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THE NATIONAL INNOVATION SYSTEM AND ITS RELATION TO SMALL ENTERPRISES: THE CASE OF THE REPUBLIC OF MACEDONIA

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Abstract: Authors summarises the research conducted for the needs of a EU-funded project to assist the Ministry of Economy of the Republic of Macedonia to develop a strategy and programme to stimulate the development of SMEs during the period 2007–2010. The research reviewed the current status of the National Innovation System (NIS), its key elements and inter-relationships. It assessed the government strategies and policies that are targeting the above-mentioned NIS elements. This paper culminates in a series of recommendations for policy intervention that can be considered for the SME development programme.

Keywords: NIS; national innovation system; STI; science, technology and innovation; R&D; research and development; SMEs; small and medium-size enterprises.

INTRODUCTION

It is now widely acknowledged that Science, Technology and Innovation (STI) are key factors in building competitive, knowledge-based economies. The creation, diffusion and exploitation of scientific and technological knowledge are key means of enhancing economic growth and productivity, thereby contributing to enterprise competitiveness. Moreover, 'science' and 'technology' are different but mutually reinforcing bodies of knowledge, created by very different institutions and actors. Although they share features such as a dependence on imagination and creativity in the solution of problems and cumulative accumulation of knowledge, they are also different (Metcalf, 2000).

In reality, however, modern science and technology are becoming increasingly interdependent. New developments in science

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open-up new opportunities for technology and vice-versa, with the consequence that many firms are increasingly involved in pure scientific research. This is increasingly encouraging public-private partnerships.

Turning to the issues of 'innovation', this involves more than just knowledge of science and technology *per se* and requires us to distinguish an invention (formulation of a working idea for a product or process) from an innovation (application of that idea to the economic process). Innovation is the successful application of a new idea, often involving new technologies or applications. Among other things, it delivers better products and services, cleaner and more efficient production processes and better working models. For firms, it means higher growth and greater profitability. For society, innovation is critical to greater productivity, competitiveness and prosperity.

For innovation to take place, it is necessary to know what potential users demand in a product and how much they are willing to pay. The production process must be organised, the inputs must be acquired and the activity managed. In other words, 'entrepreneurship' is required to bring together the market opportunities with the scientific and technological opportunities. Innovations tend to be incremental improvements in current practices and products; however, a small sub-set is 'radical' in nature, opening-up new fields or opportunities. The wider application of an innovation happens through a process of 'diffusion' so it is essential for firms to sustain their innovative trajectory, rather than simply seek one-off innovations. In this context, the target of policies designed to unleash innovation is opportunities, incentives, resources and management capabilities.

Finally, the 'absorptive capacity' of SMEs is of importance, as it influences economic growth and employment. The absorptive capacity refers to the ability to create new knowledge through investment in such new knowledge and the ability to identify the most appropriate technology to be assimilated from existing ones available to firms. It is especially important to both countries and firms that may be lagging, such as small countries such as the Republic of Macedonia, that generally do not produce the technology that they exploit. For the absorptive capacity to be effective, it is necessary for firms to

- have an existing capacity for change (a stock of knowledge within the firm)
- integrated research organisations (mobilisation, coordination and integration of knowledge between firms, research institutions and universities)
- human capital (adequate quantity and quality of scientists and engineers engagedin research engaged in production of goods and services).

This paper represents a summary of the research conducted for the needs of an EU-funded project to assist the Ministry of Economy to develop a strategy and programme for SMEs for the period 2007–2010 (Polenakovik, 2006; Pinto, 2006). The main findings are presented below, leading to a series of policy recommendations.

LITERATURE REVIEW

Innovation systems theory defines 'systems' in terms of a number of 'actors' and stresses that the relationships between them and system performance is often determined by the weakest link in the chain. This means that policy interventions should focus on the weaknesses. Systems theory also suggests that individual policy instruments applied in isolation are unlikely to have a dramatic impact on overall system performance. In complex systems there are likely to be many weak links and accurate targeting of an individual weak link will only produce incremental improvements unless

other weak links are also addressed. The policy implication is that there is a need for a broad range of policy instruments, rather than a focus on any one aspect. This also suggests the need for frequent experimentation and evaluation of single instruments and combinations of instruments, with the results being continually fed into the policy formulation process. Figure 1 presents a simple innovation system comprising four interdependent sectors, taken from Guy and Nauwelaers (2003). There are interacting groups of actors defined in terms of the public and private sectors and their roles as 'knowledge creators' or 'knowledge users'. Each sector is also characterised by a dominant issue in STI, such as:

- The supply of and demand for qualified human resources (Social and Human Capital).
- The knowledge base (Research Capacity).
- The ability to innovate (Technology and Innovation Performance).
- The capacity of markets to absorb and diffuse innovations (Absorptive Capacity).

There has been a shift in our understanding of the relationships between STI and their link to economic development. There is increasing discussion about National Innovation Systems (NIS – see Figure 2), incorporating the key actors and activities in the knowledge production and absorption processes necessary for innovation to take place. It is also increasingly acknowledged that economic growth and competitiveness are founded on well-functioning NIS in which all actors, both market and non-market institutions, need to perform well. This applies to research and higher education institutions, businesses, the public sector, as well as households as consumers of sophisticated goods.

