Technology Centres and Research Spin-offs as Two Pillars of RTD Policy in Slovenia[1]

Introduction

At the Paris Knowledge Economy Forum in February 2002 (KEF I), the Finnish case study was presented and the Finnish transition to a knowledge-based society offered as a potential model to be adapted and applied in EU Accession Countries. The Final Report[2] highlighted two factors that seem to have played a vital role in enabling Finland, a small country with limited natural resources other than its forests, to become a leading competitor in the "new economy": sustained investment in research and development, to fuel innovation, and a coherent and forward-looking response to economic crisis.

Since the early 1980s, Finland has consistently increased investment in research and development (R&D), and in the late 80s and early 90s, at a time when OECD countries were dramatically reducing government R&D support, it expanded public finance of business R&D. In its creative response to the crisis it faced in the early 90s, Finland intensified its efforts to open its economy to foreign investment, to create the economic and policy incentives for innovation, and to liberalize and deregulate domestic markets. The well-known network of companies, i.e., Nokia and its supplier network, account for 20% of Finnish exports, and they have contributed as much as one third of overall GDP growth in Finland in the past few years. This network of companies, and the robust national innovation system that underpins them, should also provide Finland with some degree of protection against downturns and shifts in particular parts of the high-tech market.

It is easy to find other reasons for choosing the Finnish model of developing a knowledge-based society as the reference point for Slovenian RTD policy. In a recent study by Manuel Castells and Pekka Himanen[3], Finland is presented in comparison to the Silicon Valley model or to the Asian experience, as a socially distinct, yet technologically equally dynamic model of the information society. As the authors state, Finland shows that a fully-fledged **welfare state** appears to be a decisive contributing factor to the growth of the dynamic, competitive new economy on a stable

[1] Presented at the Knowledge Economy Forum II, World Bank and Finland, Helsinki, March 2003. Prepared by: Dr. Darja Piciga, State Undersecretary, Science Office, Ministry of Education, Science and Sport, and Iztok Lesjak, Director, Ljubljana Technology Park.
Area: Government policies and institutions for research and development, applied research, commercialisation and links to industry: Formulation and implementation of a national strategy for knowledge development, establishment of institutions and funding mechanisms to implement such a program.

[2] Building Knowledge Economies: Opportunities and Challenges for EU Accession Countries. Final Report of the Knowledge Economy Forum "Using Knowledge for Development in EU Accession Countries" organized by the World Bank in cooperation with the European Commission, the Organization for Economic Cooperation and Development, the European Bank for Reconstruction and Development, and the European Investment Bank, Paris, February 19-22, 2002. May 2002.

[3] Castells, Manuel, and Himanen, Pekka (2002). The Information Society and the Welfare State. The Finnish Model. New York: Oxford University Press.

basis. It provides the human foundation for labour productivity necessary for the informational model of development, and also brings institutional and social stability, which smoothes the damage to the economy and to people during periods of potentially sharp downturns.

Similarly, the main goal of the Strategy for the Economic Development of Slovenia[4] is **to increase the welfare of people living in Slovenia** in a sustainable manner, with welfare being defined as a balance between economic, social and environmental components. In the field of economic development, the Strategy's overall achievement should be to raise the rates of gross domestic product growth and to thus accelerate the reduction of the development gap behind the EU; this should be achieved without widening the gaps in the areas of social and environmental development, which are somewhat narrower. The Strategy's decision to give priority to economic growth and development is underpinned by estimates showing that Slovenia's development gap in this area is wider than the average gap in the level of social and environmental development. According to the Strategy, the building up of a knowledge-based society is supported by four governmental policies, including:

• Research and development policy and technological development,

• The building of information and communications infrastructure and the development of new services.

Finland displays, at the same time, dynamic integration in the **global economy**, fully fledged membership of European institutions, and a strong affirmation of its culture, unique language, and **national identity**. Identity is also projected toward the future, building Finnish pride in the collective accomplishment of Finland as an advanced information society. For Slovenia, a small Central European country, situated at the crossroads of four European geographical areas, these are very relevant lessons that can be learned from. In the process of integration into the European Union, the need to preserve national identity is constantly emphasized.

Among the factors that have contributed to the success of the Finnish model, Costells and Himanen offer also:

A. The role of the state in the development of an innovation system. The state has played, and continues to play, a major role in guiding economic growth and building the information society in Finland. However, it has not brought the economy under bureaucratic control. Instead, it has been a major liberaliser of the economic system. Among other things, the Finnish state has acted as a promoter of technological innovation, as a public venture capitalist, and a producer of knowledge labour, thus creating the conditions under which Finnish business could restructure itself and compete globally.

B. Spatial clustering and organizational networking of knowledge-based industries have been critical sources of productivity and competitiveness in Finland, as they have been in Silicon

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[4] Slovenia in the New Decade: Sustainability, Competitiveness, EU Membership, Strategy of Economic Development of Slovenia 2001 – 2006, Summary, Institute of Macroeconomic Analysis and Development. Ljubljana, 2001.

The Strategy for the period 2001-2006 was adopted in 2001. It is Slovenia's main strategic document that identifies development goals and economic policy priorities. A more detailed presentation of the Strategy and description of the development of a knowledge–based economy in Slovenia can be found in: Challenges and Opportunities in Building a Knowledge Economy in Slovenia. Report presented at the Knowledge Economy Forum for EU Accession Countries, World Bank, Paris, February 19-22, 2002.

Valley, thus verifying the theory of milieux of innovation as drivers of technology and the economy in the informational paradigm. However, local and regional governments in Finland have also undertaken important initiatives in diffusing technology in local societies, and in mobilizing local economies into a new techno-economic paradigm.

We will therefore try, with he help of a modest comparative analysis, to define the specific areas of RTD policy where a reasonable application of the Finnish model seems (or has already proven to be) the most promising and, at the same time, to provide the necessary background information for the case study of technology centres and research spin-offs.

