Exploiting opportunities of the new economy: developing nations in support of the ICT industry

Elias G. Carayannis *, John Sagi

School of Business and Public Management, The George Washington University, Washington, DC 20052, USA

Abstract

Nations competing in this ruthless and changing “new economy” rely on industries that are often headquartered, performing research and development and executing their supply chains and distribution channels in other nations. “Supporting” nations provide the infrastructure and the ancillary resources that allow firms and industries to settle, prosper and gain market share. At the same time, these supporting nations reap economic rewards of those industries that they attract and develop core competencies themselves to expand the industry sectors.

Ireland is presented as a model for the supporting nation within the information and communication technology (ICT) industry, and is studied to identify why firms in that industry have chosen Ireland as a hotbed for regional competitiveness. Very little academic research has been done on Ireland and its burgeoning technology industries. Poland and the Philippines are introduced as potential supporting nations in contrast with Ireland.

“Why do some nations succeed and others fail in international competition? This question is perhaps the most frequently asked economic question of our times. Competitiveness has become one of the central preoccupations of government and industry in every nation . . .” (Porter, 1990)

Researchers have established links among a firm’s innovation, productivity and competitiveness (CPI). Carayannis and Sagi (2000a) expanded on Porter’s work by showing relationships among nations, industries and firms as resources are shared among them to fuel the CPI and to permit nations to compete using their local industries. The CPI Model, Fig. 1, illustrates the relationships among the major players and functions.

Carayannis and Sagi (2000a) identified a distinction among nations with respect to industries and firms, and hypothesized that primary nations provide certain resources such as national funding for risk-sensitive industries. Further, primary nations develop a culture conducive to headquartering the firms and nurturing the industries. Examples of primary nations include those discussed by Porter (1990) as industrialized nations competing with specific industries.

From Fig. 2, the Primary Nation is concerned with nurturing both the industry and the firm, using trade policy, research and development monies for risk projects, sponsoring consortia, and by linking universities with industries.

However, not every industrialized nation can be a primary nation for an industry. These non-primary nations are interested in attracting and supporting specific industries. The question arises, then, of what are the success factors associated with “supporting” nations within an industry? For example, the software giant Oracle has a large presence in several nations, including Ireland. What are the core competencies of Ireland that makes it attractive to firms in the Information and Communication Technology (ICT) industry? Why has Oracle chosen a manufacturing presence in Ireland and a sales presence in Poland?

This paper provides the metrics for identifying and understanding the role of the supporting nation. This paper uses Ireland as the model for study, due to its recent emergence as a strong software provider, and the

* Corresponding author. Tel.: +1-202-994-4062; fax: 1-202-994-4930.
E-mail address: caraye@gwu.edu (E.G. Carayannis).

Keywords: International; Ireland; Poland; Philippines; Information Technology; Innovation; Productivity; Competitiveness; Government; Industry; Firm; New Economy; National Culture
intense economic benefits that Ireland receives by using the ICT industry as a key ingredient in its global competitive strategy.

This paper contrasts Ireland with Poland, which uses the ICT industry as an enabler to productivity instead of an industry to support; and with the Philippines, which is taking steps to specifically target the ICT industry as a supporting nation.

Rather than offering a causal analysis of supporting nations, this paper presents a developmental structure to aid firms in the ICT industry in identifying those national attributes and phases that may be attractive in enhancing the competitiveness of the industry.

1. Nations, industries and firms

Nations, industries and firms possess certain attributes that make them differ in capabilities and in requirements. Fine (1998) argues that industries differ greatly in their complexities and “clock speeds”. He further observes that public institutions (nation states) and humans also may differ in this attribute. This is often called “cycle time” in firms and many industries. Even national cultures vary in their concept and use of “time” (Hofstede, 1997; Trompenaars and Hampden-Turner, 1998).

Further, the acquisition of technological capability is important to the process of raising productivity. Efficiency does not automatically follow from the acquisition of foreign machinery that uses the new technology. Sustained efficiency depends heavily on domestic capabilities to generate and manage change in those technologies. These capabilities are based largely on specialized resources such as a highly skilled labor force and
large national investments. In science-based firms, technology is accumulated mainly by corporate R&D labs and is heavily dependent upon the skills, knowledge and techniques emerging from academic research (Bell and Pavitt, 1996). Industries and firms rely upon the national competitive environment for their own competitiveness. Tapscott et al. (2000) discusses the value chains of firms and industries such as Cisco Systems, working in the digital economies.