Such innovation systems exist at different levels: global, regional and local networks of firms and clusters of industries. These systems may, or may not, be confined to a

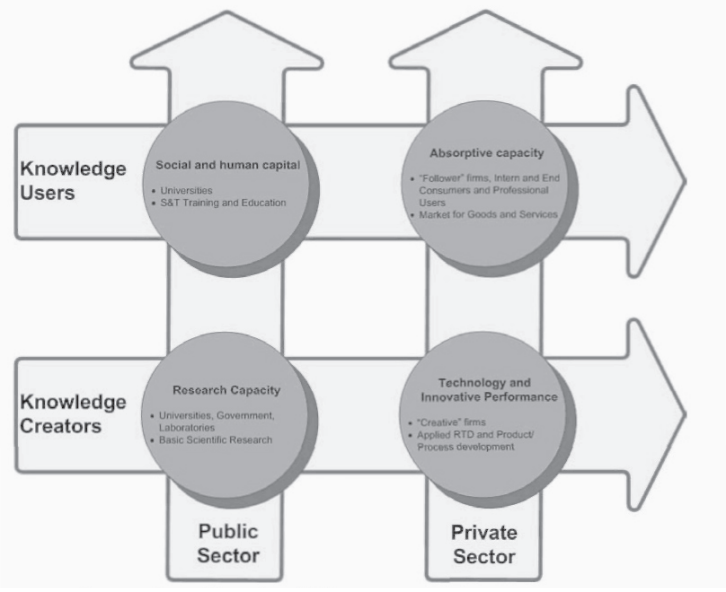

Figure 1 Issues, actors and activities in a simple STI system
Source: Guy and Nauwelaers (2003)

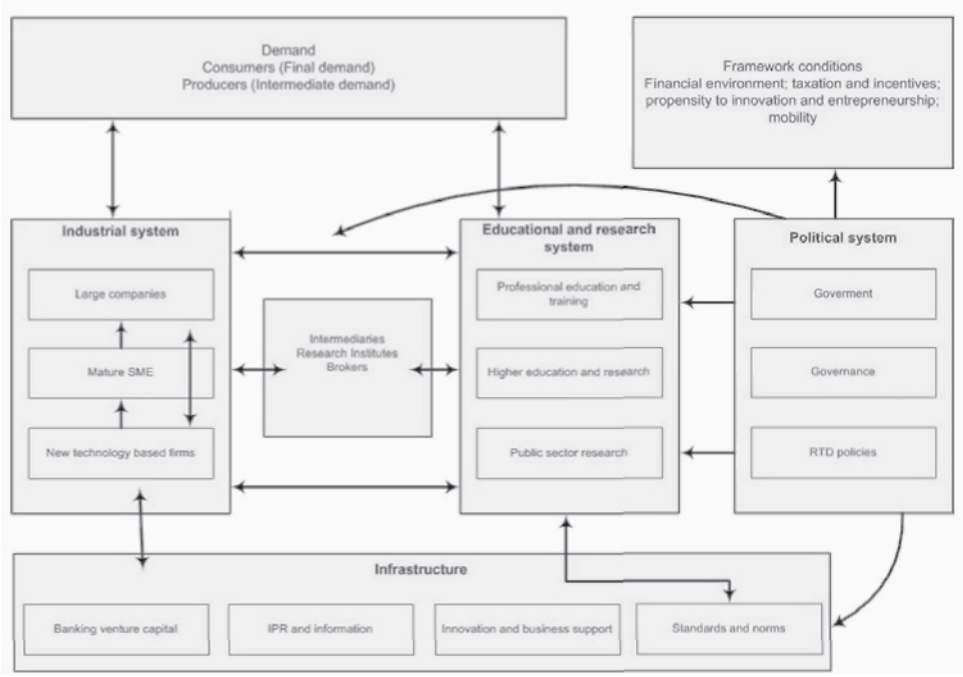

Figure 2 A National Innovation System model
Source: O' Doherty and Arnold (2003)

country's borders but national characteristics and frameworks play a key role in shaping them. The concept of NIS is, thus, a tool for analysing country specificities in the innovation process in a globalised economy, as well as a guide for policy formulation. It highlights interactions and interfaces between various actors and the workings of the system as a whole, rather than the performance of its individual components (OECD, 1999). NIS thus focuses on three complementary approaches at the micro, meso and macro levels.

There are a number of features of South East European (SEE) countries that constrain STI policies (Uvalic, 2005):

- *Budgetary constraints.* Highly restrictive fiscal and monetary policies during the process of transition to the market economy have severely limited public expenditure on STI, R&D and Communication and Information Technologies (CIT).
- *Low level of development.* Economic recovery has yet to compensate for the very substantial falls in output experience during the early years of transition. Most SEE countries had yet to reach the levels of GDP existing in 1989 and their GDP typically corresponds to no more than 30% of the EU average.
- *Industrial restructuring.* Whereas the EU is moving from a post-industrial to a knowledge-based economy, over the last 15 years SEE countries have experienced a process of de-industrialisation and a shift to subsistence agriculture.
- *Social costs.* The official unemployment rates are the highest in Europe; poverty has increased; there is greater inequality

of income distribution; and massive levels of emigration.