RTD infrastructure and policy in Finland and Slovenia

According to IMD, Finland ranks highest in the world in terms of total R&D personnel nationwide per capita and total R&D personnel in business per capita, and second in terms of total expenditure on R&D (GERD)[5]. The corresponding rankings for Slovenia are: 17, 19, 22. Slovenia, according to the last available statistical data, is the leading candidate country in the domain of R&D. The main strengths of Slovenian R&D are:

- a relatively high share of GDP invested in research and development compared to other candidate countries for EU membership,
- a relatively high quality of scientific research and activities in the public sector, with well established international cooperation, and
- relatively young and fairly numerous researchers, with negligible “brain drain”.

However, in the breakthrough towards science as a productive and developmental factor, Slovenia is hindered by numerous obstacles. One of them is the weak co-operation among public research institutes, academia and the business community, and poor links among the different actors in the R&D and innovations system in general. Further unfavourable features are a low growth rate of high-tech companies, low level of technological networking and weak organisational know-how. These are factors that are considered to have contributed also to the rather low position of Slovenia in the domain of international economic competitiveness (compared to other domains, for example societal or environmental development)[6].

Some of the conclusions from recently conducted studies on the present situation in innovation system are:

1. In the period 1999-2000, in manufacturing and selected services almost 28% of all Slovenian enterprises were engaged in innovation policy. The total investment in RTD and innovation amounted to 81.1 billion SIT, which represents 2% of GDP. Funds invested in machinery and

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[5] For more data on R&D indicators, see: Indicators for benchmarking national research policies. Calculating values for Slovenia. Prepared by Daša Bole-Kosmač. Ljubljana: Ministry of Education, Science and Sport, 2002.

[6] To illustrate this conclusion, we present data for the ratio of the richest 20 percent to the poorest 20 percent (a measure of social injustice, sources: Castells & Himanen, 2002, and UNDP, 2001): Slovenia 3.4, Finland 3.6, United States 9.0, Singapore 9.6, Advanced economies average 5.8, Rest of the world 13.5). Rankings on the economic competitiveness scales for Slovenia, Finland and USA, respectively: 32, 1, 2, (WEF, 2002); 38, 2, 1, (IMD, 2002).

equipment amount to 35% and those invested in RTD to 33%. The innovation intensity (share of innovation expenditure in the enterprise sales revenue) was 3.2%. Investment was made in improvement of product quality, introduction of new services, improved flexibility and expanding markets.[7]

2. The number of patents in Slovenia is continuously growing. The Slovenian Intellectual Property Office (SIPO) prepares patents, trademarks and industrial design protection records according to the EU methodology. In 2000 and 2001, approximately 700 patents were granted. In 2002 the number rose to nearly 950. At the end of 2002, almost 4000 patents were in force in Slovenia.[8]

However, the technological gap (measured in terms of the number of patents and the volume of investment in research and development) between Slovenia and EU countries is still much wider than the gap in GDP per capita or the gap in the share of GDP used for investment in research and development. The number of European patents per million population in 1999 was 22, in comparison to 125 as the EU average, and to 375 in Finland[9]. For Slovenia, international comparisons confirm the lag, especially in corporate innovations.

3. In 2002, Slovenia was included in the Global Entrepreneurship Monitor (GEM)[10]. The identified weaknesses are: the transfer of RTD results was the most emphasized weakness related to national economic growth, investments in RTD at the universities do not lead to commercial exploitation of innovated products, a lack of efficient knowledge transfer between research and industrial spheres, particularly to the fast growing part. In relation to knowledge diffusion, Slovenia was in last place among participating countries in the GEM survey.

4. The WEF Global Competitiveness Report for 2002 evaluates the national innovation capacity in 75 countries based on three broad elements: innovation infrastructure (the set of public investments and policies, human and financial resources and the economy's level of technological sophistication), the cluster specific environment for innovation (the presence of high-quality and specialized inputs, investments capability, presence of local demand and local related and supporting industries) and the quality of linkages between the innovation infrastructure and the cluster specific environment. In terms of its innovation capacity, Slovenia was ranked in 31st position (Finland: 2nd), by proportion of scientist and engineers it was in 20th position (Finland: 7th), regarding innovation policy it was in 32nd position (Finland: 4th), it was in 50th position for cluster innovation environment (Finland: 2nd), and in 33rd position for quality of linkages (Finland: 3rd).

5. The IMD World Competitiveness Yearbook 2002 analyses and ranks the ability of nations to provide an environment that sustains the competitiveness of enterprises by evaluating the economic performance, government efficiency, business efficiency and infrastructure. In 2002,

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[7] Source: Statistical Office of the Republic of Slovenia, Annual Report on Research and Development Activity, Census on Innovation Activity in Manufacturing and Selected Services.
[8] Source: Annual SIPO reports.
[9] Figure 3.1.1 in Indicators for benchmarking …
[10] Reynolds, Paul et al. (2002). Global Entrepreneurship Monitor 2002. Executive report. London: Ewing Marion Kauffman Foundation.

49 countries were included in the analysis and Slovenia was ranked in 38th position (Finland: 2nd), one rank higher than the year before. However, the development and application of technology ranked Slovenia in 42nd position (Finland: 1st), funding for technological development in 41st (Finland: 1st), and interest in science and technology in 37th position (Finland: 3rd).

The difference in ranks in the technological infrastructure indicators presented above is much higher than the difference in some scientific infrastructure indicators, presented at the beginning of the chapter. The results show that the areas of technological development and innovation system are very promising for a reasonable application of the Finnish model in Slovenia.