Porter (1990) identifies four stages in the evolution of national competitive development as Factor, Investment, Innovation and Wealth-Driven. Kuemmerle (2000) identifies two types of R&D facilities for global companies, including those that absorb new research results from foreign universities and competitors from foreign locations.

2. Supporting nations

Clearly, some nations are more industrialized than others. Economic studies often class nations according to financial attributes such as gross national product (GNP). Is it possible to identify and classify nations based upon these attributes, then subcategorize them as primary nations or as key supporting nations?

**Hypothesis:** It is possible to identify a supporting nation in ICT by certain common economic metrics.

To identify metrics of primary and supporting nations, a study of several factors of industrial nations was conducted to determine any correlations among the factors. Source data from the World Bank for 1998 were analyzed for correlation (Pearson’s $r$) and for statistical significance. Data variables included the size of the population in millions of people, the gross national product (GNP) in US Billions, the percent of GNP spent on research and development (R&D) from 1987 to 1997, the number of patent applications filed by residents in 1997, and the number of technicians employed in R&D per million population from 1987–1997. The study population includes the 149 nations participating in projects of the World Bank.

Table 1 shows a very strong correlation between the nation’s GNP and the number of patents originated by nationals. This is reasonable, explained by the interest by highly industrialized nations in the protection of intellectual property rights and in the furtherance of domestic research.

Also note the strong and significant positive correlation between the percent of GNP spent in R&D and the number of technicians employed in R&D. Certainly the amount of funds allocated to R&D would result in greater employment.

However, from the remaining data we conclude that there is not a statistically significant relationship between and among the:

- Size of the population and any of the attributes.
- GNP and the % spent on R&D, or the number of R&D technicians.
- Amount spent on R&D and the number of patents originated by nationals.
- Number of resident patents and the number of technicians.

It is not possible to confidently predict the success of an R&D program, for example, or a nation’s innovative abilities, on these factors. What can be used to identify a nation as a supporting nation that competes with an industry?

**Hypothesis:** national R&D spending may be a major factor in attracting industries.

We studied the change in R&D spending from 1975 to 1997 for many of the same nations.

Note the dramatic increases in R&D spending in Sweden, Finland, Italy, South Korea and Ireland indicated in Table 2. Perhaps R&D spending is a key determinant of a supporting nation. However, many other nations also indicate strong R&D spending.

The question remains. What factors may be attractors to the ICT industry? To determine these, we studied Ireland as a supporting nation, Poland as a nation not focused upon becoming a supporting nation for the ICT industry, and the Philippines as a nation that is beginning to actively target ICT firms.

<table>
<thead>
<tr>
<th>Table 1 Primary economic and technical indicators$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
</tr>
<tr>
<td>Population</td>
</tr>
<tr>
<td>GNP</td>
</tr>
<tr>
<td>R&amp;D %</td>
</tr>
<tr>
<td>Resident patents</td>
</tr>
<tr>
<td>R&amp;D technicians</td>
</tr>
</tbody>
</table>

$^a$ Source data: World Bank, 2000, Tables 1.1 and 5.12.

$^b$ ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).
Table 2
Research and Development Growth 1975 to 1997 (Total national R&D spending as percent of GNP)*

