that measures performance in research and development, tech education, patents, and other marks of technology prowess.

Israel did especially well in the R&D category, with the country ranking second in GDP expenditure on research, as well as on the percentage of the labor force with advanced degrees and the number of research professionals per million population. Israel ranked fourth overall in both those categories.

The study measured country rankings in six areas: R&D, manufacturing, the number of high-tech companies located in each country (the total number, not adjusted for population size), the number of students enrolled in post-secondary education programs, the number of PhDs working in R&D, and the number of patents per capita.

2.3 Education

As a small country with limited natural resources, the government has long recognized the importance of investing in human capital for its development. Building on a strong cultural heritage stressing excellence in education, universities began to be established in the 1920s. With the founding of the state of Israel in 1948, the government focused its attention and resources on the development of a first class educational and scientific research establishment. By the early 1970s, there were six university level centers of teaching and research: the Technion – Israel Institute of Technology in Haifa, the

\textsuperscript{10} The Bloomberg Innovation Index. (2015) [website]
Weizmann Institute for Scientific Research in Rehovot, Hebrew University in Jerusalem, Tel Aviv University and Haifa University, Ben Gurion University in Beer Sheba.

While traditional universities have not changed greatly, with about 30 percent of students receiving degrees in sciences and engineering, the growing demand for higher education over the last 30 years (1985-2015) has been met by liberalizing higher education to allow private colleges, foreign competition, and by recognizing degrees granted by technical schools accredited by the Ministry of Education. Between 1980 and 2000, the percentage of the population with at least 13 years of education rose from 21 to 41 percent for Jewish citizens and from 7 to 21 percent for non-Jewish citizens\(^\text{11}\).

Over the course of the 1990-2010 past two decades, higher education in Israel has been increasingly on the rise. In the 1989/90 school year, 88,800 students studied in 21 Israeli academic institutions. In 2010/11, 297,800 students (including 46,000 Open University students) studied in 66 Israeli academic institutions, an average annual growth of 5.9 percent. This increase is primarily a result of the establishment of academic colleges during the 1990’s and early 21\(^\text{st}\) century. The year 2010 marked an end to the rise in the number of students beginning their first degree studies. However, an increase was seen in the number of students enrolled in second degree programs. According to Israel’s Central Bureau of Statistics (CBS) 60% of Israeli young adults continue on to first degree studies. This percentage is significantly higher than that of 2000 (48%)\(^\text{12}\).

This process of establishing academic colleges provided the trained managers and workers needed by a rapidly expanding high-tech industry. Furthermore, attempts have been made from time to time to reprioritize various professional streams within Israel’s system of higher education. For instance, in the early 1990s, industry leaders saw the need to retrain many of the graduates from the top universities in electronics and computer science. Task forces were created and a major boost was given by the universities to these particular areas. In other words, there have been fairly successful attempts to shift the priorities of career work streams within the public university system to reflect the most pressing needs of industry, particularly the high-tech sector, because of its perceived growth potential and its contribution to the GDP.


ICT in Education in primary and secondary schools

Computer Science in schools in Israel

The continuous and increasingly rapid development and implementation of computer and other information technologies over the last decades is a distinct feature of modern societies. In the digital age, information and communications technology (ICT) plays a key role in creating and exchanging knowledge and information around the globe and affects citizens’ everyday life in many areas—at school, in the workplace, and in the community. Nowadays, knowledge about, access to, and use of ICT are vital for participating effectively in society in this information age. Acquiring and mastering ICT skills—computer and information literacy (CIL)—has thus become a major component of citizens’ education, and many countries have accordingly recognized the importance of education in ICT. This is beautifully described in a “Preparing for Life in a Digital Age” report by the IEA International Computer and Information Literacy Study\(^{13}\).

Israel established a strategy based upon the alignment of interests and common objectives set by government, industry and educators on the subject of computer sciences and ICT studies. The evolution of the Israeli curriculum was first comprehensively set out in a seminal article from 1995 by Prof. Judith Gal-Ezer,\(^ {14}\) with a subsequent ‘Model’ for High School education\(^ {15}\) by Prof. Orit Hazzan, Judith Gal-Ezer and Lenor Blum based on their experience evolving the Israeli curriculum from ICT into Computer Science two decades ago.

According to a report "Computing at School International comparisons - Version 5, November 2011" Israel undertook a major review of computing at school around the turn of the century, and now has the most rigorous Computer Science high school program in the world\(^ {16}\).

An important component embedding learning in schools and with teachers is Machshava Israeli National Computer Science Teaching Centre. Founded in 2000 by the Israeli Ministry of Education, Machshava is considered as the professional home for all Israeli computer science teachers. The center activities are organized around five major themes:

1. Helping create a professional community of computer science teachers;
2. Fostering the professional leadership of computer science teachers;

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\(^ {13}\) Preparing for Life in a Digital Age - The IEA International Computer and Information Literacy Study International Report. IEA. (2013) [website]

\(^ {14}\) A High-School Program in Computer Science [website]

\(^ {15}\) A Model for High School Computer Science Education: The Four Key Elements that Make It! [website]

\(^ {16}\) Computing at School - International comparisons [website]
3. Supporting, assisting and consulting academic computer science education groups, and computer science teacher educators and researchers;
4. Collecting and distributing computer science education knowledge and experience;
5. Researching and evaluating computer science teachers’ needs and the centre’s activities.

To this end, the Ministry of Education has adopted the concept of the international venture IEA-ICILS\textsuperscript{17} that has to teach students computer and information literacy. This literacy is the ability of the individual to use computers in research, to learn creativity and effective communication at school, at home and in the community.

### 2.4 Immigration

Immigration has always been a central feature of the development of the State of Israel, as Jews from many countries returned to their historic homeland, bringing diverse talents and capacities, combined with the motivation and creativity of a pioneering movement. The fortuitous coincidence of the collapse of the Soviet Union combined with the explosion of information and communications technologies in the late 1980s gave the Israeli ICT industry a major boost.

Between 1990 and 2009 approximately 1.25 million people immigrated to Israel, about 80% of them from the former Soviet Union (FSU). In 2009, immigrants from the FSU accounted for 45% of the total immigrant population\textsuperscript{18}. Between the years 1989 and 1999 almost one million refugees from Eastern Europe arrived in Israel, many with advanced degrees, technical training, and often bringing with them ambition, innovative approaches to problem solving, and a strong scholastic tradition. This increased the population by a fifth and reinforced its general educational level.

These immigrants included more than 100,000 scientists and engineers, giving Israel by far the highest number of engineers per capita in the world—140 per 10,000 employees, more than twice the level of the United States and Japan, the second and third ranking countries in the list. This massive influx of manpower ensured the development of the ICT industry until near the end of that crucial decade. However, it did create a major challenge to absorb so many people, and the government set up retraining and business development programs to facilitate the process. With the rapid expansion of the industry, skilled immigrants were quickly integrated. This expansion also attracted highly trained and experienced Israeli engineers, many of whom had previously emigrated to the US and Europe, but who now saw the opportunity to set up research centers for their foreign employers or startups of their own in Israel.

\textsuperscript{17} ICILS 2013 - International Computer and Information Literacy Study. IEA [website]
\textsuperscript{18} The population of Israel 1990-2009 Demographic Characteristics. CBS. (2010) [website]
Work Permits for Israel

A foreign national who has been assigned to work in Israel must obtain a work permit and an appropriate entry visa prior to entering Israel. Israeli law generally provides for only one type of work status, relating to the employment of foreign professionals and non-professionals alike: the B-1 visa category.

There are few areas such as nursing care of old people where Caregivers can get a work permit up to 63 months. Additional fields are Agriculture and Construction for which it is relatively easy to get a work permit. However, for high-tech people it is a different story and not easy.

An Israeli employer (or a well-known global/foreign company) must be the official sponsor of a work permit application. Therefore, there is no method for a self-employment working permit. A work permit application must contain a job position offered and provide complete details relating to the prospective employee, including their educational background, professional experience and proposed salary in Israel. Processing times for work permit applications usually range from four to eight weeks. Please refer to the "Invest in Israel" website which further explain the procedure of Obtaining Employment Permits and Working Visas for Foreign Executives, Managers and Specialists at International Firms.

2.5 Investment Incentives and Capital Market Reforms

One major area of government intervention has been in the policies and measures encouraging domestic and foreign capital investment in Israel. The investment incentive package had its origins in the Law for the Encouragement of Capital Investment (LECI), adopted in 1959 to attract private investment—especially in the most remote and least developed areas of the country — and to foster business initiatives, employment, and exports.

The law, revised on a number of occasions to take into account new technological and economic developments, did not explicitly favor the high-tech or any specific industrial sector, but rather, ventures with high value-added and marketing capabilities in local and international markets. The importance given to both new and existing projects varied according to the specific zone, whereas the contribution to exports had to be more substantial for the central areas, zones C and B, than for the peripheral one, zone A, for which the contribution to local employment was valued more. Those enterprises, both Israeli and foreign-owned, which were deemed eligible by the Israeli Investment Centre — a department of the Ministry of Economy which is in charge of the law's
administration—gained the status of “Approved Enterprises” or “Beneficiary Enterprises.” They were thus in a position to benefit from government grants—up to 24 percent of tangible fixed assets—and/or tax benefits in various forms, depending on the geographical location and the percentage of foreign ownership.

Beyond the stated goal of LECI to promote private initiative and internationally competitive products, the market-friendly character of the law can be seen in its attempt to provide institutional underpinnings to the initiatives of private investors, and to share with them the higher risk associated with the development or expansion of a venture, addressing in this way the market failures inherent in the preliminary stages of investment.

LECI deliberately introduced a bias in favor of foreign investors, which took the form of preferential tax treatment with respect to national investors. It was thought that a favorable tax regime and the relative abundance of well-trained engineers and scientists would strengthen the attractiveness of Israel as a location for multinationals. The policy was based on a specific rationale: multinationals would not only create employment in Israel, but they would also bring with them the technology, know-how, operating procedures, managerial skills and exporting channels that the nascent Israeli industry needed. In other words, the idea was to leverage the spillovers deriving from the operations of the multinationals in Israel for the development of the local high tech industry.

2.6 Foreign Direct Investment - FDI

The government’s strategy worked well: international investors flocked to Israel during the 1960s and 1970s, including high-tech giants such as IBM, Motorola, and Intel that were followed by many others. Figure 2 shows the evolution of Foreign Direct Investment (FDI) over the 1991–2002 period and Figure 3 shows the inflow of FDI for the years 2003–2014.

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This process has been facilitated by a number of reforms in the capital markets which have considerably improved the efficiency of the Israeli financial system and its internal competition. These have mainly involved deregulation and the elimination of a host of
administrative restrictions and interventions, and the welcome reform of the capital market which centered on the separation of the various funds from the banks. Reserve requirements, which had ranged well over 30 percent in the late 1980s, had fallen to an average of 4 percent by the end of the 1990s. This, in turn, contributed to a marked narrowing of interest rate spreads. Undue segmentation of the credit markets was sharply reduced; for instance, the share of mortgage credit allocated by the government fell from 70 percent in the mid-1980s to less than 25 percent by the end of the 1990s. Even sharper drops took place with respect to other forms of credit.

The reforms also saw a sharp reduction in the share of obligatory investments in government bonds by pension and provident funds. Provident funds, the largest institutional investor in the Israeli economy, were allowed to invest a much larger share of their holdings in equities and other financial assets. Alongside these efforts aimed at deregulation, there was also significant streamlining and modernization of the stock market, which emerged as one of the most technologically advanced in the world, with continuous trading and short clearing periods, against a background of fairly sound securities legislation.

There are ongoing efforts to broaden the range of financial instruments offered to the public, to ensure equal tax treatment of different classes of investors and/or savings instruments, and to encourage more long-term savings. The modernization of the financial sector is thought to have played a strong supportive role in the development of the ICT industry. To the extent that these reforms were driven by a desire to improve market efficiency, they made it easier for emerging companies to obtain funding under more favorable circumstances. Parallel progress in bringing inflation levels down to international levels also contributed to the creation of a more stable macroeconomic environment, conducive to private sector activity in a more predictable climate.

Foreign investors in the ICT sector have typically used one of two options to establish a presence in Israel: they have either set up operations directly, or adopted a strategy of mergers with, or friendly take-overs of, small local companies. As shown in Table 3, as regards operations carried out in Israel, foreign investors have placed the emphasis on the installation of research and development facilities. Microsoft built its first R&D facility outside the United States in Israel; Cisco has its first R&D center outside the United States in Israel, and Motorola’s R&D center in Israel is its largest worldwide. Those foreign companies were taking advantage of Israel’s ample supply of highly skilled engineers, and its solid track record for innovation and problem solving. In this regard, some have argued that the above competitive advantages have been a mixed blessing for the Israeli economy, in that research facilities do not generally make the same contribution to job creation and exports as do manufacturing plants. In fact they also act as a drain on limited Israeli brain power which could otherwise be used by local firms (Trajtenberg, 2005).
Table 3: Multinational Companies with R&D Centers in Israel (Partial List)

<table>
<thead>
<tr>
<th>R&amp;D Centre</th>
<th>R&amp;D Centre Sector (IVC classification)</th>
<th>Number of R&amp;D Centers in Israel</th>
<th>Establishment Year in Israel</th>
<th>Number of employees in Israel</th>
<th>Key innovations/technologies/products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>Semiconductors</td>
<td>3</td>
<td>2011</td>
<td>500</td>
<td>Development of hardware &amp; chips for I-phone and I-pad</td>
</tr>
<tr>
<td>General Motors</td>
<td>Miscellaneous Technologies</td>
<td>1</td>
<td>2011</td>
<td>60</td>
<td>Autonomous Vehicles; Human Machine Interface (HMI); Connected Vehicle</td>
</tr>
<tr>
<td>Yahoo!</td>
<td>Internet</td>
<td>2</td>
<td>2008</td>
<td>50</td>
<td>Time Traveler application, smart advertising (market segmentation)</td>
</tr>
<tr>
<td>Google</td>
<td>Internet</td>
<td>2</td>
<td>2007</td>
<td>250</td>
<td>Google Autocomplete, Live Results, Google Related, Google Instant, Google Analytics</td>
</tr>
<tr>
<td>SanDisk</td>
<td>Semiconductors</td>
<td>3</td>
<td>2006</td>
<td>700</td>
<td>Trusted Flash technology; digital cameras (with Zoran); SSD drivers</td>
</tr>
<tr>
<td>Samsung</td>
<td>Semiconductors &amp; Communications</td>
<td>2</td>
<td>1999</td>
<td>250</td>
<td>Galaxy Camera, eye tracking system for Galaxy S4 smartphone</td>
</tr>
<tr>
<td>HP</td>
<td>Miscellaneous Technologies</td>
<td>4</td>
<td>1994</td>
<td>5,700</td>
<td>Enterprise Swarm; Automatic Print Quality Inspection; Semantic Automation from Screen Capture; HP Indigo Photo Enhancement Server</td>
</tr>
<tr>
<td>Qualcomm</td>
<td>Semiconductors &amp; Communications</td>
<td>3</td>
<td>1993</td>
<td>260</td>
<td>Wi-Fi technology and the next generation of wireless LAN connectivity; Mobile enterprise security technologies; Qualcomm Snapdragon Mobile Development Platforms; Digital pen and gestures based on ultrasound technology</td>
</tr>
<tr>
<td>Microsoft</td>
<td>IT &amp; Enterprise Software</td>
<td>2</td>
<td>1989</td>
<td>800</td>
<td>Business Intelligence in the Cloud and in Office, XBOX Analytics: building a novel real-time recommendations platform for the Microsoft entertainment business</td>
</tr>
<tr>
<td>Intel</td>
<td>Semiconductors</td>
<td>5</td>
<td>1974</td>
<td>10,500</td>
<td>Pentium M microprocessor Sandy Bridge and Ivy Bridge family of processors</td>
</tr>
<tr>
<td>IBM</td>
<td>IT &amp; Enterprise Software; Semiconductors</td>
<td>3</td>
<td>1949</td>
<td>1,000+</td>
<td>ECO-2000 Optimized Crew Scheduling System; WebSphere Content Discovery Server; mobile shopping app</td>
</tr>
</tbody>
</table>

Sources: Cohen, 2013, and Ministry of Economy. Invest in Israel: The Companies sites [website]

Note: Today there are more than 250 foreign R&D centers active in Israel.21

The contribution made by multinationals to the development of the Israeli high-tech industry (in particular the ICT sector) is generally viewed as positive, given the many spillovers to the local economy, such as easier access to the international financial and

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21 Invest In Israel - Foreign R&D Centers in Israel [website]
business markets, improved export channels, and the transfer of know-how and managing/marketing skills from the personnel of multinationals to local companies.