Let us therefore take a look at the genesis of the main public elements of the Slovenian and Finnish innovation systems[11] (**Table 1**):

Element	**Slovenia**	**Finland**
Public Universities	2 up to 2002 - 1 new established in 2003	2 full universities up to the 1960s 20 in ten cities in the 1970s
National fund for RTD	Established in 1995, not effective 2000 – a new one established, gradually becoming effective	1967 - SITRA
National agency for technology development	Proposed in the mid-nineties; SIA – business plan not realised	1983 - TEKES
R&D policy councils	1992 – mostly representatives from the scientific community, with an advisory role	1963 - Science Policy Council 1986 – S&T Policy Council headed by the Prime-Minister, includes 8 Ministers
RTD investments – targets (GERD - % for R&D in GDP)	2.5% in the eighties 2.5% for 1995-2000	From 1.2 to 2.2% for 1982-1992 From 2.2 to 2.9% for 1996-1999
RTD investments – statistical data	1.5-1.6% in 1995 1.5% in 2000	2.2% of GDP in 1992 3.2% of GDP in 1999
Public incubation infrastructure investments	Proposed for EU structural founds (2003-2006)	Several 100,000m2 space for incubation facilities
Technology centres, parks, business, UNI incubators	Started in mid-nineties: 30 TC's (with different roles), 3 parks, 3+2 business incubators; 2 university incubators being established	Started in the 1980s: 19 parks with 19 TC's and 19 university incubators, 14 regional and 2 national Centres of Excellence
Association of centres, parks and incubators	Slovenian Association of Technology Centres, Business Incubators and Technology Parks (establishment in process)	Finnish Science Park Association – TEKEL, FISPA since 1988

[11] The main source for Finland: Castells and Himanen, 2002.

Castells and Himanen (2002) found the following key elements of the Finnish innovation system, which has evolved over a quarter of a century and ultimately turned the economy round after the recession in the early nineties[12]:

"1. **An active public policy of innovation** based on high investments in R&D under the guidance of the Science and Technology Policy Council. A public, free, high-quality university system, which has a strong emphasis on engineering, creates the human basis for innovation (basic research innovations, employers for the companies, and hackers). The technology research and development financer Tekes and the "public capitalist" Sitra provide financial support for risky corporate innovation; and the liberalisation, deregulation, and privatisation policy, combined with *avantgarde* thinking about open standards, creates a positive culture of innovation. Contingent political reasons have had their input, but they were not the key reasons for success.

2. **Business innovation**, which is encouraged by public action but which is ultimately based on the company's ability to recruit, keep and use its talented R&D people, providing the necessary financial basis for turning innovations into products through market mechanisms, and a company culture of innovation.

3. **Hacker innovation**, which is driven by talented individuals, who are often supported by public systems such as free universities and student grants, and has the hacker ethics as its innovation culture…"

The authors argue that although some factors can be singled out as more important than others, the decisive point about Finnish innovation is the combination of the above factors – its holistic approach. The network tendency of this system, which combines all its components, is, according to Castells and Himanen, so central, that continued networking should be spelled out as an underlying driving factor. The Finnish innovation system is not a list of factors but a unique network of interactions. In addition to their specific technological results, an important outcome of the large number of committees, councils, steering groups, forums and so on that have been established by the Finnish government has been the networking of people in industry, universities, and government. This networking has created a kind of Silicon Valley effect, in which ideas are exchanged and people take their knowledge from one environment to another.

In 1996, still partly suffering from recession, the Finnish government nevertheless decided to further increase investment in R&D from 2.2 to 2.9% by 1999, although it was otherwise cutting public expenditure. This target was achieved in 1998, also on the basis of effective realisation of the measures proposed by the documents of the national R&D policy. A considerable percentage of new investments in R&D came from the private sector.

[12] The authors define the causes of the recession to a certain extent differently from the KEF I Final report: the recession is characterised as Finland's teething troubles in the course of joining the global informational economy. An additional reason why the results of the Finnish innovation had to wait until after the recession is that this was a global phenomenon – it was necessary to wait for the massive breakthrough of the Internet for the IT revolution to accelerate in 1994. In contrast, Slovenia was not able to take advantage of its early success in ICT development.

The growth of business research and development has also been encouraged by the positive R&D environment created by bodies like the Science and Technology Council. Of course, business also increases its R&D investments independently and for direct business reasons. In 1999, the private sector accounted for 69 percent of all Finnish R&D, up from 57 percent in 1991 (data for the Slovenian BERD in 1999: 57%).

It is interesting that in a recent Phare project on technology centres in Slovenia, close collaboration and synergy between TCs and technology incubators-parks in Finland is considered to have contributed to the creation of “technology clusters” in that country. All 19 university-related Science Parks in Finland include TCs, and they are members of the Finnish Science Park Association (TEKEL). This is further justification for our decision to elaborate the Slovenian experiences with TCs and research spin-offs more in detail.

Technology Centres

Technology Centres have been in existence in Slovenia for the last ten years, either as units of research institutions or centres, or started as new entities by enterprises, and research or regional institutions. Over recent years, around thirty Technology Centres[13] have been financed by the Ministry of the Economy (or formerly the Ministry of Science and Technology), with widely differing sizes, resources, founders and organisations. While the programme has contributed - in varying degrees – to the strengthening of these institutions and to technology development and transfer, there has appeared a need better to define the scope, means, organisation and financing mechanisms of these institutions, in the light of the need for convergence with European Union innovation and technology development policies and programmes. In order to define the strategic possibilities for the development of Technology Centres in Slovenia, surveys of existing Technology Centres, companies and institutions have been conducted[14].

<u>Survey of existing technology centres</u>

Twenty-eight technology centres were financed by the Ministry of Economy in 2001; most of them were interviewed for the analysis. A further 9 centres were financed in 2000 and still other centres were financed in the past, but are not now considered “official” TCs. These centres presently serve different industries and have various degrees of regional or sector impact.

In the interviews, several people stressed the importance of communication and networking among TCs, and the lack of this aspect among Slovenian TCs. The lack of TCs in certain important sectors of Slovenia´s economy, such as the power and water supply sector, can only be explained if there is already a diversity of institutions with the necessary knowledge and technologies in this field, and therefore it may not seem necessary to finance a TC in these and other sectors.

[13] We refer in this case study to all organisations – whether formally called Technology Centres (TCs) or not – which have as their main objective promoting, implementing and monitoring applied research and technology development for a group of enterprises, whether nationally, regionally or locally.