- *Imbalances in external accounts.* The increasing trade deficits have been partly covered by capital inflows from abroad in the form of international assistance and remittances.
- *National investment and savings.* These are so low that capital for investment purposes has come mainly from abroad; however, Foreign Direct Investment (FDI) inflows remain quite low compared to CEE countries.

A key issue in the STI debate is the necessity to monitor and evaluate the performance of specific countries in terms of their STI progress. In this context a key development has been the creation of benchmarking tools, such as the scoreboards (see OECD, 2005; EU, 2005a). The European Innovation Scoreboard (EIS) is an instrument developed by the EU to evaluate and compare the innovation performance of the member states. The latest EIS report (EU, 2005b) includes innovation indicators and trend analyses for the 25 EU member states, as well as for Bulgaria, Romania, Turkey, Iceland, Norway, Switzerland, the USA and Japan. The revised list of indicators and the methodology capture additional dimensions of a country's innovation performance. Based on their Summary Innovation Index, the EU countries can be divided in four groups (EU, 2005b):

- Switzerland, Finland, Sweden, Denmark and Germany make up the group of *'leading countries'*.
- France, Luxembourg, Ireland, UK, Netherlands, Belgium, Austria, Norway, Italyand Iceland all belong to the group of countries showing *'average performance'*.
- Countries that are *'catching up'* include Slovenia, Hungary, Portugal, Czech Republic, Lithuania, Latvia, Greece, Cyprus and Malta.
- Countries that are *'losing ground'* include Estonia, Spain, Bulgaria, Poland, Slovakia, Romania and Turkey. Had it been included, almost certainly the Republic of Macedonia would have found itself in this group.

METHODOLOGY

In order to review the current status of the NIS, its key elements (Social and Human Capital, Research Capacity, Technology and Innovation Performance, and Absorptive Capacity) and the relations between them, extensive field work was conducted during June-September 2006 with objective of assessing government strategies and policies targeting key elements of the NIS.

During the research the authors reviewed existing information related STI issues at the national level (laws, regulations, reports, etc.), as well materials produced by international organisations such as donors. Additionally, more then 25 national and international experts were interviewed in order to take into consideration the 'key' players in the Republic of Macedonia relating to STI issues. Attention was paid to both STI knowledge creators and users. During the analysis the interactions and interfaces between various actors and the workings of the system as a whole, as well as the performance of its individual components were reviewed. It should be mentioned at this stage that the same actor may represent two different aspects at the same time: for example, universities may be simultaneously both 'knowledge creators' and 'knowledge users'. All interviewed 'key players' were asked to assess their institutions' STI practices, including problems and future plans and all participants reacted positively to this type of analysis.

THE CURRENT SITUATION IN THE REPUBLIC OF MACEDONIA

Research and Development (R&D) expenditures

The overall conclusion of the current status of STI in the Republic of Macedonia is that it has been largely marginalised in the fifteen years since the country became independent. The percentage of Gross Domestic Product (GDP) devoted to the R&D in 2003 was only 0.22%, compared with neighbouring countries such as Serbia 0.32%, Bulgaria 0.5%, Croatia 1.10% and Slovenia 1.53%. Moreover, although in above-mentioned countries this percentage has been constantly increasing, the equivalent figure in the Republic of Macedonia was 0.44% of GDP in 2000, 0.32% in 2001, 0.26% in 2002 and 0.22% in 2003. Indeed, it was only in 2004 that this trend was reversed (0.25% of GDP), as illustrated in Table 1.

Of greater concern is the fact that R&D expenditures are primarily on either higher education (60.2%) or the governmental sector (34.1%), with only 5.7% coming from the business sector, compared with the EU practice where the latter participates with 65.3% (see Table 2). In all other countries mentioned, as well as neighbouring countries, the business sector invests significantly more in R&D. This low level of investment in R&D by the private sector is explained by the fact that after 1990 there were significant losses in the Yugoslav and East and Central European market, and numerous large industrial complexes disintegrated, leading to large numbers of bankruptcies and layoffs. Many of the largest companies, often with their own R&D departments, disappeared and their technical staff had to carve out new economic roles for themselves.