In addition to creating state-of-the-art R&D centers, companies such as Intel and Motorola established manufacturing facilities, which rapidly became some of the largest private employers in Israel. In 2003 Intel was employing more than 6,000 workers at several plants scattered around the country (Haifa, Jerusalem, Kiryat Gat, Petach Tikva, and Yakum), and has developed into one of the top Israeli exporters, with a volume of US$1.6 billion in 2003, equivalent to 13 percent of total Israeli electronic exports. By December 2014, Intel had 10,500 employees and exported US$4.5 billion. The linkages between Intel and Israel are particularly strong, as evidenced by a rapid ramping up of multibillion dollar investments, mainly to expand capacity at existing plants, some of which have become world leaders of research and innovation.

MNCs and Exit Activities in 2015

According to IVC-Meitar Exits Report for the first six months of 2015, Israeli high-tech exit activity accelerated. It amounts to $5.29 billion in 54 deals. This is the highest half-year in a decade, second only to the exceptional H1/2012 which totaled $8.33 billion. Most of the exits were M&A and only 6% of the total were due to IPO. The following table describes the top ten. This performance is an evidence to the vibrant ICT sector in Israel. Table 4 describes the top ten exits in H1-2015.

<table>
<thead>
<tr>
<th>Company</th>
<th>Exit Value</th>
<th>Buyer</th>
<th>Field</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNDtech</td>
<td>1,250</td>
<td>D+H</td>
<td>Software</td>
</tr>
<tr>
<td>Borderfree</td>
<td>450</td>
<td>Pitney bowes</td>
<td>Internet</td>
</tr>
<tr>
<td>Comverse</td>
<td>272</td>
<td>Amadocs</td>
<td>Communications</td>
</tr>
<tr>
<td>Comverse</td>
<td>175</td>
<td>Tech Mahindra</td>
<td>Communications</td>
</tr>
<tr>
<td>Travel Fusion</td>
<td>160</td>
<td>Ctrip</td>
<td>Software</td>
</tr>
<tr>
<td>Annapurna</td>
<td>360</td>
<td>Amazon</td>
<td>Semiconductors</td>
</tr>
<tr>
<td>Panaya</td>
<td>230</td>
<td>Infosys</td>
<td>Software</td>
</tr>
<tr>
<td>Redbend</td>
<td>200</td>
<td>HARMAN</td>
<td>Software</td>
</tr>
<tr>
<td>eXelate</td>
<td>200</td>
<td>Nielsen</td>
<td>Internet</td>
</tr>
<tr>
<td>WatchDox</td>
<td>100</td>
<td>BlackBerry</td>
<td>Software</td>
</tr>
</tbody>
</table>

Source: IVC^22

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^22 $5.29 billion in exits for Israel’s high-tech industry in H1/2015: 76% of 2014. IVC-Meitar Exits Report – H1/2015 [website]
2.7 Government Support for R&D

Government support for R&D as a coherent body of policies and programs began somewhat later than the policy of incentives to private investors. By then, the economy and the flow of immigrants had slowed, after two decades of strong growth. The need to define a new development strategy was seen as a top priority. Building on considerations similar to those which had motivated the policy on investment incentives — notably, the abundance of a highly skilled labor force, a culture of technological and scientific excellence, and the scarcity of natural resources — the government decided to actively promote the development of a science-based sector by subsidizing private-sector R&D projects.

A first step in this direction was the creation, in the late 1960s, of the Office of the Chief Scientist (OCS), at the Ministry Economy. The OCS administers and grants government funds for R&D, and operates on the premise that the business sector alone is incapable of carrying on an optimal level of R&D for market growth, thus under such conditions government involvement through support of industrial R&D is needed as described in Figure 4.

Figure 4: OCS Ministry of Economy – Support Programs for R&D

![Diagram showing support programs for R&D](image)

Source: OCS report

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23 The Ministry of Economy [website]
Research and Development (R&D) is considered a fairly risky investment. As a result, R&D investment by the private sector can be scarce—a serious obstacle to the goal of maintaining Israel’s lasting competitive edge in Applied Innovation. The Government’s willingness to share in this risk greatly aids in both Chief Scientist (OCS) in the Ministry of Economy, empowered by the “Law for the Encouragement of Industrial Research & Development – 1984” (The R&D Law), oversees all government-sponsored support of R&D within Israeli industry. It operates through the R&D Fund, as well as a gamut of domestic and international programs, agreements and collaborations. The OCS supports hundreds of projects annually, ranging from incipient concepts within a pre-seed framework, to incubator and start-up companies, to autonomous industrial R&D enterprises.

The R&D Fund is the main instrument of The R&D Law. It gives partial financing of 20 to 50 percent to “Approved R&D Programs”— programs lasting one or more years that will result in the development of a new product or in a significant improvement to an existing product. The development may also lead to a new industrial process or to a significant improvement in an existing industrial process. Support for the Beta Site stage of a project can also be accredited as part of the R&D expenditure and is recognized as an important and integral part of the R&D process. The annual budget of approximately NIS 1.5 Billion (~USD 375 Million) supports applied R&D for hundreds of companies through various programs\(^{24}\) in the innovation process. The programs and interventions of the OCS take in the whole spectrum of the innovation process, trying to make up for market failures, when it appears necessary to overcome potential bottlenecks in private initiative/funding.

In the past decade, OCS grants have been reduced both in scale and in their share of the state budget. Figure 5 shows the OCS budget for the years 2000-2013.

Please note that we added a trend line in order to show the fact that the OCS budget for those years had been reduced.

\(^{24}\) R&D Incentive Programs. OCS [website]
The international program of the OCS responds to a different set of considerations. The relative strength of the Israeli high-tech sector lies in the R&D phase. Its weaknesses, however, stem from lack of expertise and skills in international marketing, due to the country’s geographical remoteness (in 2013 ICT export was 16.4% of the total export) and the small size of its companies. These two factors suggest the importance of establishing links and formal mechanisms for cooperation with companies in the target markets.

In that spirit, the fostering of contacts between national and foreign companies leading to joint R&D, manufacturing, and marketing has been an important focus of government R&D policy. Many supporting programs have been established to promote this goal, among which the most notable are bi-national funds (such as the Israel-US BIRD Foundation), parallel funding agreements, and participation in the European agreements offering partnering services (EUREKA, the Sixth and Seventh Framework Program for R&D, known as FP6 and FP7). Currently Israel participates in the EU Horizon 2020 R&D Program. The OCS is assisted in the implementation and administration of these agreements by MATIMOP, which was created to serve as the national hub for encouraging the participation of Israeli enterprises in bilateral/multilateral programs for industrial R&D.

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25 A trendline has been added
26 ICT Sector Estimate for 2014 - 4% Increase in GDP. CBS Media Release 212/2014. 12 August 2015 [website]
Encouraging growth, increasing productivity and promoting technological innovation in the industry in Israel is very important. To accomplish all these activities in today’s fast moving market will require an agile and flexible organization. This led to amending the Law for the Encouragement of Industrial Research and Development that was passed in 1984.

On June 21, 2015 the government of Israel approved the structural change in the Office of the Chief Scientist in the Ministry of Economy. The OCS will become The National Authority for Innovation. This change is in light of the importance of innovation to the Israeli economy. The chief scientist in the ministry of economy will be the head of the new administration.

More operational flexibility will be important given the new, multi-faceted, mission of the new innovation administration. Whereas the mission of the OCS so far has been focused on creating an innovation ecosystem, the new mission will be to pursue two goals simultaneously:

- Maintain Israel’s position in an increasingly competitive global innovation marketplace and
- Inject innovation into all sectors of the Israeli economy.

The main objectives of the new Innovation Authority is to encourage Innovation for Inclusive growth. This will eventually lead to increase in productivity and promoting technological innovation and R&D in the industry as a whole (including traditional industries) and services sector in Israel which is crucial for the Israeli economy.

2.8 International Support

International support programs include bi-national funds for competitive R&D, enabling a joint R&D program with a foreign counterpart. A partial list of some of the joint R&D programs appears in Table 5.

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27 Office of the Chief Scientist Israel [website]
In addition, numerous international R&D agreements with such countries as Austria, Belgium, Ireland, Germany, Holland, France, Hong Kong and China, among others, provide access to sources of national funding – Israeli companies participating in the program are entitled to receive R&D grants from the OCS.

### 2.9 Innovation: Technology Incubators

The OCS initiated the **Public Technological Incubator Program (PTIP)** in 1991 in the wake of the large influx of immigrants from the former USSR, many of whom were scientists and engineers. The Technological Incubators Program was a government response to a market failure situation. In this context market failure is defined as an early stage, high risk, innovative technological companies that cannot raise money from the private sector.

Technological incubators are support organizations that give inexperienced entrepreneurs an opportunity to develop their innovative technological ideas and set up new businesses in order to commercialize them. The goal of the incubators is to support novice entrepreneurs at the earliest stage of technological entrepreneurship, and help them implement their ideas and form new business ventures. Each incubator is structured to handle 10 – 15 projects simultaneously, and provides assistance in the following areas: determining the technological and marketing applicability of the idea, drawing up an R&D plan and organizing the R&D team, raising capital and preparing for marketing, providing secretarial and administrative service, maintenance, procurements, accounting and legal advice (Frenkel and Maital, 2014). The 1991-1998 incubators program evolved some 500 graduating companies with a 50% success rate (Trajtenberg 2000).

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**Table 5: A List of Joint R&D Programs (Partial List)**

<table>
<thead>
<tr>
<th>Fund Name</th>
<th>Countries</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIRD</td>
<td>Israel-USA</td>
<td><a href="#">www.birdf.com</a></td>
</tr>
<tr>
<td>CIIRDF</td>
<td>Israel-Canada</td>
<td><a href="#">www.ciirdf.ca</a></td>
</tr>
<tr>
<td>SIIRD</td>
<td>Israel-Singapore</td>
<td><a href="#">www.siird.org.il</a></td>
</tr>
<tr>
<td>BRITECH</td>
<td>Israel-Britain</td>
<td><a href="#">www.britech.org</a></td>
</tr>
<tr>
<td>KORIL</td>
<td>Israel-Korea</td>
<td><a href="#">www.koril-rdf.or.kr</a></td>
</tr>
<tr>
<td>VISTECH</td>
<td>Israel-Australia (Victoria)</td>
<td>Website[^28]</td>
</tr>
</tbody>
</table>

[^28]: Victoria-Israel Science and Technology Research and Development Fund (VISTECH) [website]
[^29]: Technological Incubators Program: Incubators Information. OCS [website]
The primary goal of this program is to transform innovative technological ideas in their early, high-risk stages into viable startup companies capable of raising money and operating on their own.

Additional goals of the technological incubators program are:

1. Promote R&D activity in peripheral and minority areas.
2. Create investment opportunities for the private sector, including venture capitalists.
3. Transfer technologies from research institutes and implement them into the industry.
4. Enhance the entrepreneurial culture in Israel.

The program is subject to the R&D law with regards to manufacturing, royalties and IP rights. More information can also be found at the [Israel Advanced Technology Industry](https://www.iati.org.il).

The Annual Government Budget to the Technological Incubator Program is about $50M. Also the government support to each technological incubator is as follows:

- Average budget of project: $500K
- Government grant: 85% of budget
- Incubator’s investment: 15% of budget
- Payback: 3% royalties from revenue
- Support duration: 2 years
- Extended support to Biotech/Pharma & Clean-Tech projects

The Incubator offers the entrepreneurs the following services as described in Figure 6.

- Appropriate facilities and infra-structure for R&D.
- Financing.
- Central administrative services (secretarial, accounting, legal, commercialization).
- Management & Technical assistance.
- Professional & Business guidance.
- Connectivity to potential customers, partners and investors
- Inter-tenant synergism.

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30 Israel Advanced Technology Industries: Incubators. IATI [website]
Figure 6: Services offered by Tech. Incubator

- **Secretarial Services**
- **Infrastructure / Facility-Based Services**
- **Business Services**
- **People Connectivity and Networking**
- **Financing and Access to finance**
- **Education and Access to Knowledge**
- **Brand Building**

**Fields of Activity**

The incubators operate in all fields of R&D, especially in Life science (including medical devices), Cleantech and ICT. Out of ~180 incubated companies, ~40% are medical device companies, ~10% are Biotechnology & Pharma, ~15% are Cleantech, ~30% are ICT and ~5% are in other areas such as machinery and materials. Please note that many of the medical device companies are actually ICT since they use electronic circuitry which includes computer hardware and software.

**Results**

Since 1991 and to the end of 2013, the government initiated over 1,900 companies with a total cumulative government investment of over 730 Million Dollars. Over 1,600 companies had matured and left the incubators. Of these graduates, 60% have successfully raised private investments. By the end of 2013, ~35% of the incubators graduates are still up and running. The total cumulative private investment in graduated incubator companies surpassed 4 Billion Dollars. This means that on every Dollar the government invested in an incubator company, the company raised an additional 5-6 Dollars from the private sector.