[14] Strategic Possibilities for the Development of Technology Centres in Slovenia. Final Report for the Phare Project SL9914-Skofic 25. August 27, 2002.

The transportation and logistics sector is also important for at least one region (Obalno-kraška) but there is no TC offering specialised services to this sector. The activities of a pilot project for a logistics cluster development might offer a solution to developing a specialised TC for this and other sectors without TCs.

Various technology centres also offer training and consulting services to their customers. All centres are involved in consulting and training, and some of them indicate that they dedicate a high percentage of their activity to this area.

There are several indicators that show that the gap among industrial sectors (in terms of productivity, efficiency, export, added value) is increasing. For instance, % of GDP of the wood processing industry is diminishing. Only a high level of technological development can provide the driving force of the successful future development of the sector and TCs can contribute to this objective.

As TCs seem to be so disparate and different from each other, a classification or segmentation into groups seems necessary. The characteristics of technology centres interviewed varied :

- according to **size**: there were some TCs which were "one-man-shows", while others TCs were integrated in large research or technical institutions, where it was hard to find a clear borderline between the institution and the specific TC.

- according to the quality and quantity of **services**: some TCs focused on certain publicly financed projects while others were broad-based TCs with a complex variety of services for their client companies.

- according to their **financing** mode: some TCs depended fully on public subsidies, while others had diversified income from client companies, regional bodies and publicly subsidised projects.

- according to the **number** of target group/clients: some TCs focused on services just for a few member companies, while others had a nation-wide and large number of client companies.

- according to their relationship with **science and research institutions**: some TCs had no relationship with institutions of science and research, while others are based inside, or are close to, research institutions. Still others are really consultants integrated in or associated with specific research institutes.

Survey of companies and other instutions

A limited survey of over 200 companies and institutions was conducted for the purpose of developing a TCs strategy. One of the most important messages received from the companies is that they appreciate positively the activities of technology centres. There were some remarks regarding the relatively high costs of services and lack of availability of specific services. Most of the companies (over 70%) declared that their product or process is "technologically demanding or complex". More than 80% of the companies believe that they work with their "own technology" or have improved internally existing technology. This could imply a resistance to changing their technology and a lack of understanding of the need to continuously upgrade technology, which can quickly become obsolete in a competitive market.

Companies have expressed differing attitudes and knowledge of technology centres. Some of the companies were founders (e.g Predilnica Litija) or users (e.g Goltes) of TCs. The expectations of the companies are related to their view of the business-generating potential of TCs. Those companies which strive for excellence use and demand services of domestic, as well as foreign TCs. For them, TC services offer marketable services, which have to be available to local companies and entrepreneurs. In this case, professional services and affordable cost are the main criteria for using TCs. As these companies do not usually have financing problems, the availability and reasonable cost of the services (equipment and skills) are the key to TC success. In various interviews, the low availability of technology-oriented staff and services for small entrepreneurs has been stressed.

When asked about why they use or would use a technology centre, companies and entrepreneurs explained that the main reason would be faster and cheaper development of new products/services .

Institutions interviewed[15] realise the importance of technology development, but do not fully understand their own role in the process. It is considered a difficult area, as there are no clear guidelines – and many enterprises and institutions conclude that it is better to maintain existing products or technologies or to start a search for new products and markets. Quite often (especially among those who are concerned with maintaining employment numbers), the opinion is expressed that resources should be spent on supporting existing (non-profitable) industries, which have provided employment for decades.

In relation to regional distribution, some regions expressed the worry of being "left out" of the competitiveness and technological race.

Estimation of Demand for Technology Centres

Cases of successful companies interviewed that had been assisted by technology centres (Goltes, KIV, etc.) prove that substantial improvements can be achieved through the applied usage of know-how and technology. In many cases, the TC, university and company had jointly developed a successful RTD project. The companies also used the available support programmes from the government to develop initial prototypes or models.

The demand for TC services was observed at three different levels:

1. A need for high-level technologies in specific fields, to keep abreast and develop the latest trends in these leading-edge technologies.

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[15] National institutions (National Research Institutes, head offices of Chambers of Commerce and Crafts, Universities and other national institutions) and regional bodies (RDAs, Chambers, Municipalities etc.).

2. A need to share resources or improve the sector or local groupings (clusters) of companies.
3. A need for regional services to support technology development, especially of smaller companies in regions with little access to the knowledge drivers (universities, research centres, etc.)

In the next section, technology centres will be segmented according to these different demands, and some approaches to their development will be proposed.

The locations and numbers of each type of centre in Slovenia cannot be precisely defined at this stage, as a precise policy or mapping of existing technological strengths is still missing. A range for the adequate number of each type of centre has therefore been proposed, based on the number of existing ones, interviews, indicators and discussions held at the workshops.

<u>General Conclusions of the Surveys</u>

To conclude: the existing system and infrastructure for fostering innovation and the adoption of new technology by Slovenian companies is not yet well structured. On the one hand, there is a top-down tier of TCs which are working on a national level and are well connected to international technology networks. Other TCs work closely with branches or clusters. These TCs should really understand the problems and technology deficits of their group of companies. These two types of TCs should be complemented with a bottom-up tier of Technology Advisory Centres (TACs), which disseminate information and technology transfer and help create a positive climate for innovation, new technologies and entrepreneurship.

As a result of this classification, it has been observed that Slovenian Technology Centres are not yet a homogeneous and efficient instrument for providing research and/or technology services to the market. Some centres don't even have relationships with science and research institutions and, in a few cases, their main objective seems to be obtaining grants, therefore not providing a truly "social service" to small technology-demanding companies with scarce/limited economic resources. This could be because the criteria under which TCs are eligible for receiving public funds are too broad and based mostly on the quality of "projects" presented, rather than on a study of the market needs or strategy.

