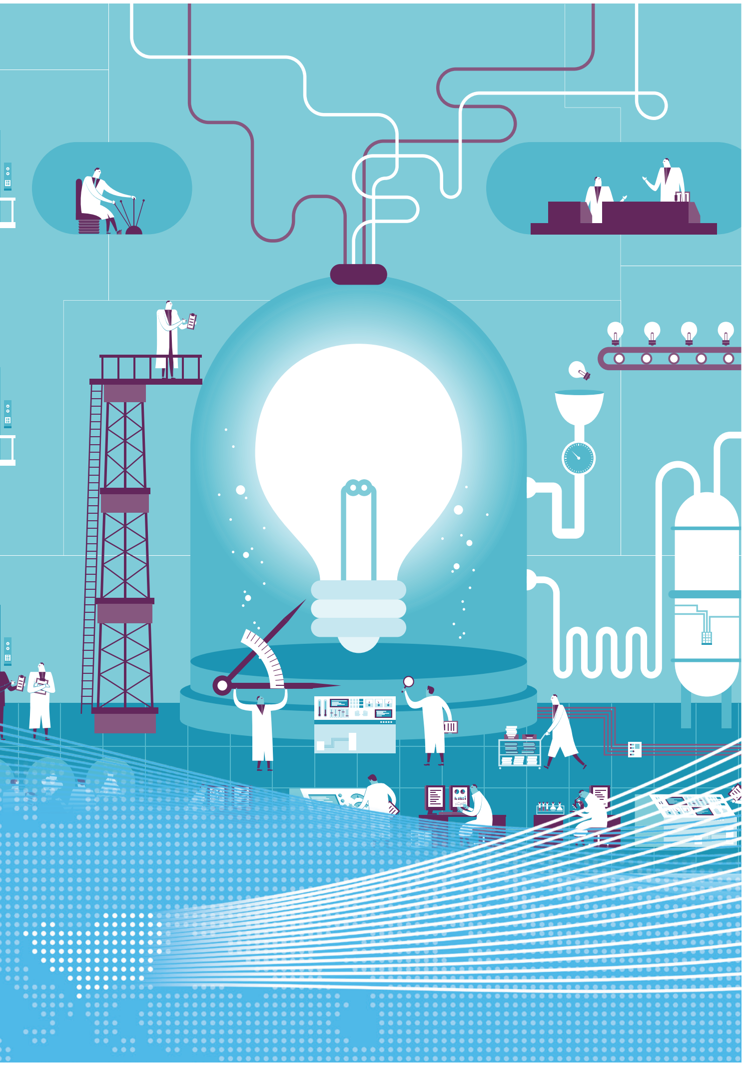
PRIVATE SECTOR DEVELOPMENT

Policy Handbook



ESTABLISHING A COMPETENCE TECHNOLOGY CENTRE IN SERBIA

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POLICY HANDBOOK

Establishing a Competence Technology Centre in Serbia

JUNE 2013

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Foreword

Between 2000 and 2008 the Western Balkan economies experienced rapid growth, modest inflation, and increased macro-economic stability. The onset of the global economic crisis, however, saw a sharp drop in external trade and industrial production across the region. The crisis underscored the fact that buoyant growth prior to 2008 relied to a large extent on external financial flows – particularly FDI flows and international capital transfers that offset large and unsustainable trade and current account deficits.

The economic crisis is forcing governments in the region to make policy choices that will have implications for their long-term competitiveness. To assist Western Balkan governments in the design and implementation of those policies, the OECD Investment Compact for South East Europe (OECD IC) implemented a three year EU-financed project called the Regional Competitiveness Initiative (RCI). The RCI's goal is to help governments in the region with the design of sustainable economic policies to support innovation and human capital development. Between 2010 and 2013, the RCI implemented pilot projects in seven Western Balkan economies: Albania, Bosnia and Herzegovina, Croatia, The Former Yugoslav Republic of Macedonia, Kosovo, Montenegro, and Serbia.*

Beginning in 2011, each Western Balkan economy had the opportunity to implement a capacity building pilot project with the OECD IC. As its RCI pilot project, Serbia requested assistance with the preparation of a feasibility study on the design of a competence/technology centre. The decision to seek OECD support on this topic came as a result of a roundtable meeting on 30 October 2010 in Belgrade between members of the Serbian business community, researchers, government officials and the OECD IC.