In order to analyse the NIS, all the 'key players' have be assessed as per Guy and

Table 1 R&D expenditure as a percentage of GDP for selected countries

	2000	2001	2002	2003	2004
Macedonia	0.44	0.32	0.26	0.22	0.25
Croatia	1.23	1.07	1.12	1.14	1.14
Bulgaria	0.52	0.47	0.49	0.50	0.51
Romania	0.37	0.39	0.38	0.40	0.40
EU-15	1.94	1.98	1.98	1.97	1.95

Source: Eurostat report (2005)

Table 2 Structure of R&D expenditure by sectors for selected countries (2000)

	Business sector	High education	Governmental sector	Non-profit organisations
Macedonia	5.7	60.2	34.1	0
Croatia	45.1	33.4	21.5	0
Bulgaria	20.5	9.0	70.5	0
Slovenia	56.3	16.6	25.9	1.2
Greece	28.5	49.5	21.7	0.2
EU-15	65.3	20.3	13.6	0.7

Source: Eurostat report (2005)

Nauwelaers (2003), but in the case of the Republic of Macedonia, it is evident that Ministry of Education and Science (MoES) is, in fact, the pre-eminent actor as far as STI issues are concerned. Before proceeding with the analysis of each sector and the relationships between the sectors, a brief assessment of the public and private sector actors is carried out.

Public sector 'actors' for STI issues

There are two types of actors in the public sector:

- Those responsible for STI policy creation such as:
  - Government
  - Ministry of Education and Science (MoES)
  - Macedonian Academy of Science and Arts (MANU)
  - Others such as professional associations, independent union for education, science and culture, etc.).
- Those responsible for implementing STI policy (e.g., MANU, public scientific institutions, higher education institutions, innovation and technology transfer centres, State Office of Industrial Property (SOIP), etc.)

Institutions responsible for STI policy

Governmental bodies currently do not take sufficient account of the importance of the scientific and R&D sector during the processes of making key decisions. With the exception of the MoES, and to some extent the Ministry of Agriculture, ministries rarely seek to use the full scientific and R&D potential available.

The MoES is responsible for policy development and monitoring of implementation of activities relating to science and R&D, however, it is evident that it has failed to assist the Government of the Republic of Macedonia to recognise that science and R&D are among the key strategy priorities essential for long term economic development of the country. The MoES's activities are currently largely restricted to co-financing activities such as:

- Developmental and innovation projects (up to 30% of total cost)
- 45 scientific journals per year
- Publication of ca. 200 scientific books per year
- Participation in ca. 50 domestic scientific conferences
- Participation in international conferences, seminars, etc. (500 people)
- International study visits for ca. 100 young scientists
- About 300 research projects in 2003 and some 186 projects in 2004.

The effects of these scientific and R&D-related activities on the national economy are not clear since there is no direct relationship between investment and economic impacts; hence the independent evaluation.

MANU is the primary national institution to promote the development of science, research, innovation and new technologies, both in the country and internationally. However, MANU is facing serious problems such as lack of funding, low level of human capital, outdated equipment, etc. with the consequence that it is not in a position to fulfil its role satisfactorily.

Other organisations, such as the Association for Popularization of Technical Culture, Independent Union for Education, Science and Culture, etc. have neither the interest nor the capacity to handle STI

issues. The Associations for Popularization of Technical Culture lack both human capital and facilities. Although they organise competitions at the primary and secondary school levels, they are unable to nurture talented young people. The core difficulties faced by the Union for Education, Science and Culture concern salaries and working conditions, with the consequence that it has failed to develop STI activities.

Institutions responsible for implementation of STI policy

MANU implements its activities through five departments (Linguistic and Literary Sciences; Social Sciences; Mathematical and Technical Sciences; Biological and Medical Sciences; and Arts) and five research centres (Research Centre for Genetic Engineering and Biotechnology, Research Centre for Energy, Informatics and Materials, Centre for Strategic Research, Centre for Linguistics and the Lexicographical Centre). The first two centres are internationally recognised for their research, but there is an overlap in the focus of the other three centres and other scientific institutions, such as the Institute of Economics, Institute for Sociological, Political and Juridical Research, Institute for Macedonian Language and Institute for Macedonian Literature. MANU's difficulties are compounded by the fact that researchers and scientists are not always allowed to apply for MoES research projects.

Thirteen public scientific institutions are active in the country: 10 within the University Ss. Cyril and Methodius and three within the University St. Kliment Ohridski. These institutes are members of the public universities but, with few exceptions, are unable to provide graduate and postgraduate education, since their main activity is research. Only the Institute of Earthquake Engineering and Seismology and, to some extent, the Hydro-biological Institute have been able to establish themselves at the international level. The institutes in the biotechnology area (Institutes for Veterinary Science, Agriculture and Tobacco) have met some success in developing new products and processes but because of the low level of support from the Ministry for Agriculture for their work, the results remain unsatisfactory.

Three public universities in Skopje, Bitola and Tetovo educate some 45,000 students. Although they combine education with science and research, the level of contact with industry is insufficient. Research and scientific papers are used by the scientific and research staff primarily for the purpose of career development. The weak link between the universities and the economy has been noted in the past and continues to be an issue.

The State Office of Industrial Property (SOIP) is responsible for the IP protection system in the country. Analysis by the SOIP shows that the industrial property rights are improving (see Table 3). The SOIP is promoting creativity and innovation through initiatives such as the International Intellectual Property (IP) day, the Patent of the Year, Makinova, *participation* in international exhibition of ideas/inventions/new products, etc.