Moreover, in terms of their geographical distribution and specialization, there is a strong concentration of TCs in regions such as the central region Osrednjeslovenska (40%), Savinjska (23%) and Podravska (16%), thus leaving important regions for balanced economic Slovenian development (southern and north-western regions) fairly unattended. Likewise, a considerable shortage and/or lack of centres dedicated to important sectors of activity has been observed, since there are none or few TCs in certain key sectors, such as wood processing, transportation and logistics.

The recently developed strategy[16] was intended to provide guidelines and benchmarks for TC's future development and to set minimum requirements for state and regional financing. On the basis of empirical findings on the state-of-the-art in Slovenia and reviewing the development and experience from other countries in Europe (Finland, Germany, Ireland, and Portugal), the strategy proposes the segmentation of TCs into three types:

- Bringing international key technologies to the national industry Technology Competence Centres (TCCs)
- Helping branches and industrial sectors to compete in relevant areas of technology and in specific clusters: Sector and Cluster Centres (SCCs)
- Bringing technology to small and medium sized companies (SMEs) outside the main knowledge centres: Technology Advisory Services (TAS)

The difference between SCCs and TCCs is one of specialization and scale: it is possible that a SCC will develop into a TCC with time and that a TCC will turn into a SCC due to a lack of own scientific know-how acceptance by their clients as a state-of-the-art institution. While TAS work at regional level, their main focus is to help small and medium sized companies in the region in the use of new technologies and the development of new products and services.

Based on the size of Slovenia, there should only be about 3-5 TCC in the country, focusing on the technologies in which Slovenia has a competitive advantage and accumulated experience and around 10-15 SCCs in the country, focusing on sectors with the potential for development of strategic clusters. A TAS should be set up in a geographical region with common industry and communications, not necessarily statistical regions and should be linked to the Regional Development Agencies (RDA), but not be made an integral part of them. TAS should have a minimum of 2 technology consultants with a technical degree and industrial experience, depending on the number of companies in the region. (Estimate: for 400 target companies 1 consultant with 20 to 30 innovation projects on a contract basis)

It is proposed that the government should modify the types of tenders determining the TCs financing, maybe even by making separate tenders for different types of TCs. For the effective technology transfer from universities and/or related institutions to industry, the knowledge owners (professors-researchers) should commit themselves fully to such programs, while also having a longer time horizon for their security. We would envisage a three- to five-year time period for future tenders, at least of competence centres TCs, instead of the current one-year tenders.

A promotional and marketing campaign for the new TC programme has also been proposed, to be launched as soon as the Strategy is approved by the Slovenian Government. This campaign (consisting of articles in newspapers, magazines, newsletters, Internet, definitions and procedures for TCs, advance of tenders to be launched, etc.) would aim at raising the awareness and preparing TCs, their shareholders, local institutions and authorities - as well as other science and

[16] Proposed by: Strategic Possibilities for the Development of Technology Centres in Slovenia. Final Report for the Phare Project SL9914-Skofic 25. August 27, 2002.

technology bodies - for the new TC concept and engaging their support in promoting their services.

Technology Parks

During the last seven years, three technology parks have been established in Slovenia: Ljubljana Technology Park (mixture of public and private ownership), Styrian Technology Park (public ownership) and Primorska Technology Park (mixture of public and private ownership). In the past years, the parks have gained experience in the field of identification, motivation, verification and inclusion of local innovation potential in the forms of newly established enterprises.

In our environment, spin-off companies from the research environment are established mainly by researchers – the bearers of ideas – and other strategic or economic partners, preferably in an environment such as Technology Parks. We have chosen to analyse this process in the case of the Ljubljana Technology Park: being located in the Osrednjeslovenska region where 62% of the Slovenian GERD is spent it has accounted for a great majority of research spin-offs in Slovenia.

Ljubljana Technology Park (LTP) in the last year offered assistance in establishing eight spin-off companies from the research and industrial spheres. To date, 51 companies are tenants at the Ljubljana Technology Park, 16 companies have outgrown the incubation period and three companies have left the park. Of all the companies included, 39 have been start-ups and 30 spin-off companies. Ljubljana Technology Park, viewed as a group of high-tech companies, represents a rapidly growing, dynamic company. It has already had 56 members since 1996. Companies currently employ 272 people with further education, while the operating processes of these companies involve at least the same number of outside workers. Revenue per employee in the companies in the park is more than 80,000 EUR, while the value added per employee is more than 20,000 EUR. Half of the companies generate income in foreign markets, while five companies are primarily geared towards exports. The fact that the companies have already attracted EUR 15 million in venture capital is further proof of their quality.

Based on their experience (the Park hosts 30 spin-off companies), they have designed a framework to manage the procedure of establishing spin-off companies. Initially, their guidance enables bearers of ideas to continue growing and developing research achievements to a level enabling the establishment of a spin-off company and the affirmation of achievements outside the academic environment in the global market. The next rule is to enable the establishment of a company independent of the physical location in the technology park incubator, on the premises of research organizations or faculty or in an industrial environment.

In the procedure itself, it is important first of all to record the activities leading to useful results for market exploitation onr the spin-off company model. These include basic and applied research financed by state schemes, research contracted by industry, consultation activities and research and development activities financed internally.

Any of these activities conducted in the academic sphere (research organisations, universities, companies) can lead to an idea providing opportunities for commercialisation of the product, process, technology or procedure. Each of them will be at a different stage of development and will have different potential for simple transfer to the marketplace at the time of assessing their market potential. We therefore need a definition of the individual phases of development of potential spin-off companies, from the start right up to full independence. In the initial phase, the developer (group) recognises the market potential of the results of its work. The idea is further assessed, and if the results are favourable, the developer continues working towards a commercial product or service. Product development shows the need to protect intellectual property. During assessment of market potential and/or patentability, mutual relations must be arranged and the staffing structure of the future company formulated (more a problem of management and marketing than of production, technology and development). Further work on the product and the business plan can lead to a decision that the idea is also a business opportunity, and that it is worth establishing a spin-off company. The capital structure needs to be defined, and decisions taken on venture capital, a strategic partner, and participation by others in the company.