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* This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence.

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Abbreviations and Acronyms

CRC	Cooperative Research Centre
CTTI	Scientific-technological park “Radmilovac”
EPO	European Patent Office
ERC	Engineering Research Centre
EU	European Union
EUR	Euro
FINS	Food Institute of Novi Sad
FP	Framework Programme
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GMP	Good Management Practices
GTS	“Godkendt Teknologisk Service” (“approved technological service provider”)
HEI	Higher Education Institution
INEP	Institute for the Application of Nuclear Energy
IPA	Instrument for Pre-accession Assistance
IPR	Intellectual Property Right
KTP	Knowledge Transfer Partnership

LTI	Leading Technology Institute
MES	Ministry of Education and Science
MSTD	Ministry of Science and Technological Development
NES	National Employment Office
OECD	Organisation for Economic Co-operation and Development
OTTI	East Bavarian Institute for Technology Transfer
PIU	Project Implementation Unit
PRO	Public Research Organisation
R&D	Research and Development
RCI	Regional Competitiveness Initiative
RSD	Serbian Dinar
S&T	Science and Technology
SEE	South East Europe
SIEPA	Serbia Investment and Export Promotion Agency
SMEs	Small and Medium-Sized Enterprises

EXECUTIVE SUMMARY

Competence centres are public-private partnerships which support competitiveness and innovation by improving the interaction between industry, researchers, and the public sector in research areas with the potential to accelerate economic growth. These institutions can take very different forms, from highly R&D-intensive centres to more business-oriented institutes offering technological services. This handbook assesses whether a competence centre is viable in Serbia and in what sector it would have the greatest impact in terms of spurring innovation.

The Serbian government requested the OECD IC's assistance in preparing a feasibility study on the design and establishment of a centre in either the agro-food or biomedicine sector. The Serbian government identified these sectors as priorities in the National Strategy on Scientific and Technological Development, which plans the investment of nearly 400 million EUR in upgrading Serbia's scientific and technological infrastructure.

A centre has the potential to facilitate greater industry-science cooperation, increasing technology transfers between firms and researchers, and strengthening the technological capabilities of businesses. Given there is no standard model for a centre, it must be carefully designed to fit Serbia's particular development context. On the basis of reviews of OECD good practices, in-depth surveys and focus group meetings of Serbian businesses and researchers in the agro-food and biomedicine sectors, this handbook recommends the following:

- The centre should be oriented to firms and researchers in the biomedicine sector.
- The centre should be an autonomous, non-profit organisation linked to a university.
- It should have a board of directors comprising representatives from business, research, and government. A small management team would implement the programme of work as agreed by the board of directors;
- The first 24 months of operation should focus on encouraging knowledge transfer activities through joint seminars, workshops and conferences;
- The following 36 month period should centre on intensifying collaborative R&D through joint industry-research projects supported either by domestic mechanisms (e.g., Serbian Innovation Fund) or international sources (e.g.,

EU Framework Programme 7, Horizon 2020, or the new EU Programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME);

- The total operating budget over a five year period is estimated at EUR 725 000, with 40% of costs dedicated to staffing. Government support should cover at least 80% of the total operating budget for the first three years of operation, with the remaining costs being offset by revenues from services and in-kind contributions from business and research partners. The government should progressively reduce its contributions, to 55% of the total operating budget by year five.

The recommendation to proceed with a centre in the biomedicine sector is based on several factors. First, there are several small and medium-sized (SME) firms in pharmaceutical development, natural herbal remedy production and medical/therapeutic device development that have the capacity to innovate and perform R&D. For this study alone 66 out of 71 surveyed biomedicine firms were SMEs; and of that number over 70% indicated an ability to innovate. Second, Serbia has a solid biomedicine research base with strong public R&D institutes and university faculties but its potential is not fully exploited. For example, clinical medicine is among the top four sources of scientific publications in Serbia. However, with a few exceptions, these institutions have a poor record of translating results of basic research into commercial applications. Third, a competence centre-type of institution that supports the biomedicine sector does not exist in Serbia and, therefore, the risk of duplicating existing support services is minimal.