The human capital involved in STI activities needs to be taken into consideration. A major indicator is the Full Time Equivalent (FTE) involved in STI; in other words, the ratio of the number of full-time researchers relative to the total work force in the country. Other relevant pieces of information include the distribution of researchers in the public and private sectors, their gender, maturity, and researchers' citation index. The FTE index in the Republic of Macedonia is 1.7. This is not

only significantly lower than the EU average (5.68) it is also below that of neighbouring countries such as Bulgaria (4.63), Slovenia (4.64) and Greece (3.30). Moreover, the distribution of researchers between higher education, governmental bodies and business sector is of concern. The Republic of Macedonia has a comparatively lower number of R&D staff in the business sector (5.4%) as can be seen in Table 4. The main reasons include the fact that the majority of businesses are in very bad shape and have limited financial muscle to devote to R&D investment and research staff. To this must the added the belief of the managers that they can manage without R&D staff. They fail to understand the nature of the relationship between R&D investment and company competitiveness and profitability. In the Macedonian R&D sector, 53.4% of researchers are female, a significantly higher percentage than in the EU and neighbouring countries (e.g., Portugal – 46.6%, Spain – 35.4%, Greece 40.9%, Slovenia – 35.8%, Bulgaria 45.5%, Romania – 42.8%); however, a pressing issue is the fact that this human capital rapidly ageing. Although data are scarce, the fact that those

Table 3 Intellectual Property rights (2001–2005)

	Year				
	2001	2002	2003	2004	2005
Total number of patent applications	125	241	435	452	436
National	65	44	47	44	53
Foreign	60	197	388	408	383
Total number of trademark applications	1186	1035	993	1056	1050
National	440	411	478	458	433
Foreign	746	624	515	598	617
Total number of industrial design applications	80	41	71	47	60
National	75	29	45	31	47
Foreign	5	12	26	16	13

Source: SOIP, annual report 2006

Table 4 Number of R&D staff (per 1000 working force) and their distribution

Country	FTE	Percentage of researchers in		
		Business sector	Government sector	Higher education
Macedonia	1.70	5.4	29.5	65.1
Finland	13.77	56.9	12.3	29.8
Sweden	10.10	60.6	4.9	34.5
EU-15	5.68	49.7	13.4	34.5
Greece	3.30	15.20	13.60	71.00
Slovenia	4.64	33.6	32.3	30.7
Bulgaria	4.63	6.4	40.2	53.1

Source: Eurostat report (2005)

defending their PhD Theses are typically in their 35s and 40s, combined with the very low level of young scientists entering R&D institutions because of Government budget restrictions and the process of external (leaving the country) as well as internal 'brain drain' (leaving R&D institutions because of low salaries, prospects and equipment), are some of the indicators of the maturity of scientific human resources.

Another determinant of the quality of R&D staff is the number of published papers in international journals. The situation in the Republic of Macedonia is very disappointing. The index of published papers per million inhabitants for the year 2004 is 39 compared with Switzerland (1757), Sweden (1598), Denmark (332), Finland (1309), EU-15 (673), Slovenia (726), Greece (458), Bulgaria (182) and Romania (84).

No discussion of R&D human resources would be complete without reference to the problem of the 'brain drain'. Significant numbers of the brightest and most able young researchers are leaving country in the hope of finding better work and living conditions. Young scientists should be encouraged to exchange experiences with their international colleagues, but they should also have an incentive to remain/return to their country of origin. Incentives are required to achieve this whilst, at the same time, recognising that the freedom to travel should not be restricted.

Assessment of private sector 'actors' for STI issues

The private sector is the key driver of economic development. Unfortunately, in the last 15 years, the link between R&D and the business sector has been tenuous at best. Private companies have failed to show interest in participating in the creation of STI policy, although in reality neither Government nor academia have provided a challenge to the business sector to get involved in STI policy development.

The most active business association are the Macedonian Economic Chamber of Commerce and Association of Chambers of Commerce; however, neither has yet initiated a project related to R&D and innovation. Some activities, such as standardisation, quality improvements, clustering, etc., are primarily donor-driven and designed to enhance the competitiveness of domestic firms, but these have not had a specific STI focus.

Macedonia boasts many professional associations, such as various engineering association, physicians' association, etc. These frequently deal with issues relating to science and its application in practice. The most notable body in this respect is the Association of Inventors, an organisation that is directly involved in STI issues by promoting innovations, organising manifestations and workshops on STI topics.

R&D expenditure by firms is typically considered a cost, without due consideration of the long-term effects of innovative products, processes and services resulting from R&D activities. According to data from the Central Registry only two small, 21 medium and 31 large enterprises actually invested in R&D activities. The total sum amounted to 1.7 million Euros in 2003 and even less in 2004 (1.24 million Euro). These figures illustrate low priority currently accorded to R&D by the business sector.