The next phase sees the establishment of a company. It may conduct its activities in an environment favourable for company start-ups and assessment of market potential: in the Technology Park incubator, companies are subsidised for up to four years. After this period, the company can remain an associate member of the Technology Park, but at commercial prices. In the next phase, the company becomes fully independent and moves to an industrial environment.

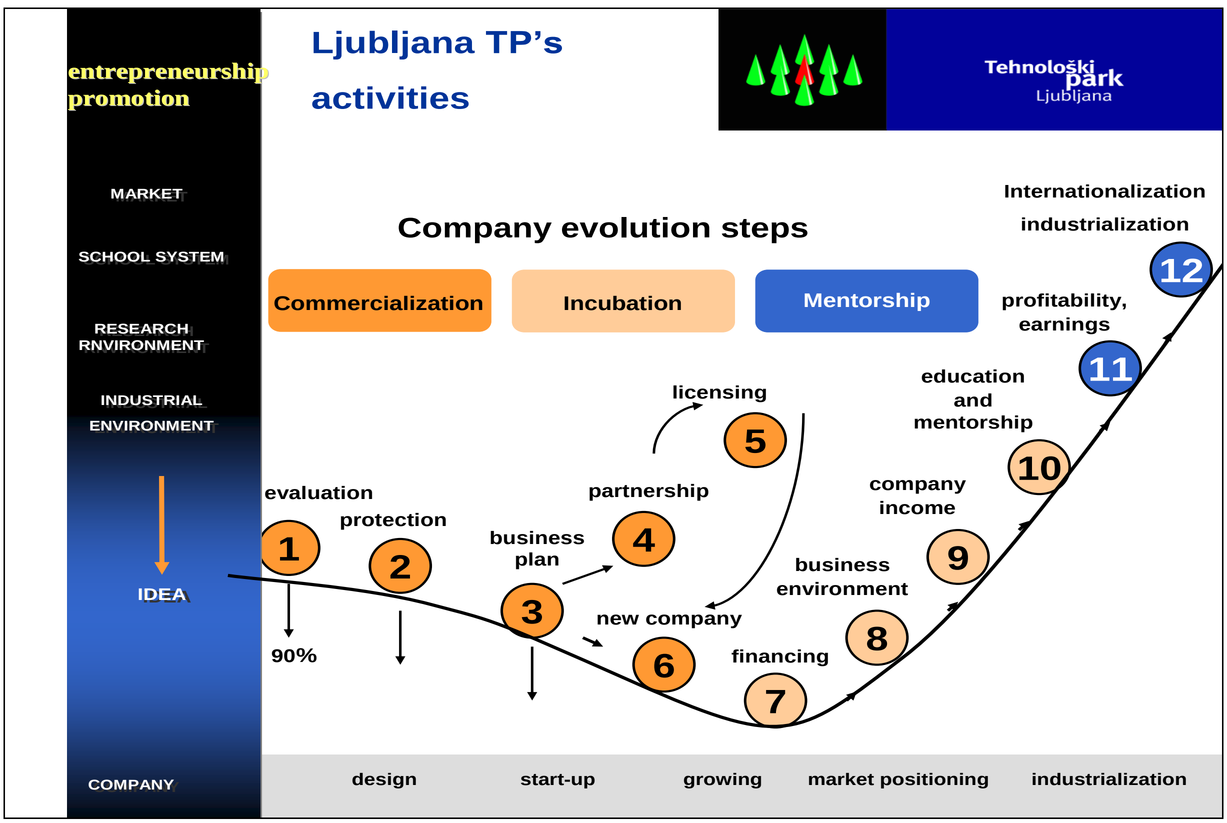

Figure 1: Development phases of companies in the Ljubljana Technology Park

Since 2000, Ljubljana Technology Park has considered 15 initiatives meeting the criteria for inclusion among spin-off companies. These include Geming – project planning of geotechnical projects d.o.o. (a spin-off from the Department of Mining and Geology, Faculty of Natural Sciences and Technology, University of Ljubljana), Vacutech – vacuum technologies and systems d.o.o. (spin-off from the Institute for Electronics and Vacuum Technology), IDS – systems with custom integrated circuits (spin-off from the Faculty of Electrical Engineering, University of Ljubljana), Stikos – switch components and regulation technology d.o.o. (spin-off from the Institute for Electronics and Vacuum Technology), Celica – research, development, production and sale of biomedical equipment d.o.o. (spin-off from the University of Ljubljana), Transcell – immunotherapy company d.o.o. (spin-off from a research project by the Educel company and the Blood Transfusion Institute), Quintelligence – intelligent knowledge management d.o.o. (spin-off from the Department of Intelligent Systems, Jožef Stefan Institute), Vode – consulting, project planning, studies, information technology d.o.o. (spin-off from the Water Industry Institute). For some content, preparatory activities to recognise market potential were conducted as early as 1999.