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweden</td>
<td>1.7</td>
<td>2.5</td>
<td>3.0</td>
<td>3.76</td>
</tr>
<tr>
<td>Japan</td>
<td>2.0</td>
<td>2.6</td>
<td>2.9</td>
<td>2.80</td>
</tr>
<tr>
<td>Germany</td>
<td>2.2</td>
<td>2.5</td>
<td>2.8</td>
<td>2.41</td>
</tr>
<tr>
<td>United States</td>
<td>2.3</td>
<td>2.7</td>
<td>2.6</td>
<td>2.63</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>1.95</td>
</tr>
<tr>
<td>France</td>
<td>1.8</td>
<td>2.3</td>
<td>2.3</td>
<td>2.25</td>
</tr>
<tr>
<td>Switzerland</td>
<td>2.4</td>
<td>2.3</td>
<td>n/a</td>
<td>2.60</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2.0</td>
<td>2.0</td>
<td>n/a</td>
<td>2.08</td>
</tr>
<tr>
<td>Norway</td>
<td>1.3</td>
<td>1.4</td>
<td>1.9</td>
<td>1.58</td>
</tr>
<tr>
<td>Finland</td>
<td>0.9</td>
<td>1.3</td>
<td>1.7</td>
<td>2.78</td>
</tr>
<tr>
<td>Belgium</td>
<td>1.3</td>
<td>1.5</td>
<td>n/a</td>
<td>1.60</td>
</tr>
<tr>
<td>Italy</td>
<td>0.9</td>
<td>1.1</td>
<td>1.5</td>
<td>2.21</td>
</tr>
<tr>
<td>Canada</td>
<td>1.1</td>
<td>1.3</td>
<td>1.4</td>
<td>1.66</td>
</tr>
<tr>
<td>Austria</td>
<td>0.9</td>
<td>1.2</td>
<td>1.3</td>
<td>1.53</td>
</tr>
<tr>
<td>Denmark</td>
<td>1.3</td>
<td>1.2</td>
<td>n/a</td>
<td>1.95</td>
</tr>
<tr>
<td>Korea</td>
<td>n/a</td>
<td>1.1</td>
<td>n/a</td>
<td>2.82</td>
</tr>
<tr>
<td>Australia</td>
<td>n/a</td>
<td>1.0</td>
<td>n/a</td>
<td>1.80</td>
</tr>
<tr>
<td>Ireland</td>
<td>0.8</td>
<td>0.7</td>
<td>n/a</td>
<td>1.61</td>
</tr>
<tr>
<td>Spain</td>
<td>0.4</td>
<td>0.5</td>
<td>n/a</td>
<td>0.90</td>
</tr>
<tr>
<td>Singapore</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>1.13</td>
</tr>
</tbody>
</table>

* Source data: Porter (1990), Table 13-1 and World Bank, 2000, World Development Indicators.

3. Ireland

Ireland is the second largest software producer in the world (Brown, 1999). Over 40% of all personal computer packaged software sold in Europe is produced in Ireland. The top ten independent software companies in the world have significant operations in Ireland. The nation’s booming GDP growth rate is 7.4% annually, the largest rate of any EU nation.

The software industry in Ireland consists of 550 companies employing more than 15 thousand. Of those software companies, 120 are foreign. The largest companies in the information technology industry in Ireland include Microsoft, Oracle, Intel, Cisco, Hewlett Packard, Dell, Compaq, IBM, Xerox, Apple, Gateway, Motorola, Netscape and Corel. The software industry is historically chronicled by Oriain (1997).

The Emerald Isle has the world’s first virtual movie studio, using the Web to create and coordinate film development. Supporting firms have emerged nearby to provide telecommunications, personnel, transportation and other resources. Iona Technologies develops software to make different types of software compatible!

In population (4 million), Ireland resembles Armenia, Bosnia, Costa Rica, Eritrea, Lebanon, Lithuania, Moldavia, New Zealand, Norway and Puerto Rico. In GNP ($69M), Ireland most closely approximates Chile ($74M), Pakistan ($61M) and Peru ($60M).

Using the % spent on R&D (1.61%), Ireland spends a bit less than the UK (1.95%) and Canada (1.66%). Further, Ireland has fewer patents registered by residents (946) than Kazakhstan (1171) and more than Hungary (774). Finally, Ireland has 506 technicians per million population, about as many as Hungary, Yugoslavia and Libya.

Given these comparisons, however, the question remains. What are the characteristics of a supporting nation that make it attractive to industries?

3.1. Ireland interviews

Several interviews were conducted with members of the staff of the Embassy of Ireland, Washington, DC.

The perceived strongest attractor of firms to Ireland is its generous tax advantages sponsored by a pro-technology industry government. However, language and access to the European Union nations are the other prime reasons cited.

Successive Irish governments identified the ICT industry and the software sector as a key strategic industry. Software is perceived at the national level as being ideal, using the highly educated workforce, without compromising the “green environment”. Software, as a digital product, is easily transported and is critical to the growing “new economy”.

A mere two decades ago, agriculture was the overwhelmingly predominant industry. Software is now one of the top three industries within the strong export-driven economy. Most of the exports are targeted to the European Union as shown in Table 3.