Private universities also form part of the private sector 'actors'. Private faculties and universities were started six years ago and are growing rapidly. Those that have been accredited include the University of South East Europe (Tetovo), the European University (Skopje), the American College University (Skopje), the New York University (Skopje), the

Faculty of Business Economics (Skopje), etc. A common characteristic is the fact that they are primarily oriented towards education rather than R&D. A notable exception is the University of South East Europe, where the Centre for Business Development (a branch of the E-Biz project sponsored by USAID) is seeking to close the gap between academia and business by transferring know-how from the university to the local economy.

Assessment of STI activities

In order to raise awareness of the importance of STI issues, it is necessary to work with various key actors, using different approaches. The dominant actors are clearly the universities but despite some notable examples of good practice, they have not performed particularly well in raising public and business awareness of STI issues.

Through the MoES, government is the major investor. In recent years the need to increase awareness of STI issues, and modernise the educational curriculum, especially in the area of entrepreneurial learning, has become obvious. Much of the effort in relation to the educational institutions has actually been driven by foreign institutions and donors. For example, the most important project relating to entrepreneurial education was initiated by the European Training Foundation (ETF) when the Republic of Macedonia was given the opportunity to become part of the regional project on entrepreneurial learning.

In the preceding 15 years, universities have been seeking to offer education programmes that are integrated with the needs of the high technology industry as well as the wider socio-economic environment. Furthermore, universities are aiming to take a lead role in relation to the economic development of the country. This is difficult to achieve. Universities continue to struggle with many basic problems, such as outdated curricula and old fashioned teaching methods that are still not in line with the requirements of the Bologna process; there is insufficient coordination between faculties; they have redundant equipment and facilities; the salaries for teaching staff remain unattractive; there are limited employment opportunities for young teaching and research staff, etc. The lack of linkage between universities and the business sector, combined with an absence of employment opportunities for qualified staff, intensify the ongoing brain-drain.

Nevertheless, in recent years universities have started to restructure their curricula according to the principles of Bologna declaration and European Credit Transfer System. Steps have also been taken to stimulate cooperation with the business sector. Although the Republic of Macedonia has 67 university level faculties and institutes, only 15 have established courses on Entrepreneurship and Small Business Management, half of which are elective.

The science-business interface is a key part of the Guy and Nauwelaers (2003) matrix. Perhaps the most heavily criticised aspect of STI in the Republic of Macedonia is the lack of know-how and technology transfer to the business community. 'Knowledge creators' should be willing to transfer their knowledge to the 'knowledge users'. As far as the knowledge users are concerned, the most important issue is the absorptive capacity of the business sector. Firms should be open to new ideas, know-how, technology and processes but this is failing to happen. Several activities are being implemented to increase the absorptive capacity of domestic companies and, again, this is mainly a donor-driven process being implemented through several projects.

The Ministry of Economy (MoE) has launched projects to help domestic businesses to adopt and implement ISO standards (e.g., 9001 and 14000) by co-financing the process of certification. This is a good example of know-how transfer to industry. The MoE co-finances up to 30% of the research projects and public scientific institutions work with the business sector on the development of new products, processes, materials, etc. A key issue is that upon completion of the projects, the grant holders have an obligation to disseminate the results of the project to the public and to business participants.

Another example is training and support in the area of ICT. MASIT, the association for information technologies, has a proactive approach to fostering ICT issues in the public and SME sectors through an aggressive awareness raising campaign on these issues.

The most recent initiative is the establishment of an Innovation Relay Center (IRC) by SINTEF, Norway in 2006. The IRC seeks to increase Macedonian business competitiveness by strengthening the technological and innovation base of SMEs. USAID and EAR have helped to establish both the National Council for Entrepreneurship and Competitiveness and the SME Forum, both examples of public-private dialogue in relation to competitiveness and small enterprise development.

With the support of the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), four Centres for Technology Transfer were established in Skopje at the Faculties of Mechanical Engineering, Electrical Engineering and Agriculture and Food and Bitola at the Technical Faculty. More than 50 companies have already benefited directly from this project which focuses on introduction of new technologies; modernisation of current technologies; new product development; and training and specialisation of human resources.

A number of examples can also be found of collaboration among researchers and SMEs, such as the CIRKO MES Centre for Excellence that is developing the Mavnet Network of Macedonian Tool Shops. Nevertheless, the current level of science-business interaction is far from satisfactory in the Republic of Macedonia.

RECOMMENDATIONS

The Republic of Macedonia is experiencing constraints in relation to STI policies, which are similar to those of other SEE countries, since gaining independence. The country has a very high rate of unemployment (36%), experiences a massive level of emigration, is undergoing a process of industry restructuring, runs major trade deficits and attracts very low level of investments, both foreign and domestic in nature. To illustrate the situation, the Republic of Macedonia has yet to attain the same level of GDP that existed prior to gaining independence. In 2003, the level of GDP was a mere 78% of 1989 level (EBRD, 2004).

Better performance in relation to science, technology and innovation would assist the process of transition and attainment of higher levels of economic growth. However, the Republic of Macedonia lacks a well defined NIS with clear and well articulated relationships between science, technology and innovation, and their link to economic development. Since economic growth and competitiveness are partly founded on a well-functioning NIS in which all actors, market-oriented and non-market institutions need to perform efficiently, an extensive evaluation of NIS is needed in order to highlight the interactions and interfaces between various actors and the workings of the system as a whole, as well as how it could be improved.