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31 Technological Incubators Program. OCS [website]
Conclusion

Policy makers in OECD countries recognized early after WWII the need for supporting R&D due the market failures in its generation (spillovers and information asymmetries), likely to results in suboptimal levels of investment in R&D. Later on policy makers realized that the risk of government failures needs also to be taken into account and followed policies to mitigate them. In Israel the process has begun in the 1970s. Government support created new R&D in Israel that would not have been undertaken had it not been for the support. Government R&D supports boosted industrial output. The total effect of successful R&D consists of both a direct effect of the firm that conducted the R&D and an indirect effect on other firms (spillover) the study shows that the total return to the economy from government R&D support is very high with spillovers coming mainly from medium to large firms.

Note 1: For more information please go to the following sources: http://www.incubators.org.il/article.aspx?id=1703

Note 2: Please look at SNI report "Public vs. Private Technological Incubator Programs: Privatizing the Technological Incubators in Israel" [website]
3 Analysis of the ICT Ecosystem for Entrepreneurship in Israel

In this chapter, we describe the Israeli ICT Ecosystem which is part of the innovation ecosystem in Israel. As a country widely described as the "start-up nation" (Senor and Singer, 2011), there is considerable interest in the system and forces that drive Israel's vigorous entrepreneurship. We start by giving an overview of Israel's Silicon Wadi and the change in the structure of the ICT industry. Next we describe the ICT market and the transformation it went through including privatization and regulations. Then we describe the financing of startups and innovation within the ICT market. We continue by describing the telecommunication, semiconductors & components, software and Internet which are important part of the ICT industry. Finally, we describe Internet usage, Cybersecurity and E-government all of which are crucial for the success of ICT industry.

3.1 Overview of Israel Silicon Wadi

Silicon Wadi (Hebrew acronym for "Silicon Valley") is an area with a high concentration of high-tech industries in few locations throughout Israel, similar to Silicon Valley in California, in the United States. The Israeli Silicon Wadi is considered second in importance only to its Californian counterpart. The area covers much of the country, although especially high concentrations of high-tech industry can be found in the area around Tel Aviv. In addition, high-tech clusters can also be found in Haifa and Caesarea. There are also high-tech parks in Jerusalem, Beer Sheba, and in towns such as Yokneam Illit which is close to Haifa, and Israel's first "private city", Airport City, near Ben-Gurion International Airport near Tel Aviv.

3.1.1 Israel as an ICT cluster

By the end of the 1990s Israel was generally acknowledged to have developed a cluster of high-technology industries. Wired magazine (Hillner, 2000), ranking locations by the strength of cluster effects, gave the Israeli high-tech cluster the same rank as Boston, Helsinki, London, and Kista in Sweden, second only to the Silicon Valley. The entire Israeli high-tech industry is close enough together, geographically, to be considered one cluster. Almost all high-technology activity is located in the densely populated areas of metropolitan Tel Aviv, Haifa, and Jerusalem. Some secondary areas with additional activity in Beer-Sheva, Kiryat Gat where Intel has a large state-of-the-art Fab, and in the Western Galilee – Misgav region and city of Karmiel.

At the core of the Israeli ICT cluster lies the Information and Communication Technologies (ICT) of software, data communications, electro-optics, hardware design, and internet technologies including cyber-security software. Related successful high-technology industries include medical technology, bio-technology, agricultural
technology, materials technology, and military technology all of which use ICT in their final products.

**Figure 7: GERD for Various Countries as a Percentage of GDP for 2000-2013**

In 1999 Israel was the largest single foreign destination of US venture capital flows. Leading US technology firms, such as Cisco, Intel and Lucent, acquired Israeli startups for their technologies. In the year 2000 foreign investors made acquisitions of Israeli high-tech firms totaling $12 billion. In 2013 total acquisitions was totaling $9.66 billion and in 2014 total acquisitions was totaling $6.9 billion and new startups raised some $3.4 billion.

The economic importance of the Israeli cluster may be illustrated with a few figures: By 2000 the Israeli ICT industry generated about $15 billion in export revenues. That number, representing about a third of all Israeli exports. ICT exports contributed 36% of GDP growth in 2000. In 2000 the industry employed 148,000 people, approximately one third of whom were scientists and engineers. In 2014 the industry employed 183,000 people. Israel had a higher share of employment in ICT industries than any of the OECD nations. Figure 8 describes the amount of employment over the years 2011-2014.

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33 OECD Science, Technology and R&D Statistics [website]
OECD (2014), "Main Science and Technology Indicators", OECD Science, Technology and R&D Statistics (database)

34 Israeli ICT Industry Review 2015. IATI [website]
In 2000, near the peak of the high-tech boom, Israel had more than 2000 high-tech firms and new ones were forming at high rate per year. Today there are 4,467 companies in the ICT sector alone. Figure 10 describes the Israeli ICT exports.\textsuperscript{35}

Over the years the ICT industry underwent transformation that Israeli entrepreneurs and companies took advantage of the situation. Figure 9 describes the transformation that occurred in the Industry.

Connectivity has been vertically integrated leading to many M&As. The advance of the Internet had contributed much for the impact on the structure of the new ICT Ecosystem. Activities such as navigation (typified by Google offering) which were in layer 4 of the six-layer of the old ICT Industry model are today intimately connected with the provision of content, application and services.

The process of merging layer 4 (Middleware, navigation, search & innovation platform) and layer 5 (Content, Application & Service) in the 6-layer model to get layer 3 in the four layer model gave rise to many new startups in the Israeli ICT sector. Waze is such a startup where the company realized the integration of using the Internet network with wireless technology and smartphones to provide a much needed service of navigation.

\textsuperscript{35} CBS - ICT Sector Estimate for 2014 [website]
Figure 9: Transformation in the ICT Industry

The Six-Layers of the ICT Industry | The New Four-Layers of the ICT Industry

Layer 6: Final consumption | Layer 4: Final Consumer
Layer 5: Content, applications, and services | Layer 3: Contents, applications, services, middleware, navigation, search, and innovation platform
Layer 4: Middleware, navigation, search, and innovation platform | Layer 2: Network operating
Layer 3: Connectivity | Layer 1: Networked element
Layer 2: Network operating | Layer 1: Networked element
Layer 1: Networked element

Source: Samuel Neaman Institute - based on information received from various companies in the ICT sector

The architectural structure of the four layers include among others the final consumers, platform, content & applications providers, network operators, and networked element providers. System and Devices substituted each other, Convergence from Heterogenous System to simplified single system. Thus, allowing firms to vertically integrate (merge with others). The competition between firms increased the buying of new innovative startups by large companies. This is seen in the Israeli ICT Ecosystem in the form of many exits and acquisitions by large technology firms from the US, China, Korea and others through 2014 and early 2015. Finally we are witnessing that the ICT sector is actually moving a step forward due to the increasing demand by the market (consumers) for getting a service anywhere and anytime. Get a Taxi is such an application which satisfies that demand. Another company that took advantage of that new structure of the ICT industry is Wix. The company was established in 2006 in response to an unmet need by small enterprise customers (the final consumer in layer 4) with an innovative platform and service (layer 3). The product is a cloud-based web development platform that allows users to create HTML5 websites and mobile sites, through the use of their online drag and drop tools. A customer can create his own original website that reflects his or her brand and get online today. Wix keeps complex techy processes behind the curtain and guarantee that the customer experience is
simple, fun and code-free. The platform also gives a complete equivalent of ERP and CRM solutions to the small enterprise.

In 2013, the ICT sector GDP in Israel was US$ 19.28 billion (at 2011 prices), representing about 12.5% of the GDP. Export reached $US 15.5 billion in 2013 and $US 17.9 billion in 2014 as described in Figure 10.

The following describes the ICT Sector Total Output, Gross Value Added and Export in 2013. All prices are at 2011 prices

- **ICT Sector Total Output**
  In 2013 total output was NIS 124.603 billion (US$ 34.509 billion), and the estimate for 2014 is NIS 128.948 billion (US$ 36.040 billion).

- **ICT sector Gross Value Added of the total GDP in the economy**
  In 2013 it was US$ 19.251 billion, representing about 7.9% of the GDP, and the estimate for 2014 is US$ 20.269 billion, representing about 8.1% of the GDP.

- **ICT sector Export of the total exports of goods and services in the economy**
  In 2013 Export reached $US15.505 billion, representing about 16.4% of the total export, and the estimate for 2014 is $US17.913 billion, representing about 18.5% of the total export, as described in Figure 10.

The following is a summary of the sector achievements in the 2013 year.

- In 2013, the Gross Value Added of ICT of the total GDP of the economy amounted to NIS 69.511 billion at 2011 prices ($US 19.251 billion) and comprised 11.1% of the total business sector GDP of the Israeli economy.

- During 2013 employment in the ICT sector stood at 185,000. This represent a decrease of 2% in the number of jobs in comparison to 2012, and its share of the total job market in Israel was approximately 5%, similar to the previous year.

- Average compensation per ICT job increased by 5.3% (compared with 2012). An increase of 3.2% was recorded in ICT manufacturing industries, an increase of 6.3% was recorded in ICT services, and increase of 2.5% was recorded in ICT trade industries.

- In 2013, Exports of the ICT sector amounted to NIS 55.985 billion at 2011 prices ($US 15.505 billion). The share of ICT in the total exports of goods and services in the economy was 16.4%, compared with 17.8% in 2012.

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36 CBS. ICT Sector Estimate for 2014 [website]
37 Annual Average Exchange Rate of US Dollar (Bank of Israel) for 2013 and 2014 was 3.6107 and 3.5779 respectively
Note: The data presented by Israel CBS are based on estimates of ICT industries, according to the new definitions of the OECD published in 2007, and are adjusted to the updated International Standard Classification of Industries (ISIC4).

ICT is a major component in the Israeli Export and it is estimated to be 18.5% of the total Israeli export in 2014. Table 6 describes the ICT exports for the years 2011-2014.

Table 6: Total ICT Exports

<table>
<thead>
<tr>
<th>Year</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total ICT Exports (in Million NIS)</td>
<td>49,808</td>
<td>60,752</td>
<td>55,985</td>
<td>64,092</td>
</tr>
<tr>
<td>Annual Average Exchange Rate (BOI)</td>
<td>3.5781</td>
<td>3.8559</td>
<td>3.6107</td>
<td>3.5779</td>
</tr>
<tr>
<td><strong>Total ICT Export (in $US Million)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13,920.24</td>
<td>15,755.60</td>
<td>15,505.30</td>
<td>17,913.30</td>
<td></td>
</tr>
<tr>
<td>ICT as a percentage of all Israeli exports</td>
<td>14.70%</td>
<td>17.80%</td>
<td>16.40%</td>
<td>18.50%</td>
</tr>
</tbody>
</table>

Figure 10: Israeli ICT Exports for the years 2011-2014 at 2011 prices

Source: CBS - ICT Sector Estimate for 2014

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39 At 2011 prices

40 CBS - ICT Sector Estimate for 2014 [website]
3.1.2 Long-term conditions favoring ICT industry growth

In order to build an innovative ICT industry Israel had to establish and build an ecosystem to support such an industry. Establishing an ICT Ecosystem was basically based on 6 main components. This is described in Figure 11.

Figure 11: Israel Startup Ecosystem

Source: Samuel Neaman Institute

The Ecosystem in which the Israeli high-tech industry operates has six core components:

- **Technological infrastructure** coupled with a policy to encourage and support innovation. It includes the physical and virtual infrastructure required for the existence of a digital ecosystem.
- **Human Capital** Refers to the enhancement of digital literacy in all parts of Israeli society and to the support of scientific and technological education.
- **Funding and supporting business Environment.**
- **Process Infrastructure** Refers to the government’s four different roles: the government as a client, service provider, regulator and sponsor.
- **Innovation** in the industry, and
- **International operations.**

In addition to the above we would like to put the spot light on the Israeli startup economy and its achievements in 2014.
3.2 Domestic ICT Market in Israel

In this section we describe the Israeli market including telecommunication, mobile and broadband. We also give a short description of the regulation process that actually transferred Israel from a monopoly market to a competitive one. This transfer gave a tremendous push to the ICT Ecosystem.

Israel – Telecoms, Mobile and Broadband Market

The Israeli communications market is characterized by fundamental technological and structural changes, large investments, and rapid development. Israel possesses a well-developed telecommunications market characterized by high penetration and a significant number of service providers. Regulation remains the responsibility of the Ministry of Communication, which has been encouraging competition through various regulatory mechanisms. Several operators have been licensed to provide VoIP services, which are usually referred to as Voice over Broadband (VOB) in Israel. Fixed network operators are required to allow VOB licensees access to their networks.

Nevertheless, telecoms incumbent Bezeq continues to dominate the fixed-line market, and only one company, cable TV provider HOT Telecom, has had success in gaining a portion of the fixed-line market. HOT Telecom supplies bundled packages including cable TV, broadband, and fixed telephony. While several providers offer fixed telephony using VOB, Bezeq and HOT Telecom are the only fixed network operators in Israel.

In the broadband market, Bezeq is Israel’s only ADSL network operator and HOT Telecom is the only cable network operator. The same duopoly\(^\text{41}\) can be seen in Israel’s pay TV market, where HOT Telecom is the only provider of cable TV while YES TV, owned by Bezeq, is the only provider of satellite TV.

The Israeli broadband market is characterized by regulatory structural separation between the providers of the internet infrastructure and the internet access service. Thus, broadband users pay two separate bills: a physical connection bill to the broadband network operator, and an internet ‘access’ bill to the ISP providing the service. This system, however, is changing; unsuccessful in stimulating competition, the Ministry of Communications will remove structural separation in exchange for the creation of a viable wholesale market.

Although there are numerous ISPs in Israel, until recently Bezeq and HOT Telecom were the only two broadband network operators. A third company, Israel Broadband Company (IBC), launched wholesale services branded Unlimited in May 2014. IBC

\(^{41}\) A situation in which two suppliers dominate the market for a commodity or service
operates an FTTx network,\textsuperscript{42} using the fiber-optic infrastructure of its parent company Israel Electric Corporation (IEC).

Unlike the fixed-line market, Israel’s mobile market is highly competitive, with five mobile network operators – Partner’s Orange, Bezeq’s Pelephone, Cellcom, HOT Mobile, and Golan Telecom – as well as a number of Mobile Virtual Network Operators (MVNOs). Cellcom is the mobile market leader, followed by Partner, which trades under the Orange brand name. All five of Israel’s mobile network operators plus ISP 018 Xphone have applied to participate in a 4G LTE (Fourth generation Long-Term Evolution)\textsuperscript{43} public tender which was scheduled for December 2014. However, following regulatory approval, Partner, Cellcom, and Pelephone have used existing or borrowed spectrum to launch LTE services ahead of the 4G auction.

Factors that have helped drive competition include full mobile number portability and regulatory barriers that prevent operators from linking sales of handsets to services, or offering discounts to customers that commit to longer periods. Strong competition has led to operators focusing on mobile data and content opportunities as well as on costs, resulting in a number of infrastructure sharing agreements.