SPIN OFF	Company	TP Lj adhesion	Tech. and people source	Initiative	Founders capital
1	AMES	Jan.96	Government sector, IJS	Entrepreneur	Personal
2	ELSIS	Jan.96	Gov. sector, IJS	Entrepreneur	Personal
3	GLOBALVISION	Jan.96	Gov. sector, IJS	Entrepreneur	Personal
4	INEA	Jan.96	Gov. sector, IJS	Entrepreneur	Personal
5	INTEKOM	Jan.96	Gov. sector, IJS	Entrepreneur	Personal
6	ISA.IT	Jan.96	Gov. sector, IJS	Entrepreneur	Personal
7	RACI	Jan.96	Gov. sector, IJS	Entrepreneur	Personal
8	RAIS	Jan.96	Gov. sector, IJS	Entrepreneur	Personal
9	RRT	Mar.96	Gov. sector, IJS	Entrepreneur	Personal
10	BALDER	Sep.96	Gov. sector, IJS	Entrepreneur	Personal
11	BIA Separations	Nov.98	Business sector, Bia doo	Management	Mixed
12	VSR	Mar.2000	Bus. sec., Elsis doo	Management	Personal
13	SILON	Mar.2000	Bus. sec.,Indata doo	Management	Personal
14	VISITEL	Mar.2000	University, FE	Entrepreneur	Personal
15	SENSUM	Mar.2000	University, FE	Entrepreneur	Personal
16	OTTO Elektronika	Jun 2000	University, SF	Entrepreneur	Personal
17	VAQUTECH	Jun 2000	Gov. sector, IEVT	Entrepreneur	Personal
18	GEMING	Oct. 2000	University, FMR	Entrepreneur	Personal
19	STIKOS	Oct. 2000	Gov. sector, IEVT	Entrepreneur	Personal
20	IDS	Nov. 2000	University, FE	Entrepreneur	Personal
21	CELICA	Dec. 2000	Univeristy, MF	Entrepreneur	Personal
22	TRANSCELL	Dec.2000	Bus. sec., Educell	Management	Mixed
23	QUINTELLIGENCE	Mar. 2001	Gov. sector, IJS	Entrepreneur	Personal
24	VODA	Mar. 2001	Gov. sector, VGI	Entrepreneur	Personal
25	XLAB	Sep. 2001	Gov. sector, IJS	Entrepreneur	Personal
26	COSYLAB	Feb. 2002	Gov. sector, IJS	Entrepreneur	Personal
27	ABSTRATUM	Mar.2002	Bus. sector, Triglif	Management	Mixed
28	HIPERGO	Mar. 2002	Bus. sector,	Management	Personal

Table 2: Spin-off companies included in Ljubljana Technology Park

All initiatives to promote enterprise, regional development and the economic environment are both welcome and essential. The primary role of the Ljubljana Technology Park on the national level lies in the internationalisation of innovation and enterprise potential. On the local level, due to the specific features of our environment, LTP can further support the particular importance of the Ljubljana Technology Park in terms of motivating, enterprise tradition, and the equalisation of existing and generation of new environments, in which the incubator function for spin-off companies from the research and industrial spheres is one of the more important activities.

The Ljubljana Technology Park is breaking new ground in our region in the area of fostering technologically advanced enterprises. The results achieved, together with the list of initiatives from academic and industrial environments, demonstrate the success of the preparatory period and the correctness of the path chosen.

In Slovenia, we find that the number of research companies, particularly from the university environment, is extremely low given the research funds invested[17]. Research institutions are far ahead in the area of generating companies based on R&D results. Unlike universities, they have organised industrial property, they have established offices for technology transfer, and they are aware of its importance and economic value. Slovenian universities lag behind in this field, despite having more staff, greater funding and more impact on generations. It seems that, despite professional qualifications, universities have dissolved awareness of development, transition, trends and their mission in a sea of self-satisfaction, rigidity and monopolies. University guidelines and action determine the level of concentration of such a solution.

In our environment, spin-off companies from the research environment are established mainly by researchers – the bearers of ideas – and other strategic or economic partners. Spin-off companies in Slovenia are typically established to commercialise industrial property. Companies can design their activities based on research or development results. They are established by researchers or bearers of ideas. Technology transfer is carried out by transferring people from the research sphere to newly established companies. The disorganised legal and promotional environment makes capital participation by research institutions practically impossible.

Employees No. in Spin-off Companies	0-5	6-20	>20
CANADA	33%	28%	39%
FRANCE	35%	43%	22%
GERMANY	51%	25%	24%
LJUBLJANA	69%	31%	0%

[17] 16.6% of GERD is invested in the higher education sector and 25.9 % in the government sector, thus showing that public research institutes are in Slovenia considerably more developed than in comparable countries. Source: Science in Slovenia.

Spin-off field of activity	Canada	Australia	France	Ljubljana
Health care medicine, environment, food, biotechnology, pharmacy	46%	43%	30%	23%
Information technologies software, informatics, communications	21%	27%	29%	27%
Electronics and mechanics electronics, instruments, energy, mechanics	14%	13%	15%	35%
Natural sciences chemistry, physics, new materials, optics, aeronautics	4%	10%	17%	15%
Undefined	15%	7%	9%	0%

Sources: OECD and TPL

Tables 3 and 4: Comparison of spin-off companies in terms of number of employees and activities

By establishing spin-off companies in our environment, we at least ensure that the added value of industrial property (and the related new jobs) remains in the country. When industrial property is sold abroad, all the added value of technology or products developed at home remains abroad. However, none of these solutions take account of the fact that the owner of the industrial property is actually the institution in which the results were achieved, with public funding in at least half of all cases. Thus by failing to arrange conditions in this field, public institutions are closing the door to an important source of income, greater independence from public funds and greater links with the market and with industry.

University Incubators

Across the industrialised world, governments, regional bodies, universities and research centres are recognising the opportunity for growth and innovation which come as a result of better commercial exploitation of the results of applied scientific and technology research. This is closely linked with a greater entrepreneurial drive which generates wealth from academic and technological research. Some leading areas and regions have based much of their growth on the creation of high-value added start-ups, based on ideas or research coming out of institutions of higher education (universities and technical schools) and research centres. These research spin-offs and start-ups are New Technology Based Firms (NTBF), and their rate of creation constitutes an indicator of wealth and prosperity in a modern society.

The creation of spin-offs can be greatly accelerated, and their chances for survival enhanced, with the support of a number of instruments, ranging from entrepreneur training, business plan assistance, awareness campaigns, to physical and office and laboratory premises. The conjunction of these tools represents the university incubator.

Government intervention in 2002 launched the preparation for two business plans for establishing university incubators at the Universities of Ljubljana and Maribor[18]. The Ljubljana Technology Park succeeded in forming a team from different faculties for preparing a Ljubljana University Incubator (LUI) business plan. The real added value is in connecting the faculties (professors, students and knowledge) from socio-economic and natural sciences oriented faculties into one team. The LUI will act as a pre-incubation facility with the possibility of extending the incubation tenants to Ljubljana Technology Park. The Maribor case is slightly different but does not vary in critical incubation characteristics. The business plans were accepted in January 2003 and there is a public program for 2003-2004 for establishing and implementing the incubators at existing universities.