The agro-food sector would also benefit from a centre given the number of businesses and researchers in this domain, however, there is a risk that a new institution would duplicate some of the services currently offered by existing R&D institutes. For example, the Food Institute of Novi Sad (FINS) located in the northern province of Vojvodina purports to develop new technologies in collaboration with industry and academia, in addition to providing consulting and testing services to businesses. Instead of designing a new centre in agro-food, efforts should be made to reform the governance structures and research agendas of existing institutions to involve greater business community participation.

On the basis of reviews of competence centres and technology institutes in OECD countries, the success of a Serbian biomedicine centre will come down to four factors. First, the centre will need to address demand side considerations and ensure there is a market for its services, especially amongst SMEs. To strengthen its sustainability, it must target its services to Serbian SMEs as much as possible. Second, the centre should have a stable source of funding to cover its operating expenses. At the outset the majority of resources will need to come from public sources (i.e., government). In many OECD countries competence centres and technology centres receive significant funding from public sources, although proportions vary. Third, the location of the centre should be near a 'knowledge hub' – in other words in close proximity to the businesses and researchers who would ultimately use its services. Fourth, a qualified executive director is paramount. This individual should have industry and research experience to build confidence and broker co-operation between businesses and scientific institutions.

Introduction

Objective

The overall objective of this handbook is to assess the need for a competence centre in Serbia. This study was developed under the Western Balkans Regional Competitiveness Initiative (RCI) project. The RCI is a three-year programme, funded by the European Union and being implemented by the OECD Investment Compact for South East Europe, which aims at strengthening the economies of the Western Balkans by fostering innovation and human capital development. As part of the RCI, the government of the Republic of Serbia requested the OECD's support in assessing the feasibility of such a centre in two sectors: agro-food and biomedicine.

Competence centres and technology centres seek to increase industry-academia collaboration and encourage knowledge flows between innovation actors. Ultimately, the goal of such a centre is to enhance the level of innovation activity in a specific field or geographical region. However, a centre can take very varied forms and some models may be more adapted than others to the specific context of Serbia.

The Serbian government envisages the establishment of a centre with a view to improving collaborative relationships between R&D institutions and SMEs. The establishment of a centre would bridge the gap between science and its practical application through the diffusion of technological knowledge and scientific research to businesses. In the long-run, a centre would boost competitiveness in sectors and technologies of strategic importance to Serbia.

Both the agro-food and biomedicine sectors present interesting challenges with regard to innovation. The agro-food industry is a traditional sector in which many small businesses with limited innovative capacity operate. However, customers' increasing inclination towards quality, diversity, safety and sustainable food production calls for innovative solutions. In bio-medicine, the most significant challenge lies in the concentration of R&D capacities in universities, research institutions and the largest firms and in the insufficiently exploited connections between science and industry.

This project builds on the premise that innovation is one of the most fundamental processes underpinning competitiveness. Innovation is indeed the driver of growth in output per unit of labour and capital invested (OECD, 2010a). Innovation can also lead to increased exports by increasing productivity and allowing businesses to satisfy rapidly evolving and more sophisticated consumer demands in foreign markets. More generally, an ability to develop new products, processes, organisational arrangements and marketing strategies allows companies to raise the value added of their outputs and thereby increase their profitability.

The project also takes into account the specific characteristics of innovation today by focusing on knowledge flows. Innovation is no longer an isolated process, but is facilitated by connections with external actors (OECD, 2010a). Innovation in firms implies moving away from a 'closed innovation' model of exclusive reliance on internal ideas towards 'open innovation' which leverages both internal and external sources of knowledge and paths to market (Chesbrough, 2006). Also, the production of knowledge is shifting from individuals to groups, from single to multiple institutions, and from a national to an international level (OECD, 2011d).