\section*{Key Developments in the Market}

Nine years after the start of privatization, the government has sold its final remaining 0.97% interest in Bezeq; a Net Neutrality law covers fixed line ISPs as well as mobile operators; the Ministry of Communications is developing a wholesale market including Bit stream Access, lease of access segments, dark fibers, tubes, and transmission services; Israel’s Antitrust Authority has given Bezeq conditional permission to merge with its satellite TV affiliate YES; the Ministry of Communication has published a network-sharing policy; network sharing agreements have been set up between Partner and HOT Telecom, and between Cellcom and Golan, among others.

Cellcom, Pelephone, Orange, Golan Telecom, Hot Mobile, and Marathon Mobile have all won spectrum in a 4G LTE auction concluded in January 2015; following regulatory approval, Partner, Cellcom, and Pelephone have used existing or borrowed spectrum to launch LTE services ahead of the 4G auction; the Ministry of Communication has published a network-sharing policy; network sharing agreements have been set up between Partner and HOT Telecom, and between Cellcom and Golan, among others.

\textsuperscript{42} Fiber to the x (FTTx) is a collective term for various optical fiber delivery topologies that are categorized according to where the fiber terminates

\textsuperscript{43} What is 4G LTE and Why it Matters. Verizon Wireless. (2012) [website]
Regulation

Israel has pursued progressive liberalization and privatization in its communications and information technology subsector. These reforms have included privatization, with the sale by the Government of its controlling interest in Bezeq, Israel’s incumbent fixed-wire line service provider, in 2005; adoption of a regulatory regime suitable for a multi-operator environment; and competitive local exchange carrier (CLEC) licenses for infrastructure, transmission, data (broadband) and telephony services, a wireless tender carried out in 2010 which led to the entry of two new infrastructure-based operators, and an ongoing process for the development of a wholesale market in fixed communications.

Facts and data on the evolution of Israel’s ICT market, from the monopoly-based market it was until 1994 to the ultra-modern multiplayer market it is today, in 2012, with a focus on structural and regulatory developments could be found in a report describing the transition from Monopoly to Competition.  

Regulatory functions are exercised by the Ministry of Communications.

The Communications Law (Bezeq and Broadcasts) of 1982 empowers the Minister of Communications to enact legislation concerning all relevant telecommunications services and equipment, including technical specifications for telecommunications equipment and type approvals. The Communications Law also states that any license and change thereof must contribute to competition in the field of telecommunications. It also provides that a licensee must fulfill certain prerequisites (requirements vary from one licensee to another).

The Communications Law was amended in August 2001 to eliminate the existing cable television franchises and introduce a revised licensing regime. This allows use of cable infrastructure for the provision of telephony and advanced fixed telecommunications services, such as data communications and broadband Internet access, in addition to multi-channel subscriber television already provided by franchise. In May 2003, a new amendment to the Communications Law allowed CLECs to compete in the fixed telecommunications services without USO (universal service obligation) as from September 2004. The Ministry of Communications subsequently issued a set of regulations to establish the terms of procedures to apply for such a license, called a “Specialized Domestic license”, and, to date 5 such licenses have been granted. These

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44 Telecommunications in Israel 2012. Israel Ministry of Communications [website]
45 The Ministry of Communications [website]
operators comprise over 30% of the fixed telephony market as of 2012, with the cable incumbent (HOT), providing most of these lines.

In 1984, the regulatory and operational functions in Israeli telecommunications were separated. All telecommunications facilities, which had until that time been government operated, were transferred to the newly established Bezeq Company. Bezeq was granted a tightly-regulated monopoly for the provision of telecommunications services. The rise of the ICT revolution in the 1990s, the interest of existing and potential carriers in using the new technologies to provide enhanced services, and a desire to confer the benefits of competition onto the consumer, have led the Ministry to initiate strategic amendments to the existing regulatory structure. For more information on the Israeli market transformation from monopoly to competitive market relating to the evolution and structure of Israel’s ICT market, from the monopoly-based market it was until 1994 to the ultra-modern multi-player market it is today, in 2015 please see a report by the Ministry of Communication\(^{46}\).

### 3.3 Financing Channels\(^{47}\) for High-Tech and Innovation Industry

In 2014, Israeli high-tech capital raising set an all-time record as 688 companies attracted $3.4 billion. The amount was up 46 percent from $2.3 billion raised by 659 companies in 2013, and 88 percent above $1.8 billion invested in 563 companies in 2012. The average company financing round in 2014 was $5.0 million, compared to $3.5 million in 2013 and $3.2 million in 2012. Figure 12 describes the total capital raised by Israeli high-tech companies over the 2005-2014 period.

\(^{46}\) Telecommunications in Israel 2013 - From Monopoly to Competition: 1994-2013. Israel Ministry of Communications [website]

Breakdown of capital raise by Israeli high-tech companies in the ICT sector is depicted in Figure 13.

The software sector reached an all-time peak in 2014 as 155 companies attracted $737 million, well exceeding the former record $504 million of the year 2000. Sector investments were up 53 percent from the $483 million attracted by 115 companies in 2013, and more than 2.5 times the $281 million raised by 93 software companies in 2012. The average financing round was $4.8 million.

The communications sector followed with 110 companies that raised $382 million that was off 4 percent from $396 million invested in 115 companies in 2013, but 34 percent higher than the $285 million raised by 84 companies in 2012. The average financing round of communications companies was $3.5 million.

In the Internet sector 169 companies raised $941 million. The amount raised was exceptionally high for the sector, even surpassing the $927 million registered in year 2000. It exceeded the $515 million raised by 184 companies in 2013, and was up 150 percent from $382 million raised by 146 Internet companies in 2012. The average financing round was $5.6 million.

In the semiconductor field 20 companies raised $189 million which is a decrease of 9 percent from the $207 million raised by 31 companies in 2013, but 10 percent above $172 million raised by 38 companies in 2012. The average financing round was $9.5 million.
Breakdown of the total capital raised in 2005-2014 by Israeli high-tech companies by specific sector (ICT sectors and other sectors) is depicted in Figure 14.
Figure 14: Total Capital Raised in 2005-2014 by Israeli High-Tech Companies

Source: IVC High-Tech Yearbook 2015
3.4 Telecommunications, Semiconductor and Software Industry

The ICT industry in Israel represents some 4,467 companies covering the fields of telecommunication, semiconductors and components, software and Internet, and cybersecurity. The following describes those segments and their relationship to the new four layer model of the ICT industry described above in Figure 9.

Telecommunications

Many recognized telecommunications standards and protocols, such as WiMAX, VoIP, and TDMoIP, were developed and pioneered in Israel, and a versatile cluster of companies in all sizes and areas of expertise have emerged there.

Motorola has backed innovation in Israel for many decades, opening a local research center in the country in 1964 and paving the way for more multinationals to follow. The company’s Israeli branch was responsible for the development of the Spirit, the first car phone with voice recognition. Telecom equipment giants Cisco and Alcatel Lucent, as well as telecom semiconductors leaders PMC-Sierra and Broadcom, all have a prominent presence in Israel. Some of those companies also have a long history of investments and acquisitions in the country.

Cisco has made eleven acquisitions over the years with an overall disclosed value of over $6 billion, placing it as one of the top foreign acquirers of Israeli technologies. Over the years, the telecom equipment company acquired companies such as Infogear Technology for $308 million, P-Cube for $200 million, Sheer Networks for $122 million and the recent $5 billion buyout of NDS, which will strengthen Cisco’s position in the service provider video ecosystem. In addition, Cisco has been acting as a strategic investor for many telecom-related start-ups, investing in at least one venture per year since 2004. Among the company’s investments are prominent startups such as Celeno, Amobee (which was acquired in March 2012 by Singtel for $340 million), Compass EOS and CTERA. Other leading global telecom companies that operate a local R&D center include Avaya, Samsung (STRI - Samsung Telecom Research Israel), Polycom and Sandvine.

The demand for high-bandwidth applications such as HDTV, the increasing usage of VoIP applications, and ever-growing rates of Internet data traffic have all contributed to the telecom industry’s most pressing need – bigger pipes. While some service providers try to squeeze their legacy networks to the limit, other network operators are investing heavily in both fiber to the home (FTTH) and fiber to the node (FTTN) networks. In light of this, issues such as networks management, providing support for

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48 Telecommunications in Israel 2013 - From Monopoly to Competition: 1994-2013. Israel Ministry of Communications [website]
new applications and creating innovative ways to better monetize subscribers and decrease OPEX, are becoming critically important. These challenges provide substantial opportunities for Israel’s thriving telecom sector. Catering to the emerging needs of the global industry, many local telecom vendors leverage their vast experience in one domain to introduce solutions in adjacent fields, thus growing into multi-layer telecom service providers. Therefore, it is quite common to come across the same vendor in different telecom segments, as depicted below.

- VoIP & Video Conferencing
- Ethernet Access Devices
- Carrier Ethernet & IP Networking
- Optical Networks
- IPTV, Video and Broadcast
- Network and Traffic Management

### Semiconductors and Components

Israel has long been recognized as a leading force in the semiconductor industry. The semiconductor sector drives growth in many markets including microprocessors, data and voice communications, wireless, IP and networking communications, consumer, automotive, defense and more, representing prime opportunities for investment and cooperation.

After reaching a bottom in the second quarter of 2012, semiconductor market growth resumed in the fourth quarter of 2012 and extended into the first quarter of 2013. This next wave of semiconductor demand was spurred by the launch of Windows 8 for tablets, increased enterprise IT spending, and next generation smartphones, tablets, and gaming platforms, The recovery will accelerate into the second half of 2013 and beyond.

As the largest hub of fabless companies outside the U.S., the Israeli semiconductor industry is well set to benefit from this growth. For example, Israeli companies are at the forefront of the memory chip sector. Notable developments include the USB flash drive, which was initially developed by M-Systems (acquired by SanDisk) and Saifun’s (acquired by Sapnsion) non-volatile memory that enables various types of devices (e.g. mobile phones, cameras, PDA, and set-top boxes, to name just a few) to retain stored information even without a power source.

There are dozens of Israeli companies which are developing semiconductors and components for different types of systems in the areas of mobile, telecom, storage, medical devices, defense, automotive, home networking, RFID, and others. Among them is Tower semiconductor, a provider of customized solutions in various
complementary metal oxide semiconductor (CMOS) technologies, including digital CMOS, mixed-signal and radio frequency CMOS, and CMOS image sensors and power management devices. Revenue for the year ended December 31, 2013 amounted to $505.0 million, as compared to $638.8 million for the year ended December 31, 2012.

**IT & Software and Internet in Israel**

Israel is considered a vital player in the digital world. Leaping almost 400 percent in a decade, Israeli software exports rose from $1.5 billion in 1998 to $8.5 billion in 2012. That software helps power everything from PC motherboard chips to cell phones, and is deployed in business, consumer and technical applications around the world.

Israeli companies such as Amdocs, Check Point, Comverse, Mercury Interactive, Nice Systems, VocalTec and some newcomers such as Wix have developed breakthrough software solutions, giving the industry – and the country – its well-deserved reputation for innovation, creativity, and diversity. The country has attracted a great deal of attention from global tech leaders. Many companies including HP, IBM, Microsoft, Oracle, and Sun have established operations and manufacturing centers in the country. Over the last five years (2010-2015) there was a burst of activity in the Internet sector. This has resulted in a growing number of Israeli companies in Internet-related areas making successful exits. At the end of 2014 there were 1,324 companies in the IT & Enterprise software and 1,626 companies in the Internet field.

**Start-up Companies and Superstars**

The strength of the industry is reflected by its record of revolutionary solutions, including some of today’s most common software solutions. Instant messaging, voice over IP, voicemail, public key cryptography, Internet firewall and cellular billing are technologies envisioned and developed by Israeli companies. They are used the world over across many fields: telecommunications, finance, retail, healthcare, government manufacturing and more. Check Point, Amdocs, Comverse, Mercury and many other Israeli software companies became world leaders in their domains.

As a hub for emerging software technologies, most large software vendors maintain R&D facilities in Israel. Many of these centers, which support major product lines, were established through acquisitions of local companies. Others have established local R&D and manufacturing centers, many of which now play a significant role in their

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49 Tower Semiconductor Ltd. - Annual Report Pursuant to Section 13 Or 15(D) of the Securities Exchange Act of 1934 [website]

50 Israel Inspired by innovation - Software Industry. The Israel Export & International Cooperation Institute (2010) [website]

51 IVC Database [website]
parent companies’ operations. Multinationals with Israeli operations in software export more than $3 billion annually.

Looking forward to tomorrow

The stream of innovation continues. Israeli companies are taking a leading role in developing IT security, Cybersecurity solutions, cloud computing, business intelligence, virtualization, e-government and internet applications.

More than 100 Israeli software companies are active in the cloud computing space—the delivery of business and consumer services over the internet which is considered the next revolution in the IT market. These companies are delivering a wide range of solutions in areas such as IT security, IT management, Web applications, automated software quality, telecom applications, business intelligence, and enterprise application domains, especially CRM, ERP, collaborative applications, HR management, knowledge and content management, as well as industry-specific applications. Other notable fields of innovation include business intelligence, next generation information-centric security solutions, authentication, network security, IT management, application lifecycle management, content management, storage software and others. In these fields and others, clusters of new Israeli companies are emerging, offering an unmatched variety, quantity and quality of innovation.

3.5 Empowering Society - ICT and Internet Usage

An important part of the ICT industry in Israel as well as the economy is how the society as a whole is empowered by using the technology offered by the industry. In this section we describe Internet Usage in general and in the health system and by teachers in the educational system.

The Digital Economy Today

Mobility, cloud computing, social networking, sensor-nets and big data analytics are some of the most important trends in the digital economy today. Collectively these trends are making possible the future of “smart everything” (i.e. grids, homes, business processes, energy, healthcare, transport and government), as well as empowering businesses, consumers and society at large. In the OECD area, the number of connected devices in households is projected to increase from an estimated 1.7 billion today to 14 billion by 2022 (OECD, 2013a).
According to Internet World Stats (IWS) there were 5,928,772 Internet users as of December 31, 2014, representing 74.7% of the population. When it comes to teenagers about Ninety percent of Israeli teens use Internet. In a report from July 14, 2009, the penetration rate of the Internet in Israel continues to rise, with 4.3 million users over the age of 13 at the end of 2008, according to Israel’s business daily Globes as reported on July 14, 2009 in its online edition and based on a survey by TIM/Teleseker.

In a new OECD Report "Measuring the Digital Economy – A New Perspective" it is stated that on average, almost 80% of adults and 95% of 16-24 year-olds in the OECD use the Internet, most of them on a daily basis. The report indicates that the total, daily Internet users in Israel in 2013 as a percentage of 16-74 year-olds was 74.1%. Based on OECD data we produced Figure 15 which shows Israel in comparison to some selected countries that we chose from that report on Internet users.