Highlights of the Slovenian R&D policy for increased economic competitiveness

On the basis of previous analytical work, the following opportunities for Slovenian R&D were defined:

- Improving co-operation and transfer of knowledge and qualified staff between the sectors, by providing a more stimulative environment for RTD (through development of clusters, technological networks, technology parks, incubators at universities, technological centres, etc.; co-financing the work of junior researchers employed by enterprises or technology and development centres);
- Strengthening international co-operation in R&D, emphasis on the integration of SMEs in the EU OP, increasing the mobility of researchers (in both directions) and activating the scientific and research potential of the Slovenes living abroad;
- Increasing investment in applied research and innovations, prioritisation of R&D investment, target-oriented research.

A consistent set of goals, targets and measures (including the Barcelona goal of 3% of GDP for R&D by 2010, two thirds of it coming from the private sector) to operationalise the defined priorities has already been incorporated in governmental documents (adopted or under preparation) and is adequately supported by the solutions of the new Research and Development Activities Act, adopted in autumn 2002. For example:

- Increased inclusion of representatives of the economy in the institutional decision-making process related to R&D policy – particularly as members of the future Council for Science and Technology (CST) that has to be appointed by the end of May 2003;
- In 2003, the new National Research and Development Programme will have to define the priority fields for mainstreaming public funds into R&D (to be prepared in 2003);
- In view of assuring an effective distribution of public funds, two agencies will be established in 2003, one for scientific research and the other for technology development. The objectives of the newly established agencies will involve also the stimulation of cooperation among knowledge-based institutions and the corporate sector (the economy).

The Ministry of the Economy's Programme of Measures to Promote Entrepreneurship and Competitiveness 2002–2006, adopted one year ago, is the plan of operations to implement the

[18] The results of the Phare project on university spin-off incubators have been of great help: Strategic Possibilities for the Development of Science/Technology and University Spin-off Incubators in Slovenia. Final Report for the Phare Project SL9914-Skofic 23. July, 2002.

development policy for the entrepreneurial sector and to increase competitiveness through supplementary financial incentives (state assistance) to enterprises. A stimulative environment for innovations in enterprises is created by supporting technology development projects of enterprises, transfer of knowledge from public research institutions to the business sector, technological parks and technology centres. The latest Ministry of the Economy measures supporting the changing demands of innovative enterprises are geared towards the development of spin-off incubators at universities, clusters and technological networks. The creation of technology networks and clusters are also new measures that will further boost the added value of the Slovenian industry.

At the same time, the Ministry of the Economy has prepared proposals not only on fiscal incentives for enterprises to significantly reallocate their investment from physical capital to human capital, but also on how to restructure the financial market to become more conducive to risk investment.

Lessons to be learned from the case of Slovenia

It is obvious that Slovenia is at the beginning of building an innovation system comparable to the Finnish model. As shown in the previous sectionss, the strategies are defined, action plans accepted and the measures are already operationalised in public tenders for financing of private and public RTD organizations, networking, internationalisation, clustering, incubation activities, etc. However, some problems still remain. The strategy has not yet become an integral part of the social paradigm in Slovenia.

The data presented in the previous sections clearly show that decisive improvements were achieved in the period 2000-2002. Since similar R&D goals and targets as for the period 2001-2006 had been already set for the previous period (1995-2000)[19], it is worth considering the factors that might have contributed to the recent advancement and that can give us some optimism as far as the possible leap-frogging of Slovenia on the scale of economic competitiveness is concerned.

Possible internal factors contributing to structural changes in Slovenian R&D policy/activity:

- Changes in the R&D policy are now envisaged by the general development documents of the Republic of Slovenia, as a part of the new development paradigm, embedded in the overall strategy for the economic development.

[19] One of the three main long-term goals in the National Development Programme, adopted by the Slovenian Parliament in January 1995, was: »the increase of the use of knowledge in the economic, social, cultural and environmental development of Slovenia«. Among the measures planned to achieve this aim many were not operationalized or effective. The following were defined: establishment of agencies for the transfer of knowledge, establishment of a technology development fund, fiscal incentives to promote business R&D, support for the transfer of researchers into the business sector (with a substantial increase in the number of experts in the economy), increase in government investment in technology development, public support for spin-offs from universities and public research institutes, state support for linking research institutes in similar or connected R&D areas, etc. This implementation deficit can be considered also as a characteristic of the transition period (as proposed in the Strategy for the Economic Development of Slovenia).

- New directions in the R&D policy are now supported by thorough analytical work (empirical results) and by progress in the social sciences, recognised also by some leading social scientists in Slovenia (recent economic and sociological theories on R&D, the role of the state, co-operation between academia and industry, etc.).
- The splitting up of the previous Ministry of Science and Technology, with its emphasis on academic research, and integration of technology development measures in the programmes of the Ministry of the Economy, the latter also becoming an active partner in R&D policy.
- Active involvement of the business community (Chamber of Commerce etc.) in the definition and operationalisation of R&D policy.

External factors stimulating technology development, development of the Slovenian innovation system, transfer and use of research results, co-operation between business, university and government sectors, etc.:

- EU enlargement process (Phare programme, FP 5 and FP 6, other R&D programmes, Structural Funds, Lisbon Declaration, Barcelona Declaration, establishment of ERA, benchmarking exercises, etc.),
- Incentives from other international organisations (WB, OECD, UNDP, etc.),
- Examples of leap-frogging of small economies (Finland, Ireland, etc.).

It is possible to conclude, or at least to hope, that the synergetic functioning of the factors proposed above might, to a certain extent, account for the relatively lower effectiveness or even absence of some of the factors described as decisive in the Finnish case. Nevertheless, our modest study was only intended to stimulate more intensive and sophisticated comparative research on the Finnish and Slovenian paths to a knowledge-based society that will result in some elaborated proposals for the Slovenian, and hopefully, also other accession countries' R&D policies.

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