Forfás is the policy advisory and co-ordination board for industrial development and science and technology. It is the body in which the State’s legal powers for industrial promotion and technology development have been vested. It is also the body through which powers are delegated to Enterprise Ireland for the promotion of indigenous industry and to IDA Ireland for the promotion of inward investment.

The Industrial Development Agency (IDA) is the government agency responsible for ensuring that overseas companies establishing an operation in Ireland

Table 3
Ireland exports (Ireland product exports and destinations, 1999)*

<table>
<thead>
<tr>
<th>Principle exports</th>
<th>% of total exports</th>
<th>Destinations</th>
<th>% of total exports</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronics and software</td>
<td>40</td>
<td>EU (not UK)</td>
<td>45</td>
</tr>
<tr>
<td>Chemicals</td>
<td>23</td>
<td>UK</td>
<td>24</td>
</tr>
<tr>
<td>Food and livestock</td>
<td>15</td>
<td>NAFTA</td>
<td>11</td>
</tr>
<tr>
<td>Other</td>
<td>22</td>
<td>Remainder</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

* Source: NSD
receive assistance. This assistance includes education, training, employment and R&D grants. The IDA is also the liaison between industry and education. Clients include Arthur Andersen, Apple, Digital, EDS, Ericsson, IBM, Intel, Microsoft, Novell, Oracle, Sun and Symantec.

Chart 2, Primary and Supporting Nations Model, indicates a strong relationship between the supporting nation and the university. IDA was established with a mandate to work closely with industry and the universities to provide both the financial and the skill set support. Universities have been strategically directed to implement computer-related courses. New initiatives include Limerick University and Dublin City University. The government sponsors the Software Program in Advanced Technology (PAT) across the country, in addition to the Advanced Software Technologies Institute (ASTI) in seven universities. The latter focus is on distributed systems, intelligent systems, high performance computing, and image analysis. Dublin City University has a 99% employment rate among its graduates.

Ireland identified the telecommunications support and infrastructure necessary to house their software industry and link it to the global clients. Telecom Ireland, recently privatized, has invested $5B in the country’s integrated digital network. Three of four customers have bypassed the analog “last mile” problem plaguing the US telecommunications industry, and have digital connectivity. 80% of Dublin is cable ready. All schools have Internet and all students have an email address. There is a 48% cell phone penetration, greater than most industrialized nations.

Another key to success has been the continued availability of young, well educated citizens. 50% of the population is under 28 years of age.

According the interviewers, strong attractors often overlooked include social links to the United States (headquarters for the industry and many of the firms) and a liberal organization structure. Most organizations are horizontally flat, including the government. Any idea or project will be visible.

Due to the rapid expansion, often the universities are unable to accommodate the demand. Ireland must host trade fairs to attract technicians from the EU. Xerox is building a large manufacturing facility in Dundalk, near the border with Northern Ireland, to take possible advantage of the larger labor pool and the strong culture.

3.2. Ireland national culture

The Irish interviews noted the strong work ethic. This is an area of possible interest and benefit for the software industry. “Work ethic” is difficult to measure. However, Ireland rates very low in “Power Distance” (PD), 49th of 53 rated by Hofstede (1997). PD is the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally. It is similar to Germany, Great Britain, Finland, Norway, Denmark and Israel in this important trait.

Ireland also ranks very low in Uncertainty Avoidance (UA), 47th of 48 countries listed. It is similar to the US, India, Great Britain, Hong Kong, Sweden, Denmark and Singapore. UA is the extent to which the members of a culture feel threatened by uncertain or unknown situations.

Carayannis and Sagi (2000b) identified relationships between the phases of systems development and Hofstede’s cultural dimensions. Ireland is similar to the Scandinavian nations and Great Britain in these two traits, and is not identified with the strong programming powerhouses of the US and Germany, phases later in the Systems Development Life Cycle (SDLC). However, Ireland favors the earlier design phases of the SDLC, particularly due to the strong ability to deal with uncertainty, vagueness, and other common attributes of early to middle project detailing. This is the area most likely to become strength for Ireland.

3.3. The Irish transformation

To augment the lack of R&D consortia, industry organizations establish branches in regions where their firms are concentrated. The Business Software Alliance is branched in Ireland, for example. The Telecommunications Industry Alliance (TIA) has a location in Brussels that oversees Northern Europe.