**Figure 15: Total, Daily Internet Users, 2006 and 2013 as a % of 16-74 Years Old**

<table>
<thead>
<tr>
<th>Country</th>
<th>Total users, 2006</th>
<th>Total users, 2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>94.78%</td>
<td>89.84%</td>
</tr>
<tr>
<td>Denmark</td>
<td>94.63%</td>
<td>94.63%</td>
</tr>
<tr>
<td>Netherlands</td>
<td>93.96%</td>
<td>93.96%</td>
</tr>
<tr>
<td>Finland</td>
<td>91.51%</td>
<td>91.51%</td>
</tr>
<tr>
<td>Switzerland</td>
<td>90.40%</td>
<td>90.40%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>89.84%</td>
<td>89.84%</td>
</tr>
<tr>
<td>Japan</td>
<td>88.65%</td>
<td>88.65%</td>
</tr>
<tr>
<td>Korea</td>
<td>87.90%</td>
<td>87.90%</td>
</tr>
<tr>
<td>Germany</td>
<td>83.96%</td>
<td>83.96%</td>
</tr>
<tr>
<td>Belgium</td>
<td>82.17%</td>
<td>82.17%</td>
</tr>
<tr>
<td>France</td>
<td>81.92%</td>
<td>81.92%</td>
</tr>
<tr>
<td>OECD</td>
<td>78.88%</td>
<td>78.88%</td>
</tr>
<tr>
<td>United States</td>
<td>76.18%</td>
<td>76.18%</td>
</tr>
<tr>
<td>Israel</td>
<td>74.10%</td>
<td>74.10%</td>
</tr>
<tr>
<td>Poland</td>
<td>62.85%</td>
<td>62.85%</td>
</tr>
</tbody>
</table>

Source: OECD Report

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52 Israel Internet Usage and Telecommunications Report. Internet World Stats [website]


54 The Israeli society is heterogeneous and some groups do not use the Internet intensively and some use it in a very limited way.
ICT and health

Governments today have recognized the large-scale changes that are made possible by health ICTs and in response they are developing approaches to leverage these technologies to pursue a range of health system reforms, such as primary care renewal and results-based financing. While the potential gains from greater use of these technologies have been apparent for years, most countries are still facing major implementation and adoption challenges. This highlights the large gap between what is possible and where we are now, with little known about how to fully leverage ICTs to improve the health and wellness of the population. Data on successful adoption and use across countries is therefore an essential learning tool for policy development in this area.

Ten pilot countries (Brazil, Canada, Finland, Germany, Israel, Korea, the Netherlands, Switzerland, the United Kingdom and the United States) are currently testing the OECD Guide to Measuring ICTs in the Health Sector and broad implementation is expected in the near future.

ICT Integration in Teacher Education: the Case of Israel

E-society, E-education, E-generation, E-learning and other E-concepts reflect the new reality caused by rapid emergence of Information and Communication Technologies (ICT) in our lives. Taking into account the current and future needs of the e-generation, many countries try to reorganize their educational systems defining the important abilities required in the 21st century: multiple literacies, expertise, innovation, critical thinking and problem solving. The Israeli Ministry of Education also plans the similar process.

The MOFET Institute implemented a study on the subject. The study examines three aspects of ICT integration in teacher education in Israel:

- The policy of the Ministry of Education and of the colleges of education,
- The implementation of ICT by faculty members, and
- The state of pre-service teacher preparation to teach using ICT.

This study was conducted using mixed qualitative and quantitative research approaches. Research on policy issues was based on semi-structured interviews of 34 policy makers and academic management in the Ministry of Education and Colleges of Education as well as on the analysis of various official documents.

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55 ICT Integration in Teacher Education: the Case of Israel, Proceedings of Society for Information Technology & Teacher Education International Conference (2011) [website]
Using UNESCO’s Theoretical Framework for the evaluation of ICT Integration in educational systems, (UNESCO, 2009) it can be stated that Israeli Teacher Education has passed the “e-readiness” stage (infrastructure establishing and achieving the basic ICT literacy among faculty and pre-service teachers) and is moving on to the next “e-intensity” stage where the main efforts focus on developing innovative pedagogy, upgrading the curriculum, promoting organizational change and supporting the further professional development of teacher educators.

3.6 Cyber Security in Israel

Israel is considered as one of the world’s major hubs of innovation and entrepreneurship in the information security field. The number of Israeli cybersecurity firms continues to increase. The Israeli national Cyber Bureau estimates that the number of active firms has doubles from 150 in 2010 to 300 in 2015.

Some of the more prominent Israeli Cybersecurity companies are CyberArc (Issued in NASDAQ. Company’s value is estimated at $2 billion), Adallom (Raised $50 Million) and Cybereason (recently raised $25 Million, among other from Lockheed Martin).

A substantial number of Israeli cyber security companies were acquired by International Corporation in the last five years. The most outstanding acquisitions in 2015 are these of CyActive (acquired by PayPal), Intellinx (acquired by Bottomline Technologies) and Hyperwise (acquired by Check Point).

Israel’s proven success in developing innovative security solutions has also brought practically every major global security vendor to establish a local R&D presence, frequently following acquisitions of Israeli companies. This includes McAfee, CA, Cisco, Microsoft, Intel (McAfee), Webense, EMC (RSA), IBM, and others. A recent addition to this list is GE, which will soon open its first Israeli Global Research cyber lab.

Israel’s National Cyber Bureau

Established in 2011, Israel’s National Cyber Bureau, headed by Dr. Eviatar Matania, functions as an advising body for the Prime Minister, the government and its committees, which recommends national policy in the cyber field and promotes its implementation, in accordance with the law and government resolutions (See

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56 Guide To Measuring Information and Communication Technologies (ICT) In Education. UNESCO Institute for Statistics (2009) [website]

57 Cyber Superpower: Sales of Israeli Companies - 10% of the Deals Worldwide. TheMarker (2015) [website]

58 Israeli ICT Industry Review 2015. IATI [website]
Resolution No. 3611 of the Government of August 7, 2011\textsuperscript{59}). The Bureau works to promote the national capability in cyberspace and to improve Israel's preparedness in dealing with the current and future challenges in cyberspace.

The National Cyber Bureau is charged with promoting three central areas in the cyber field in Israel:

1. Advancing defense and building national strength in the cyber field
2. Building up Israel's lead in the cyber field
3. Advancing processes that support the first two tasks

\textbf{Activities of the National Cyber Bureau}\textsuperscript{60}

The Bureau promotes many significant activities in various fields in cooperation with industry, academia and the governmental sector. Several of them are listed below:

In the field of cyber defense:

- Formulating a national defense strategy.
- Establishing cross-industry and industry-specific regulation.
- Promoting cyber security within the civilian and private sectors, in cooperation with other government offices.
- Working towards the establishment of a national cyber situation assessment and the definition of the national cyber threat reference.

Promoting Israeli cyber defense industry:

- Establishing the "Kidma" (Advancement of Cyber Defense R&D) program to prioritize the cyber defense industry, in cooperation with the Chief Scientist of the Ministry of Industry, Trade and Labor, in the amount of 80 million NIS over two years beginning in 2013. This sum has been increased to 100 million NIS\textsuperscript{61}.
- Establishing the "Masad" (Dual Cyber R&D) program to promote national and defensive cyber technologies together, in cooperation with MAFAT (Directorate of Defense R&D in the Ministry of Defense), in the amount of 10 million NIS for 2012-2013\textsuperscript{62}.
- Encouraging investments by international companies in the State of Israel.


\textsuperscript{60} Prime Minister’s Office - Bureau’s Activities [website]

\textsuperscript{61} The “Kidma” Program to Advance the Cyber-Security Industry in Israel. Prime Minister’s Office [website]

\textsuperscript{62} “Masad” Program – Dual Cyber R&D. Prime Minister’s Office [website]
German-Israeli Cooperation will lead to German-Israeli Platform for Defensive Cybersecurity Research.63

The Israeli Ambassador to Germany Yakov Hadas-Handelsman visited Fraunhofer SIT (June 2015) to discuss the new cybersecurity research partnership between the Institute and Israel. In cooperation with leading academic research institutions in Israel Fraunhofer SIT will establish a Cybersecurity Innovation Center in Israel. Main focus of the joint research activities is to bridge the innovation gap and accelerate the development of secure software, systems, and services. The cybersecurity research cooperation between Fraunhofer SIT and Israel aims at creating a network of excellence and producing new ideas for innovative cybersecurity. For further details please go to Fraunhofer SIT News & Events.

3.7 Israel - E-Government

Modern society is an information society. Creating and developing this information society forms the heart of the e-government vision. Israel’s Ministry of Foreign Affairs and Ministry of Finance, are responsible for all e-Gov. projects in Israel64.

In this section we will discuss the government of Israel e-government initiative and the use of this platform by the Israeli society. This is very important as it will contribute to the competitiveness of the nation and ease of dealing with government offices.

In May 2002, the government of Israel decided to realize the e-government project. This document reviews the five layers model of e-government – a model that was created by the General Accountant in the Ministry of Finance, and presents the initial foundation to promote initiatives in the area of e-Government in Israel.

Five Layers Model65

The computer unit in the General accountant office, headed by Mr. Itzhak Cohen, was working for 6 years on forwarding the e-Government project. The actual activity in this area began at the start of 1997, with the nomination of the governmental Internet committee and the initiation of “Tehila” project. Along the way many projects and initiations were added. Toward 2002 the master plan was created and a government decision was passed, to significantly forward and allocate resources for the e-government services.

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64 Israeli Government Portal [website]
The master plan was based on the advanced e-Government model, developed in the General accountant computer unit. This model is used to forward the many initiations on the way to achieve the e-Government vision. This model is called: “The five layers model” and relates to all the layers that need to be addressed in order to realize the vision. The five layers model divides the e-Government layout technologically, and describes the entire systems required for the realization of a full e-Government vision.

The layers are laid horizontally. Each layer deals with a certain depth level along the line of communication between the citizen and the government.

The citizen is at the head of the pyramid. As lower the level is - so it contains a more infrastructure technologies. In spite their relative distance from the end-user, they are the ones allowing the required functionality.

Naturally there is no need for the full layout in order to provide the basic levels of e-Government, such as general information site on the Internet. The aspiration for a seamless government, a fundamental organizational restructuring and a full and convenient service to the citizen, require parallel handling in all five levels as described in Figure 16. The five levels from bottom to top are:

Layer 1 – Inter-governmental communication infrastructure
Layer 2 – Inter-governmental applications
Layer 3 – Application secured infrastructure
Layer 4 – Services Infrastructure
Layer 5 – Support and Assimilation

**Figure 16: Five Layers Model of Israel E-Government**

The report, which surveys 150 nations around the world annually, also gave an especially high mark to the government’s online portal “Gov.il,” lauding it as “Very well organized.”

The report also ranked Israel as the fourth-leading country in e-participation projects, a ranking gauging public participation in online government ventures.

The UN General Assembly held a special awards ceremony on Monday 26 June 2012, in which Israel was honored with an international award for improved online services.

In the United Nations E-Government Survey 2014, the Israeli government portal offers services geared towards citizens, the private sector and tourists wishing to visit the country, as well as students and members of the Jewish Diaspora. The portal also offers online forms and a forum for G2C and C2G interaction and discussions; many online payments can be made through the portal.

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4 Case Studies of Successful ICT Startups

4.1 The Role of Failure & Success in Innovation: Two Case Studies

The Role of Failure & Success in Innovation: Two Case Studies

...If you can meet with triumph and disaster
And treat those two imposters just the same....

Rudyard Kipling, “If” (published in 1910)

These two case studies show how innovative startups in Israel emerge both from great success - and immense failure, and how those two “imposters” are equally fertile in spawning startups.

Success

The RAD “Cloud” - In the office of Yehuda Zisapel, co-founder of the RAD group and a pioneer entrepreneur, there is an unusual graph on the wall. It showed RAD Data Communications at the center, surrounded by a cloud of dots, with each dot representing a start-up that the mother ship RAD helped create, formally or informally. The dots were arranged in concentric circles, each with its own color code, like ripples in a pond. RAD is the company Zisapel founded in 1981 together with his brother Zohar. The RAD cloud or cluster comprises 128 companies (though not all survive to this day), many of them not far from RAD’s home office in Ziv Towers on Raul Wallenberg Street, in the hi-tech area known as Atidim, in Ramat Hahayal, a northern Tel Aviv neighborhood. Together, they account for 15,000 well-paid hi-tech jobs and billions in export dollars. The success rate is 70 per cent. Zisapel and his brother created the cloud, starting over 33 years ago, and are extremely proud of it. The RAD Group is today a global Israel- based family of independent companies that make network and telecom software and hardware. It employs 3,500 workers and has annual revenues of about $1.4 billion. The RAD employs some 15,000 workers. Yehuda Zisapel explains: When a creative engineer approaches me, I encourage him or her to start a company. We first appoint a CEO. But from Day Zero, the infrastructure of the RAD group creates a full-fledged company with all the necessary functions, in a sense ‘outsourced’. Little by little the new company hires its own. There is no holding company. Each company in the RAD Group operates independently, but “under a common strategic umbrella.” This decentralized approach keeps each business flexible and alacritous, but leverages synergies inherent in small entrepreneurial businesses. It

is how RAD is very big but manages to feel small. Whenever a market opportunity is identified that needs technology, a marketing approach or corporate culture that does not exist in any of the other companies, a new business is created. This has happened 128 times to create the RAD viral cloud. Three Israeli scholars have studied viral start-ups intensively, including RAD. In their 2013 book “The Evolution of a New Industry: A Genealogical Approach” Drori, Ellis and Shapira document six “genealogies” – Telrad, ECI, Tadiran, Fibronics, Comverse, as well as RAD. Each of these companies spun off numerous other start-ups virally. During the period 1991-1995, some 39 startups emerged from these six mother ships, including 14 from Tadiran, a communications firm founded in 1932, and 13 from Fibronics, an early pioneer in fiber-optics founded at the Technion. And the viral process is accelerating; 171 new start-ups emerged from the six founding firms from 1996 to 2000, and 222 during the years 2001-2005.
Figure 17: RAD Genealogical Map

Source: The Evolution of Innovation Network and Spin off Entrepreneurship - the Case of RAD

The Moran “Cloud” - Dov Moran is one of Israel’s most famous entrepreneurs. His startup, M Systems, pioneered the flash memory stick and was acquired by SanDisk. Rather than rest on his laurels, and bountiful wealth from the $1 billion ‘exit’, Moran founded Modu, a startup that sought to produce a clever modular smartphone. The company was underfinanced and eventually closed. The day that it closed, Moran walked down the street and opened a new startup, Comigo. Fifteen new startups emerged from the wreckage of Modu, including two founded by women. Why would anyone start a new business after losing their job and livelihood in a failed one? First, because Israelis all understand that entrepreneurship is risky, that most startups fail, that there is no shame or blemish in failure, and that failure is an efficient school for future success. Second, because starting new businesses is far more interesting and challenging – and difficult -- than working for old established ones, despite the risk.
4.2 Five Case Studies

In order to prepare the case studies we interviewed key personnel at the selected companies. The following are the six main questions we asked:

1. Company formation process
2. Finance and Fundraising
3. Israeli government support and human capital
4. Reasons for success and failure
5. Exports, international markets and globalization
6. Policy Recommendations that could support company’s success

The case studies cover a brief description of successful ICT start-ups. We focused on the innovation and incubation process. The questions enabled us to describe the origin of the entrepreneurs and the startup phase. The most important outcome is the innovative team and the observation of the markets and product definition which led the entrepreneurs to come with a solution to an unmet need in the marketplace. There many other parameters that lead a startup to succeed and they are covered in the case studies.
The following are case studies based on recent interviews that were conducted by SNI especially for this World Bank study: Check Point, Wix, Silverbyte, Ceragon Networks and Shadow.com.