SMEs are at the core of a well articulated NIS and they should be utilising the benefits of a well-developed system. This is currently not the case in the Republic of Macedonia. The lack of clear responsibilities of NIS actors means that their relationship with SMEs is the weakest point in the system. Much more needs to be done to increase the SMEs' role in relation to the NIS. A key issue would be promotional activities designed to raise the awareness level among SMEs of STI issues, combined with the direct benefits to the company arising from R&D activities. Reinforcing SMEs capacities in relation to STI issues should translate into enhanced NIS performance. In order to strengthen the SME sector in relation to STI issues, a number of policy recommendations can be identified, as discussed below:

Increase investment in R&D

- Facilitate discussions to encourage the Government to adopt a target of 1% of GDP to be invested in R&D by 2010.
- Initiate a dialogue with SMEs on the importance of increasing investment in R&D and adopt a target of 40% participation by the private sector in R&D by 2010.
- Encourage the development of Business Angels investor networks and other private sources of capital to supplement shortfalls in funding for new technological ventures.

Introduce technological and industrial development zones

- Undertake a feasibility study to select possible Industrial and Development Zones (TIDZs).
- Prepare a programme of support for TIDZs, since as export processing zones they can be an important mechanism for acquiring technology and diffusing it throughout the local economy.
- Negotiate the incentives package with the Ministry of Finance relating to infrastructure; lease land at low or zero cost for 99 years; finance for factory space; co-financing of salaries; tax exemptions (0% CIT for ten years; 0% PIT for five years; 0% public utilities, etc.) for companies investing a minimum of Euros 2 million and employing at least 30 workers.
- Work with the Investment Promotion Agency (Invest Macedonia) to promote the investment opportunity to international companies.
- Identify opportunities to increase participation in international trade since this is an important source of impetus for rapid technological innovation.
- Strengthen already established industry clusters, or initiate new clusters relevant to SMEs.

Establish technology/science parks

- Collaborate with the MoES to streamline the relevant legislation (Law on Science and Research Activity, Law on Technological Culture and Law on Technological Development), enabling the creation of technology parks.
- Collaborate with the Ministry of Finance to secure state support (infrastructure, tax incentives, etc.) to stimulate investment in technology parks.
- Establish technology/science parks. There is potential to create at least three viable technological parks in Stip, Bitola and Skopje, however, this is constrained by a lack of funds.
- Network existing technology transfer centres.

Promote R&D benefits to SMEs

- Ensure that the Ministries of Economy and Education and Science collaborate to develop an awareness raising campaign (media campaign, best practice fairs, brochures and practical guidelines for SMEs, information on web portals, etc.) highlighting the role of investment in R&D in relation to enterprise competitiveness and profitability.
- Collaborate with Business Associations to organise roundtables by successful companies to highlight best practices in commercialisation of innovations.
- Raise awareness of the importance of R&D at regular meetings, conferences, etc. of the network of Business Associations.
- Develop award schemes which reward innovative solutions to business problems.
- Assist universities to use occasions like 'Science Day' to organise fairs and stalls promoting R&D activities with the active participation of SMEs.

Introduce a National Innovation System/STI scoreboard

- Create an independent public-private body to oversee the introduction of a system of innovation indicators and its measurement, based on the EC Innovation Scoreboard methodology.
- Adopt indicators from the new EU Charter action plan for Research and Innovation.
- Raise awareness of existence of these indicators among SMEs, as well as the relevant public institutions that will provide data for the Innovation Scoreboard.
- Prepare and publish an annual Innovation Scoreboard for the Republic of Macedonia, benchmarked against EU countries.
- Introduce an independent public-private partnership as an integral part of the newly created IRC, Start-up Centres, Technology Transfer Centres etc.

Strengthen the science-business interface

- Publicise to SMEs the services, know-how, software and equipment available via the Technology Transfer Centres and university research institutes that have the capacity to be used as R&D providers.
- Stimulate R&D faculty staff to promote their ideas and knowledge to SMEs through direct contacts, internship programmes, practical work in relation to graduate research, etc.
- Establish regular networking among the Technology Transfer Centres, CIRKO, IRC, CIPOZ, etc. in order to diffuse best practice, develop a common SME databank, organise regular events to promote new developments, etc.
- Undertake feasibility studies to establish science parks, hi-tech business incubators, spin-off firms, etc. exploiting links between universities and SMEs.
- Introduce entrepreneurial education among university students, especially science, technology and engineering students, building on the experience of the Ss. Cyril and Methodius University Business Start up Centre.
- Encourage universities to utilise their knowledge of project application and management procedures to assist SMEs to apply for international funds.
- Reform the higher education system, such as adjusting curricula to generate new links between universities, industry and government, thus strengthening the NIS.

- Upgrade the library system through the development of an e-library system open to wider public, including firms.
- Develop 'open access' to scientific information for SMEs and other interested parties.