Ireland is concerned about retaining the allegiance of the ICT industry in the event of a change in the national economy. It is easier now for companies to relocate within the EU. This is prompting Ireland to become a primary nation in software development, to court and entrench the industry, and to strongly link the industry to the national economy.

Government R&D funds have traditionally gone to the universities. However, the newly established Technology Foresight Fund, as a freestanding research organization, now controls much of the research funding. Although the universities are resisting this change, it completes the requirements within our CPI Model to become a primary competitive nation.

Other initiatives include creation of Dublin’s “City West” Digital Park as permanent home for several of the incubators and smaller firms. MIT is establishing the European presence with a Media Lab in Dublin.

4. Poland

We studied Poland both to compare with Ireland as a supporting nation, but also to isolate any traits that may
be characteristic to the transition economies in their quest to attract the ICT industry.

Poland is strategically situated as a land bridge between Eastern and Western Europe. In 1990 Poland began the Balcerowicz Program of radical market oriented reform, including the use of ICT to accelerate the process of European integration. Poland supports the Action Plan of the European Council of March 2000, which encourages this policy.

Like Ireland, government support for research is channeled through an agency, in this case the KBN (State Committee for Scientific Research). Poland’s Industrial Development Agency (IDA) primary focus is transformation of the existing heavy industrial enterprises.

In many ways, Poland and Ireland are similar. Both are strategically situated near strong ICT growth regions of the European Union and the other former block nations. Both have highly educated workforces. Both have strong technical competencies. Yet there are obvious structural differences, as can be seen from A Selective Comparison of Ireland and Poland (Appendix A).

Clearly the ICT industry has opportunities in Poland (Anon, 1999). However, referencing the CPI Model, it becomes evident that Poland is focused on transitioning the existing industry rather than attracting and sustaining newer ICT industry. While the national telecommunications infrastructure is still being actively developed, the annual market growth for ICT products is among the highest in Europe.

Interviews with officials of the Embassy of Poland in Washington, DC highlighted this emphasis on current industries (including heavy industries of machine building, iron and steel, coal mining, chemicals, shipbuilding, food processing and textiles). Further, privatization is ongoing but incomplete. Telecommunication costs remain high. Tax rates are increasingly burdensome.

5. The Republic of the Philippines

The Philippines contrasts with both Ireland and Poland as a potential ICT industry supporting nation. Like the others, the Philippines is strategically situated in the South Pacific. There are 7100 islands to be linked by a new telecommunications infrastructure.

In population (75 million), the Philippines resemble Egypt, Ethiopia, Thailand, Iran, Turkey, Vietnam and Germany. In GNP ($79M), the Republic most closely approximates Peru, Pakistan, Ireland, Chile, Egypt, Malaysia and Venezuela. Using the percent of GNP spent on R&D (0.22%), the Philippines spend the same as Syria, Azerbaijan, Costa Rica, Egypt, Malaysia, Jordan and Tunisia.

Further, the Philippines have fewer patents registered by residents (125) than do Lithuania, Latvia, Malaysia, Mongolia and Chile. Finally, they have fewer tech-

nicians per million population than The Gabon, Syria, Burundi, Malaysia, Venezuela and the Central African Republic.

The Republic established a National Computer Center (NCC) early, in 1971, as the catalyst for government modernization. They began targeting ICT firms in earnest in October 1997 with the IT21 Action Agenda, published by the National Information Technology Council (NITC)(Anon, 1997). This plan documents a common vision, provides a timeframe for implementation of several goals, and indicates a strong and significant link between the NITC and the National Economic and Development Authority (NEDA):

- 2000 — The national telecommunications infrastructure.
- 2005 — Information technology use will be pervasive in daily life and Philippine companies will be producing competitive IT products for world markets.
- 2010 — The Philippines will be a Knowledge Center in the Asia–Pacific, as well as the leader in IT education and in business applications.

According to the plan, the government will lead the way by automating and providing the seed market for new ICT firms.

The principle strengths offered are a well-educated and price-competitive labor force, English proficiency, a growing track record of successful IT work, government interest in the industry, less regulation than other neighboring nations, and a strong national spirit of entrepreneurship. However, there remain a weak IPR enforcement, a scarcity of available investment capital, and a small domestic market. There is a scarcity of trained IT personnel despite the fact that Philippine universities graduate 70,000 engineers and 100,000 computer scientists per year (Clifford and Kripalani, 2000).