### Check Point

- **Name of Company:** Check Point Software Technologies Ltd.
- **Year of Establishment:** 1993
- **Number of Employees:** 3,500
- **Stage of Company:** Revenue Growth
- **Operational area:** Software Security
- **Web site:** http://www.checkpoint.com/
- **Founders:** Gil Shwed, Shlomo Kramer, and Marius Nacht
- **Target Markets:** Check Point offers a complete security architecture defending enterprises’ networks to mobile devices, in addition to the most comprehensive and intuitive security management.

### Brief About

Check Point is a worldwide leader in securing the internet. The company provides customers with uncompromised protection against all types of threats, reduces security complexity and lowers total cost of ownership. Check Point first pioneered the industry with FireWall-1 and its patented Stateful inspection technology, which constitutes the foundation for most network security technology today. Check Point develops new innovations based on the Software Blade Architecture, providing customers with flexible and simple solutions that can be fully customized to meet the exact security needs of any organization.

### Company Formation Process and Fundraising

Check point was established by the three entrepreneurs in 1993. They worked together during their military service. The vision of the founders was to “secure the internet”. At that time there were only few tens of websites. The innovative idea of the entrepreneurs was to create a protective barrier between the corporate networks and the external world (the Internet) in such a way that the rate of incoming and outgoing data would not be slowed down. In addition this barrier, known as a “Firewall” would grant the user control over the type of incoming and outgoing data.

Upon the establishment of the company, the entrepreneurs raised $250,000 from few private investors and the initial development work was done in a garage operation mode. Since the Internet began to develop at that time there were other competitors
with similar ideas, and so speed in design and time to market were crucial. By the end of first quarter of 1994, the company began to sell its product and meet customers’ demand.

At that time the company won best of show title at the INTEROP Exhibition in Silicon Valley and received an indication that the product is important and relevant with great potential.

Check Point is a company with no debt (beyond the initial $250,000 raised). Its funding sources are by way of the ownership structure (share offerings) and through sales. The company maintains a positive cash flow at all times. Careful planned work, cost control and maintaining positive cash flow are key values of Check Point since its inception.

The company’s management made a decision not to use the funds from the OCS programs for their R&D operations. The main reason was the OCS requirement to repay the grant through royalties from sales as well as the desire to keep focus. With true focus on product excellence and customer needs company’s management expected that income will be higher than external funding. However, in 1998 the company participated in the OCS MAGNET program for two years. In addition the company received the title of "Approved Enterprise" by the government after having met the criteria for benefits under the Encouragement of Capital Investments. Today, the company has no direct funding or subsidies or other kind of help from the government.

The Advantages and Disadvantages of Establishing a Company in Israel

**Advantages**

- Entrepreneurship, innovation and creativity - in the beginning the company was based only on Israelis. Their entrepreneurial function and the ability to think in a big way and with open mind about how to penetrate the market and how to reach the right individuals in the marketplace. All these elements facilitated the establishment of the company and its successful development.

- Cognitive and flexibility in thinking - Israeli workers are capable of rapid response that allows them to overcome obstacles and to improvise solutions, especially compared with other countries.

- Efficiency and devotion – team work and joining around a common goal, working hard as much as necessary in order to achieve goals and show results. All this is done through effective thinking and cost-effectiveness.

**Disadvantages**

- From the beginning Check Point has chosen to have an organizational structure in accordance with the global approach in order to penetrate international markets. This translated into building an Israeli senior management team while at the same time building a global team of Israeli, US, European and Eastern European people. This method offers advantages by allowing the company to recruit the best people
in the world without being limited to a particular country. However, this is difficult and complicated to implement. The difficulty is in creating a common corporate culture. Such a culture usually requires building a trust which can be created through personal contact and it requires too much investment in terms of travel, accommodations, schedules, adjustments, etc. In addition, it requires to instill a set of shared values and common interests. This by itself is a very challenging task when it comes to dealing with 3,500 employees worldwide.

- As a global Israeli company, Check Point needs to invest much more effort in bringing an acquired American company to Israel than vice versa. Over the years, the government has not added incentives and increased taxes. So the attractiveness of bringing a company to Israel is very small compared to the existing possibilities in the world.

**Reasons for Success**

- The concept / product / solution to the problem was simple and innovative which responded to an unmet need. Check Point’s product gave a simple and friendly solution to the user that did not require knowledge and understanding of the code (the code has been moved to work behind the scenes).

- The market at the time was a growing and booming market and Check Point entered it at the right time.

- Leading Team – the people that were selected to lead the organization, the common goal, the organizational structure and a mix of local and international employees was a key to the growth of the company while keeping a leadership position in the marketplace over time.

**Operating in International Markets**

From the beginning, the company saw itself as an international company, targeting international markets with an emphasis on the US market. To this end, Check Point set two key principles that still hold today:

- Simplicity - client can work with the company’s products at any time and in any language.

- Type of sale – A third party (partner or reseller) sales of the products to end users using a B2B model. This helps in overcoming cultural and language gaps and at the same time get a better understanding of the markets.

Today Check Point is a global company with 50 locations worldwide. The company gives technical support in every country it operates and employs sales people all over the world. The key R&D work and majority of the corporate management team is in Israel.
**Wix.com**

- Name of Company: Wix.com (NASDAQ: WIX)
- Year of Establishment: 2006
- Number of Employees: 1000 (800 in Israel)
- Stage of Company: Revenue Growth
- Operational area: SAS/Internet
- Web site: [www.wix.com](http://www.wix.com)
- Founders: Avishai Abrahami, Nadav Abrahami and Giora Kaplan
- Target Markets: Non-Technical Individuals, Small Businesses

**Brief About**

Wix.com is a leading cloud-based web development platform with more than 71 million registered users worldwide. Wix was founded on the belief that the Internet should be accessible to everyone to develop, create and contribute. Through free and premium subscriptions, Wix empowers millions of businesses, organizations, professionals and individuals to take their businesses, brands and workflow online. The Wix Editor and highly curated App Market enable users to build and manage a fully integrated and dynamic digital presence.

**Company Formation Process and Fundraising**

Wix is the brainchild of its three founders, Avishai Abrahami, Nadav Abrahami and Giora Kaplan which served together in the Israel Intelligence Unit 8200. In 2006 they raised seed money from private investors in order to establish a startup in the field of data. As part of establishing the company and constructing a website, the threesome discovered that creating their own website was difficult, and very costly. It was this agonizing experience that led them to a light bulb moment - build a platform that empowered anyone to create their own website with no coding or design skills needed. Better yet, it should also be free.

Wix provides hundreds of customizable website templates and a drag and drop website builder. Users can add functionalities such as social plug-ins, eCommerce, contact forms, email marketing, CRM, Billing, ERP modules, and community forums to their websites using a variety of Wix-developed and third-party applications. Wix is built on a freemium business model, earning its revenues through premium upgrades. Users must purchase premium packages in order to connect their sites to their own domains, remove Wix ads, add e-commerce capabilities, and buy extra data.

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The word fermium is a combination of the words free and premium.
storage and bandwidth and more. Today the company is in constant growth of registered users at a rate of more than 1.5 million new users each month and increasing number of Premium Subscriptions.

Wix is backed by VC investors. In November 2013, Wix had an initial public offering (IPO) on NASDAQ, raising about $127 million for the company and some of its shareholders. In 2015 the company filed a request to the Ministry of Finance to establish a development center of 100 employees in Beersheba. The request was accepted and confirmed and 25% of the employees’ salaries in Beersheba facility will be paid by the government.

The Advantages and Disadvantages of Establishing a Company in Israel

**Advantages**

- Human capital is very high-class – Wix as a company that wants to grow and become a major Israeli company, needs to recruit leaders in their field. The company is considered today as one of the sought after by Israeli high-tech workers as a place to work for.
- In many places throughout the world there is a lot of respect to Israeli companies.

**Disadvantages**

- It is much more difficult for an Israeli public company to raise money from investors. US companies enjoy greater trust than Israeli companies. In addition a limited access to investors has adversely affects when trying to raise capital.
- There are many difficulties in Israel in the field of regulation that the company is forced to deal with as a growing company. A set of rules which are different compared to the United States for the issuance of the company on the TASE. Moreover, over the years, the Israeli stock exchange established more and more difficult rules for the companies, an act which makes the listing on the TASE almost impossible for companies traded on the American parallel.
- As a global company that wants to bring foreign workers from other countries in order to help the company learn and understand foreign markets the company is facing laws that do not allow it to do so.

**Reasons for Success**

The company does not employ sales people at all. In fact it uses all of its non-paying clients to advertise Wix. This is done by specifying the company’s name on the site built by a customer. A customer who does not pay, serves as the company’s marketing man and he/she creates free traffic to wix site. Approximately 50 percent of the Subscriptions are from free traffic sources.
Wix offers all the necessary tools for managing and promoting the small business in one internet platform. It offers ERP, Finance, and Analytics modules. It also offers support in Social and Mobile presence. The platform also support Scheduling, Billing, Payments, Logistics, Management of inventories, invoices, shipments, possibility for coupons, Newsletters, Merchandising and E-mail Marketing.

- The business and marketing model has proven itself to be successful in bringing the company to generate cash this year. Results of Q2 2015 show collections of $57.4 million and Adjusted EBITDA of $3.5 million.
- Wix is a leader in its technology and succeed in staying ahead of its competitors.
- Employees enjoy coming to work at Wix and there is a good atmosphere and culture of support and team work.

Operating in International Markets

Wix.com is a leading cloud-based web development platform with more than 65 million registered users worldwide from 190 countries. Wix was founded on the belief that the Internet should be accessible to everyone to develop, create and contribute. Wix’s headquarters are in Tel Aviv, with offices in San Francisco, New York and Miami in the USA, Vilnius in Lithuania, and Dnepropetrovsk in the Ukraine.

Silverbyte

- Name of Company: Silverbyte
- Year of Establishment: 1992
- Number of Employees: 70
- Stage of Company: Revenue Growth
- Operational area: IT & Enterprise Software: Enterprise Applications
- Web site: www.silverbyte.com
- Founders: Mr. Avi Moscona - President & Co-Founder; Mr. Amnon Zusman
- Target Markets: Hotels, Restaurants, Hospitality companies

Brief about

Silverbyte is a leading supplier of hotel management technology software solutions to the hotel and hospitality industry. The company is a major supplier to the Israeli market and command about 75% of the market. Silverbyte’s Optima Line platform can be operated either as a system installed at the customer’s premises or as a Cloud software. Optima Hotel Management Software represents a unique solution for hotel groups connected to the leading on line global reservations systems.
**Company formation process and fundraising**

Founders recognized on the basis of a common social background. Both previously worked in senior positions with large defense organizations and decided to leave and start a software company in the field of hospitality software different than what they were engaged with before. As part of a strategic move, MER Telecommunication entered as a partner and bought some of Silverbyte’s shares. This enabled the company to develop a complementary product that helped in marketing the main platform.

The company has been profitable over the last 20 years of operations thanks to its technological leadership, and command and control of the smallest details. In addition the company is constantly monitoring the dynamic and changing environment in which it operates and rapidly response to changes in the marketplace.

In 2000 the company received a grant from the Office of the Chief Scientist to further develop its Optima Platform. Since its inception, the company did not seek to raise money from outside investors. The founders used private and family funds to run the company and grew with the market. They used credit line from one of the banks in Israel. This was part of management philosophy in order to keep control and manage the company according to its certain set of values that contributed to its success in the marketplace. Today Silverbyte supply about 75% of the hotel management software in Israel.

**The advantages and disadvantages of establishing a company in Israel:**

**Advantages**

- The Israeli market needed a local company that understand technology as well as the local culture.
- People are very creative and open minded to new ideas. They challenge other ideas and sometimes disagree with others, thus creating a fruitful dialogue.
- There is less organizational hierarchy, which contribute to creativity and innovation.
- Israeli companies have a good reputation in many places throughout the world.
- The government encourages export by giving tax deduction to those companies that have a significant amount of export.

**Disadvantages:**

- Israel's location, which is far from the key markets, is a disadvantage in terms of marketing activity in international markets.
- Today the company is using local agents to sell in foreign markets. However, the Company is aware of the fact that in order to increase its growth rate through export it will need to establish overseas branches.
Reasons for success

- Continuously investing in research and development because of changes in the marketplace. A significant percentage of income is reinvested in R&D, leading to technological innovations and creativity. This approach enables the company to introduce innovative new products with high quality and very good customer opinion.

- Listening to customers - listening and ready to change as the demands and requests of customers stemming from their operating experience are key to the success of the company.

- Human Capital – It is the company policy to recruit talented employees that are also motivated and have the ambition to succeed. This is essential to the success of the company.

- There is open channel of communication and management constantly cares about feedback from its personnel. Turnover of employees is extremely low. More than 50 percent of the employees and managers of the company are women and the company attributes its success to this fact.

- A positive attitude to criticism and failure – it is customary to say in the company that the truth resides in the smallest detail and understanding the importance of auditing and investigations of faults and failures. This approach allows drawing conclusions, quickly applying corrections and real time reports from the workforce.

Operating in International Markets

The company export its products to 25 countries including USA, Germany, Belgium, UK, Spain, Russia, Switzerland, Philippines and South Africa, to name a few. Revenues from export are significant.