This openness in innovation processes implies that the effectiveness of an innovation system is not only measured by the strengths of its separate elements but also by the quality of the linkages connecting them. Collaboration between the different components of an innovation system is essential to reap the full benefits of innovation processes. Thus, in order to move towards innovation-driven competitiveness and higher-value added production, partnerships between enterprises and the scientific community need to be reinforced.

To evaluate the need for a centre and determine whether the Serbian government should proceed with its establishment, this study answers the following questions:

Box 7. **Needs assessment and feasibility study guiding questions**

Question 1: Would a centre respond to businesses and academic institutions' needs?

Question 2: Would a centre bridge a policy gap in Serbia's innovation support system?

Question 3: Are the pre-conditions needed for the implementation of a centre already in place?

Question 4: What are the risks that should be considered when establishing a centre?

Question 5: What should be the main features of a centre?

Question 6: Which process should be followed to establish a centre?

Question 7: What resources (financial and human) are required by the centre?

Structure

This handbook is divided in five sections. Section one provides an overview of existing competence centre and technology centre models in OECD countries. These types of centres have been developed under varied forms, from university-driven and project-based competence centres to more business-oriented technology institutes. While these instruments share similar characteristics, they differ in many respects. The appropriate centre for Serbia depends upon understanding Serbia's particular context.

Section two reviews Serbia's efforts to support innovation. It first analyses broad innovation performance indicators to measure the level of innovation in the country and identify the main actors in innovation processes. Then, the section examines the innovation support system that the government has put in place. The objective of this section is to understand where policy gaps exist and determine whether a centre could meaningfully contribute to bridging these gaps.

Section three assesses businesses and research institutions' need for a centre. This section focuses specifically on the agro-food and the biomedicine sectors and aims at evaluating firms and researchers' innovation behaviour, capabilities and needs as well as their potential interest in a centre.

Section four seeks to determine whether a competence centre is indeed feasible in the Serbian context. It looks at whether the key pre-requisites for the successful establishment of a centre are in place. This section also identifies potential risks in the establishment of a centre and provides specific recommendations which should be taken into account in the design and implementation of a centre.

Section five proposes a framework for the design of a centre and outlines an Action Plan for its implementation.

Methodology

This handbook is based on both qualitative and quantitative assessments. It also results from active consultations with potential project stakeholders and beneficiaries through surveys and focus groups. The involvement of stakeholders and beneficiaries is essential to ensure that the centre will ultimately be designed in a way which meets demand. More specifically, the handbook builds on the following:

1. *A review of international best practices in establishing competence centres.* An initial scoping paper was prepared on the basis of desk research and interviews with selected experts from the OECD area. The paper described the general policy objectives and characteristics of competence centres. It identified their basic operating features such as the eligibility criteria for participants, activities, organisational and governance structures, legal status, financing and evaluation. It also reviewed potential risks associated with the establishment of these centres. Finally, the paper outlined factors which generally contribute to the success of competence centres.

2. *Surveys specifically designed and conducted for the purpose of the project.* The first objective of the surveys was to assess the innovation behaviour, needs and capabilities of businesses and research institutions in the Serbian agro-food and biomedicine sectors. The business surveys identified areas in which agro-food and biomedicine firms currently innovate, the areas in which they plan to innovate in the future, as well as the constraints they face when they engage in innovation activities. The research surveys focused on research institutions' innovation behaviours, their collaboration with the private sector as well as their commercialisation efforts. The surveys also evaluated businesses and research institutions' potential interest in a centre and whether such an instrument could respond to their main innovation needs. The surveys were designed and conducted following a similar methodology (see Box 4, Section 4).

3. *Focus groups in the agro-food and biomedicine sectors*. Focus groups were held with a view to complementing the quantitative survey results with qualitative information. To ensure a well-balanced representation of all potential stakeholders in a centre, the focus groups in both sectors included key representatives from businesses and academia as well as government officials from the Ministry of Education and Science and the Ministry of Economy and Regional Development.

4. *Interviews with experts*. The OECD team, in collaboration with project counterparts in Serbia, interviewed a number of local and international innovation policy experts as well as industry and research specialists in agro-food and biomedicine (see list of experts interviewed in Annex A).