The IT21 plan addresses several of these points. Education funding and government promotion of technology training will increase the IT staff training levels. The NADA is actively targeting foreign direct investment. The small domestic market will increase as the Internet and IT permeate the homes and businesses.

Several unique aspects of the Philippines, as noted in the IT21 document, include a preferential treatment of local companies in learning IT from foreign firms, and a user-oriented strategy to encourage building a critical mass of local supporting firms. Telecommunications have recently been deregulated. Calling Centers were established to increase public phone use. The number of ISPs has increased dramatically to encourage web use.

Seagate, Fujitsu, Apple, NEC, Acer, Cypress Semiconductor, James Martin, NCR and Platinum Technology have recently established or have planned a major presence, either in manufacturing or assembly
operations. Software exports are expected to exceed US$300M this year.

The government funds about 60% of all R&D, high in comparison with the industrialized nations. Thus most of the technology is imported. Clearly the ICT industry also has opportunities in the Philippines as well as in Ireland and for similar reasons.

From the view of national culture, the Philippines rate very high in PD, 4th of 53 and contrasts with Ireland, which ranks very low. The Republic ranks very low in UA, and joins the USA, India, Malaysia, and Great Britain in that category. Again, referring to the model developed by Carayannis and Sagi (2000b) that identified relationships between the phases of systems development and Hofstede’s cultural dimensions, the Philippines are similar to Singapore and Malaysia in these two traits. The traits favor the earlier planning phases of the SDLC particularly due to the strong ability to deal with uncertainty, vagueness, and other common attributes of early to middle project detailing.

6. Conclusions

From the interviews and research, identifying Ireland as representative of the supporting nation in the ICT industry, and contrasting Ireland with Poland and the Philippines, we conclude that

- a primary nation possesses all the major factors associated with the CPI model: proactive government policies, industrially-focused education system, industry organizations, R&D consortia, communications links, and a supplier infrastructure to sustain progress. Chart 2 describes the primary nation model.
- A supporting nation, although technologically able and having a majority of the factors of the primary nation, often misses on the full benefits of economic progress by not establishing the consortia, the organizations and the joint R&D facilities necessary to provide sustained improvement and innovation. Chart 3 describes the model of the supporting nation.
- A nation may be primary in one industry and supporting in another.

The competencies of a supporting nation in the ICT industry include certain infrastructures:

- Communications — fast links across the nation and to the globe. Ireland has an excellent fiber backbone. The Philippines is developing the infrastructure.
- Governmental — tax and policy bases proactive to the firms. Ireland boasts very low tax rates on certain products, and has established a program of digital parks. The Philippines is following suit, but must improve the enforcement of intellectual capital laws.

- Cultural — national traits suited to the type of work involved.
- Economic — low unemployment, low inflation, characteristic of both Ireland and the Philippines.
- Supporting Industries — Ireland has printing, manufacturing and telecommunications firms located to manufacture, distribute and support the software industry products. The Philippines is working to establish the domestic markets and the ancillary industries.
- Educational — Ireland has one of the finest information systems curricula in Europe. The Philippines intends to lead Asia in the decade.

Certain distinct phases may be involved for a nation to transform to a primary or a supporting nation. These phases include:

1. Identify an industry to support or develop.
2. Attract companies with economic incentives, favorable government policy, and communications infrastructure suited to that industry.
3. Develop education and skill sets compatible with the targeted industry through government programs.
4. Enforce intellectual property legislation.
5. Focus R&D to the industry through the universities.
6. Develop skills in the industry.
7. Create local consortia.
8. Redirect R&D to the newly established consortia. Begin to identify and create a new industry sector to be associated with the national strengths.
9. Compete globally in the newly established industry sector.
10. Establish organizational presence in other nations, using them as supporting nations.

Further research is warranted for locating transition and newly industrialized nations as models for confirming
these findings, and for developing a model for primary and supporting industries.