Ceragon Networks

- Name of Company: Ceragon Networks
- Year of Establishment: 1996
- Number of Employees: 430 in Israel; 1,000 International
- Stage of Company: Profitability Growth
- Operational Area: Communications
- 2014 Revenues: $371 M
- Web site: www.ceragon.com
- Founders: RAD Group and Entrepreneurs
**Brief About**

Ceragon Networks is the #1 wireless backhaul specialist. We provide innovative, flexible and cost-effective wireless backhaul and fronthaul solutions that enable mobile operators and other wired/wireless service providers to deliver 2G/3G, 4G/LTE and other broadband services to their subscribers. Ceragon’s high-capacity solutions use microwave technology to transfer voice and data traffic, while maximizing bandwidth efficiency, to deliver more capacity over longer distances under any deployment scenario. Based on our extensive global experience, Ceragon delivers turnkey solutions that support service provider profitability at every stage of the network lifecycle enabling faster time to revenue, cost-effective operation and simple migration to all-IP networks. As the demand for data pushes the need for ever-increasing capacity, Ceragon is committed to serve the market with unmatched technology and innovation, ensuring effective solutions for the evolving needs of the marketplace. Our solutions are deployed by more than 430 service providers in over 130 countries, worldwide.

**Company Formation Process and Fundraising**

The company was established as part of the RAD Group on the basis of very advanced military technology used by the entrepreneurs during their military service. In light of the growth in the telecommunication market they wanted to use that technology and adapt it to the civilian microwave communication market. The company has experienced significant growth during the high-tech boom of the communications market in the early 2000. Ceragon Networks was first listed on the NASDAQ on September 6, 2000 (symbol: CRNT). As a result of the 2001 economic crisis and weakening in its markets, sales decreased and the company was forced to reduce its workforce and restructure its operations in order to improve its profitability. In 2007 Ceragon released the first packet-based microwave platform in the industry, the FibeAir IP-10 platform, which awarded the company with the Best of WIMAX World Award in the category of Industry Innovation. In 2011 the company acquired Nera Networks in order to expand its market share in Africa and Latin America. In 2013 Ceragon launched its revolutionary IP-20 platform— a single platform serving all radio transport technologies. This SDN-ready platform contains a rich product line for wireless backhaul that is powered by a common software-defined engine, marking a strategic milestone for the company. Today the company’s goal is to continue growing through sales and the acquisition of companies abroad.

**Using OCS Funds**

In 2000, the company used OCS funds for development. However, it was decided later not to use the OCS programs due to "a rolling loan" effect which did not fit with the company's management. In 2014 the company joined two OCS MAGNET consortia on top of a yearly approved generic plan. This enabled the company to be involved in
developing new core technologies and share knowledge with other participating companies.

Reasons for Success

- Over years of operation, the company could dramatically change direction, due to the collapse of some markets, and enter new growth markets in accordance with the changes that have happened in the industry.
- Company’s ability to constantly maintain its technological leadership in relation to its competitors.
- Innovation in production processes and not just in R&D, enables the company to lead a more affordable and competitive production.

International Marketing Activities

The company has established a sales network now scattered over 51 countries worldwide. About 45 percent of production is now done in Israel, while the remaining 55% of production is divided amongst 3 global production centers.

As a multinational company, the biggest challenge faced by Ceragon is recruiting people abroad and overcoming cultural differences which exist for an Israeli company operating in foreign markets.

As an Israeli company operating and competing in the international market the most important thing is the quality of its products.

- **Shadow Technologies**
  - Name: Shadow Technologies
  - Year of Establishment: 2013
  - Number of Employees: 15
  - Stage: R&D
  - Market and field of operational: Internet
  - Web site: shadow.com
  - Target Markets: End users

Brief About

The Company is developing a search engine platform - Shadow.com helping to collect and summarizes what people say about any topic, product or person on review sites, social networks and news sites. The platform enable the surfers to express their own views, votes and opinions on anything. Shadow.com, also provides a platform for
business owners to create and maintain their business page, update info and respond to users comments. Shadow.com gives the crowd the needed insight to make decisions fast without the need actually to read hundreds of reviews by summarizing many reviews from many sources into a small set of key statistics.

**Company Formation Process and Fundraising**

The idea for the startup was born from the observation of the entrepreneurs that there is an increasing importance to "what people say on all sorts of things" during the process of decision-making before purchasing.

The two founders of Shadow (Eli Mashiah and Israel Mazin) have worked together before and have a shared record of success. Already in 1990, they established a company in the field of information security (Memco Software). This company was merged later (1998) with Platinum Technology Corporation and in 1999 was acquired by Computer Associates. The two founders recruited others to their new startup in order to develop the concept and establish a working cohesive team to lead the company. The previous success enabled the entrepreneurs to invest their own capital and in addition they raised more money from private investors. Until today the company has raised $ 3 million.

The company did not use any funds from the Office of the Chief Scientist or other government support.

**Advantages and Disadvantages of Establishing a Company in Israel**

Israeli companies in the field of Internet are judged based on their performance, just like the rest of the Internet companies around the globe. The metrics include the number of users and volume of traffic, how viral is the site and number of returning visitors. In the Internet field, there is no advantage to a particular country and the most important thing is the proof of web surfers.

**Advantages**

- Creativity and initiative - Israelis stand out with creative thinking, flexibility and innovativeness.
- Good networking communication – Acquaintance with entrepreneurs and developers in the industry.
- Good understanding of the subject – Many successful new companies in the Internet sector have been established creating a large pool of people who understand the field very well which strengthens the flow of ideas. Israel could be considered as a kind of “small Silicon Valley”.
Disadvantages

- The high costs of R&D personnel- most of the development is done in Israel and parts are outsourced to people in developing countries in order to reduce development costs.
- Difficulty in recruiting good skilled workers with the experience in working and managing Lean software development activity.
- There is increased competition for creative open-minded, and knowledgeable people.

Reasons for Success

Experience of people who know the particular technological field. Business networking that help in promoting the platform and increase prospects for future investment. Also the fact that the company was able to raise money from private investors, using advanced technologies and good technological and professional relationships with large companies. In addition the company was able to purchase another company whose technology contributed to the development of the Shadow product.

Possible Reasons for Failure

One of the problems which is faced by a company that targets the end consumer market is the problem of crossing the difficult and dangerous chasm known as Death Valley. Many Internet companies fail at this point, which is between the seed stage and the next round of raising investment money from a VC. To do that the company must prove itself in terms of traffic and number of Internet users.

It is difficult to do so if you are an Israeli Internet company. It would have been much easier if the company were located in Silicon Valley where many opinion leaders, relevant knowledge and extensive networking exist.

Operating in International Markets

Shadow has developed technologies to suit the worldwide market. However currently most of the efforts are primarily focused on the US market.
4.3 Conclusions

The issue of using OCS grants is very individual at each company’s level. Some companies did not use it because of bureaucratic issues involved in the process of applying and receiving the various grants. In addition it highly dependent on the technological field and current trends in the industry. For example the cybersecurity is currently very popular field and it is relatively easy to raise more “attractive” money from different sources as compared to the Office of Chief Scientist. Moreover, it is the policy of some companies such as Check Point and Shadow not to use the OCS grant.

In order to incentivize high-tech companies located in the center of Israel to open R&D branches in peripheral zones like Southern and Northern parts of Israel, the government offers a program like “high salary path” in which it subsidizes manpower salaries. Wix took advantage of this opportunity and decided to open a new R&D branch in the Negev area where it will employ 100 engineers.

TASE is in decline. The number of public companies listed on the TASE fell by 27 per cent, from 654 in 2007 to only 475 in 2014. Up to a fourth of current listed firms are thinking of delisting. TASE is fading, with both falling turnover and lower numbers of listed firms. This is according to Yossi Beinart, Chief Executive Officer of the Tel Aviv Stock Exchange who spoke at the first Israel Growth Conference, held on June 1 2015 at the Tel Aviv Stock Exchange (TASE). Ceragon is an example of a company that was listed on the TASE in late 1990s and later in 2000 was listed in NASDAQ. Today the company enjoys the duality. Since then regulations have become stricter requiring companies to face complex issues in comparison to other stock exchanges. Wix as a newly growing company was listed only in NASDAQ and not on the TASE because of regulations that made it difficult for their management.

From all the above case studies the following should be pointed out:

- A company must respond to a real unmet need in the market
- None of the companies are me-too company
- Cohesive team is a key to success
- High level human capital which is creative, innovative, hardworking, open minded and has experience.
5 Learning from the Ingredients that Make Israel a “Start-Up Nation - Replicability to Emerging/Developing Nations

What are the ingredients that made Israel a startup nation? Are they distinctive or are they generic? If these ingredients are generic, how can emerging and developing nations replicate them? To address these questions; (i) we compare Israel to Singapore, an innovative high-income economy that has also sought to promote an entrepreneurial ICT culture but followed a different path than Israel; (ii) we analyze the absorptive capacity and the readiness to replicate innovation support programs in two countries: Poland, an emerging economy and Armenia, a developing one.

A prerequisite for the successful replication and absorption of Israel’s experience in a developing country is a sufficient absorptive capacity of the developing country. World Bank studies of absorptive capacity in Eastern Europe and Southern Africa show that there are important complementarities between innovation and absorptive capacity. “For a country to be able to reap the benefits of increased access to international technological knowledge, it requires some minimum prerequisites. The ability for firms to absorb technology to a large extent depends on the skills levels of its labor force and the managers. In addition, R&D has been proved to be increasingly important to technology absorption in addition to “new to the world” innovations. (“Fostering Technology Absorption in Southern African Enterprises”, page 34).

The World Economic Report’s (WEF) Global Competitiveness Report 2014/15 classifies countries by their “Stage of Development”: Singapore and Israel are classified in Stage 3, the innovation-driven stage of development, Poland is in transition between stages 2 and 3 and Armenia is in stage 2, the efficiency-driven stage. In the rest of this chapter, we first present the Israeli success ingredients, briefly introduce the Polish and Armenian economies and innovation cases and finally discuss the replication examples of success ingredients in each of these two countries.

What are the Ingredients that Made Israel a Startup Nation?

This Chapter analyzes the ingredients of the Israeli experience with the view to distilling lessons for developing countries. Moreover, as mentioned above, the chapter discusses the “absorptive capacity” required to draw upon the lessons from the Israeli innovation experience. We identify ingredients which could be replicated in and adjusted to the conditions of other economies in contrast to distinct or unique ingredients which are hard to replicate, such as the spillovers from military to civilian R&D or the immigration of scientists and engineers from the former Soviet Union.

A key success ingredient is the important but limited role that the Israeli government played in subsidizing the emergence of the private sector. The government’s intervention was limited in time, allowing the private sector to develop so that today
the economy is driven by the private sector with strong orientation towards international markets. The emergence of the private sector was no small feat for a country, which was originally founded on a socialist ideology, and was dominated by state-owned and union-owned companies. A brief description of the other ingredients follows below:

1. The beginning of the Israeli R&D based industries is attributed to its strong military sector after the 1967 war and to military R&D cooperation with the US, Germany and France. The close synergy between military and civilian R&D is another success ingredient: Israeli defense industries have traditionally focused on components, electronics, avionics and other systems. The development of these auxiliary systems has also given the high-tech industries an edge in civilian spin-offs in security, electronics, computers, software and the internet sectors.

2. The availability of a skilled workforce is another success ingredient of the ICT sector. Public investment in higher education facilitates the training of high-quality engineers and scientists and is vital for supporting state-of-the-art basic research in universities. Novel ideas, technologies and inventions originating from universities benefit the high-technology sector through Academia-Industry partnerships and can be utilized for the creation of new products and processes.

3. Another key ingredient is the National Innovation Ecosystem, which includes the legal framework introduced by the R&D Law and government support programs via the OCS. The legal framework and the OCS programs are amenable to replication. Impact analysis studies evaluating the results of these programs have been conducted and could be useful for assessing the modifications required in the programs’ replicability to other environments.

4. The Jewish diaspora and immigration: in a global economy, international networking becomes a key competitive advantage. Israel has benefited from immigration of Jews from the diaspora, who, inter alia, contributed to the development of highly ranked research universities. Since 1990, large scale immigration from the former Soviet Union included a high share of scientists and engineers.

5. Investment incentives such as the LECI were introduced in Israel when the international trade agreements were less stringent than today and other countries such as Korea, and the other Asian Tigers subsidized capital investment massively. Today, massive subsidization of capital investment is more problematic.

6. Openness and transparency of information is another key success factor in the development of an ICT sector and the inclusiveness of other sectors. The Government should make sure that there is access to information concerning technology, markets and more.

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7. Availability of finance is crucial for the success of high-technology industry. This should be available on a competitive basis in academia and in all the stages of the innovation process, starting with the pre-seed stage even before a start-up company is established.

8. Culture of risk-taking, audacity and “out of the box” mentality. In Israel personal strength stemming from a solid inner-core of decisiveness is considered a crucial aspect of a mature identity. Daring or “chutzpah”, independence, self-confidence and assertiveness are highly respected in Israel. These ingredients are used in the next section for comparison with Singapore and the following section, the ingredients are also be used in the analysis of Armenia and Poland to explore whether their innovative and absorptive capacity suffice to learn from Israel and Singapore.

Figure 20 describe the Innovation Capability of Israel with respect to High Income OECD countries and High Income countries in general. From the figure we can see that Israel scores well which is also proved by its innovative high-tech industry.⁷¹

![Figure 20: Innovative Capabilities of Israel with Respect to OECD Countries](image)

Source: Israel Country Profile 2013⁷¹

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⁷¹: Israel Country Profile 2013. The World Bank [website](website)
5.1 A Comparison with a Similar Country - Singapore

We compare Israel to Singapore, an innovative high-income economy that has promoted an entrepreneurial ICT culture, like Israel, but followed a different path development. Both Singapore and Israel are highly placed in innovation rankings; for example, in the Bloomberg Innovation Index, Israel and Singapore rank 5th and 8th, respectively. However, the two countries differ significantly in their GDP per capita (in current US$): in 2013 Israel’s was 36,050, and Singapore’s $55,182\textsuperscript{72}.

A recent 2015 HBR (Harvard Business Review) paper illustrates the similarities between Singapore and Israel: both benefitted from skilled immigration and both have mandatory military conscription. The Singaporean National Framework for Innovation and Enterprise (NFIE) drew inspiration from a joint program between Israel and the United States called the Binational Industrial Research and Development Foundation (BIRD). NFIE eventually helped bring a flood of diverse investors into Singapore by offering to put up 85% of the capital in a start-up.

A study by Deloitte and Trigger-Foresight consulting, funded by Google Israel, compared the impact of Israel’s tech economy on the country’s overall economy to Singapore’s. Israel, according to the study, is a world leader in the size of its “internet economy” but its internet economy has not translated into economic benefits for the non-ICT sectors, as it has in Singapore. The GDP for both countries was similar throughout the 1980s — but then Singapore’s GDP took off, leaving Israel behind.