Develop R&D human capital and reduce brain drain

- Create a network of Macedonian scientists abroad to stimulate joint projects with Macedonian universities, research institutions and SMEs.
- Increase salaries, enhance quality of R&D equipment and raise the status of R&D staff in research institutions.
- Provide financial support to scientist to participate in international conferences and events.
- Provide financial scholarships funded by government and SMEs to stimulate students to study technology and engineering subjects, especially at the Master of Science and PhD levels.
- Establish a Fund (MoES and MoE) to stimulate young scientist to commercialise their ideas, knowledge, innovations, etc.
- Provide facilities for young innovators (e.g., space, equipment, trainers, internet, etc).
- Encourage SMEs to provide practical work experience for young innovators.
- Stimulate R&D staff transfer to SMEs on R&D positions.
- Strengthen the capacities of professional associations.
- Provide free or low cost on-line access to scientific journals and data bases
- Develop a tracking system to assess careers paths of R&D staff.

Intensify international cooperation

- Increase information and awareness of the wide range of possible exchange/knowledge transfer programmes available (e.g., by MoES through regular information provision to universities and SMEs).
- Provide training on project application preparation and project cycle management to enable universities and SMEs to obtain and manage exchange programmes.
- Promote R&D through international technological alliances to take advantage of the growing globalisation of research.
- Raise awareness of the many possibilities of EU funded projects (see www.europa.eu.int), including a greater focus on Structural Funds, 7th Framework Programme (FP7), Competitiveness and Innovation Framework Programme (CIP), European Investment Bank (EIB), Risk Capital Action Plan (RCAP), EUREKA, INNOVA, etc.
- Form international linkages allowing local firms and institutions to partner and sub-contract with similar organisations in more advanced economies, such as through Diaspora channels, public-private partnerships, etc.
- Stimulate SMEs to utilise existing international networks (through MoE and business associations).

Increase technology dissemination

- Encourage knowledge creators (universities, public institutes, etc.) to organise fairs and forums to showcase new products and services to SMEs (e.g., Skopje fair exhibitions, Makinova, Entrepreneurship Fair/Europe Day, promotion of international projects at Faculty of Mechanical Engineering, etc.) and attract SMEs to

these events through closer collaboration with business associations.

- Introduce university courses on issues such as new product development, innovation management, commercialisation of innovations, etc.
- Organise courses/seminars for SMEs in the area of new product development, innovation management, etc. with the support of the MoE and MoES.
- Join global value chains such as R&D, design, logistics, marketing, etc.

Strengthen Intellectual Property (IP) rights

- Increase awareness among scientists and SMEs of IP issues, such as procedures for obtaining patents, registering trademarks, registering industrial designs, etc.
- Simplify procedures and reduce costs of the above IP procedures, in line with international best practice.
- Stimulate scientists to protect their IP by establishing an award scheme reward and recognise successfully protected innovations.
- Increase awareness of the penalties and costs associated with non-compliance with IP rules and regulations among SMEs and scientists.

Introduce R&D tax incentives

- Stimulate innovation in the SME sector by offering tax incentives, such as tax credits for R&D. Any R&D tax incentives need to aligned with EU guidelines.
- Introduce lower levels of VAT (e.g., 5%) and abolish customs duties for investment in innovation-related technology by SMEs, universities and health research institutes.
- Introduce a volume based R&D tax credit enabling all SMEs carrying out R&D exceeding a minimum threshold (e.g., Euro 5000) to claim a tax credit as a part of the company's annual tax return.
- Introduce tax exemptions for research and investment in renewable energy sources by SMEs.
- Reduce the tax liability for companies in proportion to their expenditure on R&D and innovation.
- Providing an extra tax incentives for companies exhibiting high growth rates of R&D expenditure (e.g., an average increase of+15% over three years).

CONCLUSION

The paper has analysed the current situation at STI and the NIS and their relationship to the SME sector in the Republic of Macedonia. Once the weaknesses are clear, a series of recommendations for improvement of the current status is proposed. The analysis presented in this paper is only a starting point. A more in-depth and systematic approach of the STI and NIS issues is needed to take all the issues into consideration. Nevertheless, in the absence of such an analysis, the recommendations highlighted above will enable the Government of the Republic of Macedonia to formulate more relevant policy responses and incorporate them into the SME Development Programme (2007–2010).

BIOGRAPHY

Radmil Polenakovik holds a PhD in Management from Ss. Cyril and Methodius University in Skopje, Macedonia. He is teaching Human Resource Management, Ergonomics, Entrepreneurship and Small

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Ricardo Pinto received his PhD from the London School of Economics (LSE) and also worked at the Centre for Economic Performance. He has 15 years of International Consultancy experience based on assignments in Central and South Eastern Europe, as well as Africa and Central Asia. His works with governmental institutions and business support organisations involved in private sector development (economic development, SME development, informal economy, regional development, competitiveness, innovation, etc.). He is a Certified Management Consultant and a member of OECD LEED Trento Centre "Scientific Advisory Group on Entrepreneurship"; OECD Enterprise Forum; Local Economy editorial board, etc.

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