Appendix A

<table>
<thead>
<tr>
<th></th>
<th>Ireland</th>
<th>Poland</th>
<th>Philippines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor force (M)</td>
<td>2M</td>
<td>20M</td>
<td>32M</td>
</tr>
<tr>
<td>GDP (B)</td>
<td>582B</td>
<td>158B</td>
<td>65B</td>
</tr>
<tr>
<td>Telephones per 1000</td>
<td>435</td>
<td>228</td>
<td>37</td>
</tr>
<tr>
<td>Telephones per employee</td>
<td>133</td>
<td>121</td>
<td>132</td>
</tr>
<tr>
<td>Cost to call USA per 3 min ($)</td>
<td>1.45</td>
<td>3.65</td>
<td>4.96</td>
</tr>
<tr>
<td>Daily newspapers per 1000</td>
<td>150</td>
<td>113</td>
<td>79</td>
</tr>
<tr>
<td>Radios per 1000</td>
<td>699</td>
<td>523</td>
<td>159</td>
</tr>
<tr>
<td>Televisions per 1000</td>
<td>403</td>
<td>413</td>
<td>108</td>
</tr>
<tr>
<td>Mobile phones per 1000</td>
<td>257</td>
<td>50</td>
<td>22</td>
</tr>
<tr>
<td>PCs per 1000</td>
<td>271</td>
<td>44</td>
<td>15</td>
</tr>
<tr>
<td>Internet hosts per 10,000</td>
<td>157</td>
<td>41</td>
<td>1</td>
</tr>
<tr>
<td>Scientists and engineers in R&amp;D per million population</td>
<td>2,319</td>
<td>1,358</td>
<td>157</td>
</tr>
<tr>
<td>Technicians in R&amp;D per million population</td>
<td>506</td>
<td>1,377</td>
<td>22</td>
</tr>
<tr>
<td>Science and engineering students %</td>
<td>31</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>Science and technical journal articles</td>
<td>900</td>
<td>3,895</td>
<td>-</td>
</tr>
<tr>
<td>High-tech exports ($)</td>
<td>24B</td>
<td>684M</td>
<td>18B</td>
</tr>
<tr>
<td>Expenditure for R&amp;D % GNP</td>
<td>1.6</td>
<td>0.8</td>
<td>0.2</td>
</tr>
</tbody>
</table>


References


Elias G. Carayannis is on the faculty of the School of Business and Public Management of the George Washington University in Washington, DC, as well as Director of Research on Science, Technology, Innovation and Entrepreneurship, European Union Center, SBPM, GWU and faculty member of the GWU SBPM Environmental Studies Center as well as the GWU SBPM Social and Organizational Learning Studies Center. Dr. Carayannis received his Ph.D. in Technology Management from the Rensselaer Polytechnic Institute in Troy, New York in 1994, his MBA in Finance from Rensselaer in 1990, and his BS in Electrical Engineering from the National Technical University of Athens, Greece, in 1985. Dr Carayannis’ teaching and research activities focus on the areas of strategic government–university–industry technology partnerships, business/war gaming and technology roadmapping, technology transfer and commercialization, international science and technology policy, technological entrepreneurship and regional economic development. Dr. Carayannis has several publications in both academic and practitioner, US and European journals such as Research Policy, Journal of Engineering and Technology Management, International Journal of Technology Management, Technovation, Journal of Technology Transfer, R&D Management, Growth and Change, The Review of Regional Studies, International Journal of Global Energy Issues, International Journal of Environment and Pollution, Le Progres Technique, and Focus on Change Management. He has consulted for several technology-driven government and private, large as well as small organizations such as the NSF SBIR, the NIST ATP, Sandia National Laboratories’ New Technological Ventures Initiative, the General Electric Corporate Training & Development Center, Cowen & Co, First Albany International, Enterprises Importfab, and others. He is fluent in English, French, German, Greek, and has a working knowledge of Spanish. He is citizen of the United States of America and the European Union.

John Sagi is a doctoral student at the George Washington University, with interests in global information technology and he conducts his doctoral research under the guidance of Professor Elias G. Carayannis of the SBPM, GWU. John Sagi is also a professor of business and computer studies at Anne Arundel Community College, Arnold, Maryland. Professor Sagi spent ten years as information resources manager for FMC Corporation, developing and managing telecommunications and software solutions. He is a retired Naval Officer, with proven experience in managing large information systems. His last position was Database Administrator at NATO Headquarters, Brussels. He has degrees from the United States Naval Academy, Johns Hopkins University and the George Washington University.