The different performance of these two economies could be related to the productivity differences in the non-ICT sectors. The productivity (TFP) in the non-ICT sectors in Israel has shown low performance while the ICT flourished. The local R&D in the ICT sectors seldom had any impact domestically. Despite the proximity, there hardly were any innovation complementarities with the rest of the economy\textsuperscript{73}. Most of the investments in ICT in Israel focus on ICT manufacturing companies while there is insufficient investment in ICT technologies in traditional and mixed-traditional technology sectors. Other countries such as Singapore, understand that the more significant economic advantages of ICT come from sectors that utilize, rather than produce, ICT. International experience indicates that investment in ICT in traditional industries and in the services sector may lead to improving efficiency of these industries, for example, in the US, the services sector were the primary contributor to GDP growth in the last decade, in large part due to its adoption of advanced ICT (e.g. by Walmart). The Report "Israel 2028: Vision and Strategy For Economy and Society in

\textsuperscript{72}World Bank

\textsuperscript{73}Morris Teubal, Promoting High Technology Entrepreneurship in Israel, (2013) [website]
a Global World” (2008) concludes that Israel can learn three key lessons from Singapore’s experience: (i) Single-minded dedication to engineering; (ii) Emphasis on world class education, above all excellence in math, as a foundation for educating engineers. In fact, Singapore ranks near the top in PISA international tests in science and math; and (iii) Excellent infrastructures.

The comparison between Israel and Singapore is illustrated in the “spider” graph below which clearly shows the superiority of Singapore in all the dimensions analyses, except one: innovation. The other two countries are discussed in the next section.

**Figure 21: Global Competitiveness Index – Israel, Singapore, Poland, Armenia**

![Graph showing Global Competitiveness Index](source: World Economic Forum)

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75 The Global Competitiveness Index (GCI) published by the World Economic Forum, provides twelve pillars that decompose how each country compares to other economies along different dimensions of economic competitiveness, including innovation and some of its driving factors.

5.2 Poland and Armenia

In this section, we identify ingredients which could be replicated in and adjusted to the conditions of Armenia and Poland in contrast to distinct or unique ingredients which are hard to replicate, such as the spillovers from military to civilian R&D or the immigration of scientists and engineers from the former Soviet Union.

Both Poland and Armenia have gone through transitions from a planned economy to a market one since the 1990s but there the similarity ends. Since the collapse of communism in 1989, Poland’s economy has grown by more than that of any other country in Europe and was the only European economy to avoid a recession during the global crisis in 2008. Poland is located next door to the EU’s biggest economy, Germany and is used as a springboard for doing business in the CEE. Poland joined the EU in 2004 and still receives significant aid from the EU as “structural funds”, partly as grants to SMEs and start-ups.

The Armenian economy is landlocked, and disadvantaged in trade and transport due to strained relationships with Turkey and Azerbaijan. Its main trading partner is Russia and it joined the Russian-sponsored Eurasian Economic Union rather than link with the EU as its neighbor Georgia did. Although the share of high-tech in total exports is less than 3% (2012), the IT industry is one of Armenia’s fastest-growing sectors. Armenia has a long history as a science hub of the former Soviet Union.

Similarly to the Jewish Diaspora, Armenia benefits from close ties with the Armenian diaspora’s scientific communities, entrepreneurs and investors. Israel’s development is perceived as a model by many in Armenia: Israel prospered in spite of its closed borders with hostile neighbors; it did so by developing high technology exports of nontangible goods like ICT, which bypass the distance from markets. Many Armenians expect their diaspora to fulfill an active role in the ICT, education and tourism sectors. For example, according to Noubar Afeyan, an entrepreneur and venture capitalist based in Boston MA, Armenia does have a large network of people in the diaspora who are engaged in venture capital and can be called upon. Yet, he believes that a large state-driven, state-managed venture capital is bound to fail.  

Innovation support programs and instruments in Poland and Armenia have been inspired by various long standing programs in other countries. For example, programs such as matching grants for R&D, SMEs and startups have been pioneered by government agencies such as: the US SBIR, the Finnish TEKES, the Singaporean Ministry of Trade and Industry, and the Israeli OCS and The Israel Small and Medium Enterprises Authority (ISMEA).

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77 Interview with Noubar Afeyan by Itzhak Goldberg on June 13, 2014 in Yerevan
Innovation support in Poland is mostly funded by EU’s Operational Program for the Innovative Economy (OP IE) and is managed by the Ministry of Economy and implemented by the Polish Agency for Enterprise Development (PARP). Another key agency supporting innovation is the National Centre for Research and Development (NCBiR) which is the implementing agency of the Minister of Science and Higher Education. An example of the learning process between Israel and Poland is the collaboration in 2010 between the Israeli MATIMOP (see chapter 2) and the Polish NCBIR to support joint R&D projects involving parties from both countries. Another example is the establishment of the fund Giza Polish Ventures I (GPV I), with investments of the Israeli Giza Venture Capital and the National Capital Fund, owned by the state-owned Bank Gospodarstwa Poland.

Unlike Poland, Armenia cannot rely on the EU to support its innovation system. Bilateral aid from donors is limited and Armenia’s budget is hardly in a position to provide generous support to innovation. One modest but important innovation support instrument has been inspired by the Israeli incubators experience: the Enterprise Incubator Fund (EIF). The EIF is a technology business incubators and consulting company, established in 2002 within the framework of the World Bank’s “Enterprise Incubator” project. The design of the EIF was based on a Feasibility Study for the Establishment of Technological Incubators in Armenia (1999-2001), funded by the WB and implemented by an Israeli consulting company named BSA.

5.3 Conclusion

This chapter analyzed the distinctive and generic ingredients that make Israel a “start-up nation”. The objective was to see which of these could be used by other countries in order to build their own high-tech industry. On the basis of the analysis in the preceding chapters, this chapter summarized the ingredients and identified those ingredients that could be used by other countries in order to build their own high-tech industry. The message is that while some ingredients of the Israeli and perhaps the Singaporean experience, such as the military and historical legacy, might be harder to replicate, major ingredient such as human capital, legal framework, R&D and infrastructure, can be used as models of learning and replication.

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78 Kapil, Natasha; Piatkowski, Marcin; Radwan, Ismail; Gutierrez, Juan Julio. 2013. Poland - Enterprise innovation support review: from catching up to moving ahead. Washington DC: World Bank [website]

79 Interviews with Itzhak Goldberg of the WB and Benjamin Bachrach of BSA Israel, The Speaker, 22 November, 1999
6 Conclusions and Lessons for Emerging and Developing Countries

The World Bank’s Growth Commission (2008), chaired by Nobel laureate Michael Spence, wrote in the chapter on The Art of Policy Making that “It is relatively easy to identify the shared characteristics of the high-growth cases and easy to appreciate their collective importance. But it is hard to know how to replicate these characteristics”. Similarly, it is easier to identify the success ingredients of innovation success cases like Israel than replicating them. In chapters 1-5 of this report, we identify the ingredients of the Israeli case and in this chapter, we address the challenge of replicating these ingredients in other countries. To conclude this report, we sum up the (i) development of Israel’s ICT and innovation and (ii) highlight the lessons for emerging and developing countries.

Israel was founded in 1948 after WWII, absorbing massive immigration of refugees and fighting for its survival in numerous wars. The conditions for the development of the start-up nation has developed since the 1980s as there has been a major change in the government’s attitude toward the private sector: from socialist ideas and preferential treatment of state-owned and union-owned enterprises in the 1950’s, to liberalization, openness in foreign trade and a strong market economy. In the past fifty years, Israel’s economy has become a hub of technological innovation. “Its companies have developed voice mail, an ingestible video camera that fits inside a pill, the USB disk on key, and many more important and ubiquitous products.” The lesson from this history for developing countries, some of which have undergone conflicts and instability, is that success is possible in spite of a difficult history and a precarious political situation.

The Innovation Ecosystem Model which we describe in this case study is actually based on two key economy sectors:

- Research economy sector, which is driven by research universities.
- The commercial economy sector, which is driven by the marketplace and gave Israel the name of “Start-Up Nation”.

The players of this Innovation Ecosystem include physical resources such as funds, equipment, facilities, as well as human capital (students, faculty, staff, industry researchers, industry representatives, etc.), both of which are crucial to the Ecosystem’s success. The institutional entities which are participating in the ecosystem include the universities, transfer technology offices known as TTOs at the universities, some of the colleges, business schools within the universities, business firms and enterprises,

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venture capitalists (VC), industry-university research institutes, government supported Centers of Excellence within the universities, the military, and last but not least is the government and/or local economic development and business assistance organizations, funding agencies.

In this report we identified several ingredients which explain the success of the Israeli innovation model or the emergence of the startup nation. Some of these ingredients are distinct or unique to the Israeli culture. Yet, many ingredients are generic and thus can be replicated in other countries. As they have been discussed in detail in the previous chapters, we list them briefly below.

Lessons/ingredients that could be learned/replicated

1. Investing in education (primary, secondary and tertiary) is a key enabler in the development of high-tech industry. Expenditures by Government on tertiary education are essential to support research universities that will not only generate basic research, but produce engineers and scientists. This human capital is the most important asset in establishing an ICT sector.

2. Taking advantage of the diaspora. Expats who acquired high degrees and experience in the West and come back to their home countries generate benefit for the development of high-tech economy in developing countries.

3. Connectivity (whether the Internet or mobile phones) is increasingly bringing market information and financial services to those who need them. The experience of the successful startups studies in this report (e.g. Wix, Shadow) show how the mobile platform is emerging as a very powerful way to extend economic opportunities and key services to millions of people.

4. Good Governance: Encouraging Innovation and Business Expenditures on R&D through Good Governance. This will, eventually, lead to investments by the private sector.

5. National Innovation Ecosystem, the climate in which innovators and entrepreneurs operate, is a necessary albeit insufficient condition for replicating the success of the Israeli model. The Ecosystem must be complemented by research universities, skilled labor force, R&D investment, entrepreneurial spirit and risk culture.

6. Government interventions were designed so as not to hamper the emergence of the private sector: (i) business expenditures on R&D (BERD) are about 85% of the total R&D investment (ii) privatization of the incubators started during 2000. This development owes its activity to the rapidly growing private venture capital that traditionally did not fund such projects. As of 2015, there are 24 private technological incubators which are partially supported by the OCS. (iii) the OCS support programs are designed to avoid “crowding out” of private funds that would have been used to finance the project had the government support not
been granted.\textsuperscript{81} Thus, developing countries could learn from the OCS how to design innovation support instruments that avoid crowding out of private investment.

7. From the beginning the OCS did not “pick winners”, but rather responded to market demand\textsuperscript{82}. The OCS followed neutrality up until 10-15 years ago, when more targeted policies in biotechnologies and nanotechnologies were initiated. The Israeli policy shifted from horizontal toward thematic R\&D support, with specific domains and sectors under its scope\textsuperscript{83}. In the early stages of the development of the innovation economy in Israel, neutral policies have proven successful and the lesson from this sequencing of policies is that governments in developing countries might consider avoiding sector targeting (“picking winners”), in the early stages of building the innovation economy\textsuperscript{84}.

8. International cooperation with academia and industry is essential for the success of the Israeli model. To enhance internationalization of R\&D, the governments should support for example, Bi-National R\&D Funds that will choose projects on a competitive basis. Admittedly, some of the ingredients that allowed Israel to internationalize are distinct and hard to replicate: (i) spillovers from military R\&D\textsuperscript{85}, (ii) supportive diaspora, well represented in the international R\&D community. As noted in chapter 5, the lesson from comparing Armenia to Israel is that while some ingredients of the Israeli model, such as the military and historical legacy, might be hard to replicate, major ingredients such as human capital, legal framework, R\&D and infrastructure, can be models of replication.

9. The development of the ICT sector in Israel has been export-led and only recently did Israel realize the lack of diffusion of ICT to other sectors of the domestic economy and is actively changing policy. Larger countries may choose a combination of export and domestic led strategies but undoubtedly the pressures and discipline of international competition are essential for innovation. Not surprisingly, a small country like Armenia followed an export-led development of its ICT sector from its inception.

\textbf{\underline{Technology Absorption Versus Innovation}}

In chapter 5 we used the examples of Poland and Armenia to illustrate their absorption of knowledge from Israel and other developed countries. A key conclusion is that absorptive capacity in the emerging and developing country is a prerequisite for the replication of innovation from a developed country. Absorption capacity can be built by a committed and long-term government investment in education and R\&D, to

\begin{itemize}
\item \textsuperscript{81} The impact of government support to industrial R\&D on the Israeli economy. The Ministry of Economy. (2008) [website]
\item \textsuperscript{82} Innovation Policy for Development: an Overview. Tel Aviv University, NBER and CEPR. (2005) [website]
\item \textsuperscript{83} Israel Policy profile. KETs Observatory - European Commission (2012) [website]
\item \textsuperscript{84} Goldberg et al (2011), page 126
\end{itemize}
name just these two examples, as is abundantly clear from the Israeli experience. Investments in education and R&D are non-distinct, but rather generic ingredients that can be replicated.

Israel’s innovation model mostly consists of “new to the world” innovation. The discussion in chapter 5 shows that in developing countries technology absorption is a critical stage. In emerging markets such as China, India and Russia, technology absorption takes a more dominant role than new to the world innovation. As argued in chapter 5, knowledge flows from Israel to Poland or Armenia depend on their absorptive capacity. Absorptive capacity, as Aghion and Haravel (2015) articulate, can be built by investment in R&D which creates a capacity to assimilate and exploit new knowledge. Israel’s investment in R&D relative to its GDP is the highest in the world and for other countries to absorb and replicate its innovation model, high investment in R&D will be needed.

Information technology is becoming a fundamental enabling infrastructure of the competitive new regime. ICT is a critical part of what enables the organization and coordination of global production networks and the integration of global supply chains. Carl Dahlman (2015) posits several implications for developing countries: “The enabling environment consists of the government regulations and institutions that facilitate the operation of business and the economy. It includes the basic institutions such as government rule of law, efficiency of capital and labor markets, ease of setting up or shutting down business. It also includes the ability of the government to create consensus and the ability to help people who fall through the cracks in the system”.

Lessons for entrepreneurs in emerging/developing countries:

While most of our recommendations are oriented to policymakers, the interviews with the entrepreneurs and CEOs of startups and their staff in chapter 4 lead us to some recommendations for startups in emerging and developing countries:

1. Your product must provide a solution to an unmet need, in the domestic market or abroad. Therefore, you as an entrepreneur should understand the target market very well.

2. Entrepreneurs must be people who are not afraid of risky long term projects. Policy makers need to cultivate a culture where such entrepreneurs can thrive and prosper. The culture involves risk-taking, audacity and “out of the box” mentality. Daring, audacity and assertiveness need to be encouraged and respected.

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86 The distinction between the two is that innovation is new to the world while technology absorption is new to the country


88 Technology, globalization, and international competitiveness: Challenges for developing countries. United Nations (2007) [website]
3. In the view of the entrepreneurs, the optimal management model requires that the Israeli CEO stay close to the development center in Israel, i.e. close to the heart of the new company. This is in contrast to the conventional advice of venture capitalists and views in the literature that an export-oriented industry such as ICT, cannot grow far from their main customers i.e. that the “solution is outward migration, moving headquarters abroad...” and indeed the CEOs of Check Point and of Wix, for example, have stayed in Israel and hired people in their main target markets.

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