5. *A study visit to Slovenia*. A study visit to Slovenia was organised with project counterparts from Serbia to learn from good practices in an OECD and EU member country. Slovenia is an interesting case study for Serbia as it has made significant progress in narrowing the gap with the EU both in terms of Gross Domestic Product (GDP) per capita and labour productivity. Innovation and R&D have been important to the improvement of Slovenia's economic competitiveness. From a policy perspective, Slovenia has developed a wide range of innovation support instruments encouraging co-operation between public R&D institutions and businesses. In addition to visiting a centre of excellence, a competence centre and a technological park, the OECD arranged meetings with business and academic partners in each of these centres as well as government officials responsible for their implementation.

Chapter 1

Competence centres and technology institutes

This chapter examines different centre models which have been put in place in OECD countries. More specifically, it compares two categories of centres: competence centres and technology institutes. As detailed below, competence centres tend to be research-oriented and articulated around collaborative R&D projects while technology institutes are more business-oriented and focus on providing companies with R&D and technological services. The objective of this section is to understand their economic rationale, their similarities, their distinct characteristics as well as the circumstances in which one model may be more effective than the other to stimulate business-academia linkages and innovation.

Economic rationale for competence centres and technology institutes

OECD countries have established a number of centre programmes linking businesses with academic and research institutions. While models differ, competence centres and technology institutes aim to:

- Raise competitiveness
- Improve collaboration between academia and industry to support innovation;
- Transfer know-how and technology;
- Increase the innovation capabilities of locally-established firms;
- Develop human capital and research skills

More generally, competence centres and technology institutes encourage collaboration between enterprises and research institutions in areas with commercial potential. They address the fundamental issue of translating research performance into economic benefit. From an innovation system's perspective, competence centres and technology institutes position themselves in-between universities and businesses, acting as intermediaries or 'bridge builders' (Åström et al., 2009).

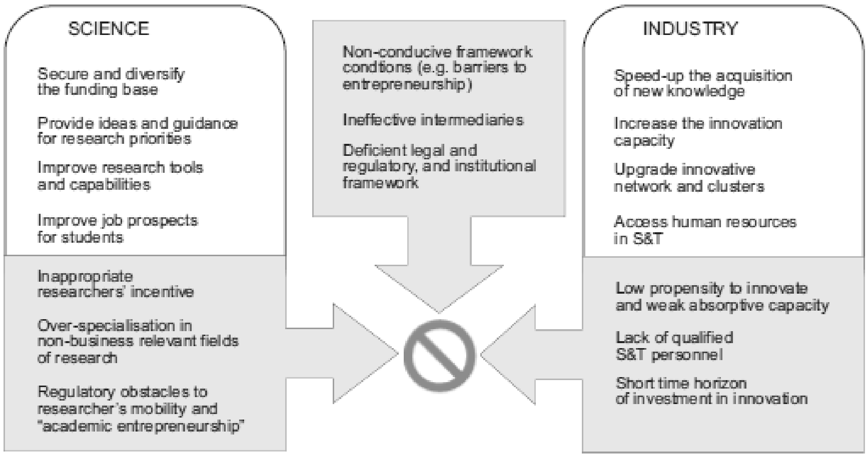
Interactions between public research and industry are crucial to reap the benefits of innovation. Public research is particularly valuable when it spills over to a large number of firms and sectors. In fact, firms tend to develop technologies that have first been explored by the public research sector (Le Guellec and van Pottelsberghe, 2001).

The rationale for establishing competence centres or technology institutes stems from the barriers to industry-science collaboration (see Figure 1). Public researchers in universities or research organisations may have little incentive to interact with the private sector. For instance, the evaluation of research results is often based on publications and citations, rather than granted patents, licences sold, commercially exploited patents, R&D contracts with the private sector and other indicators which reveal cooperation with firms (Goglio, 2006). In addition, research institutions are frequently specialised in non commercially-relevant fields, limiting the potential for collaboration. Strict regulations on public research institutions may also be an obstacle to collaboration with the private sector. Finally, even when research institutions perceive the benefits of collaborating with businesses, they tend to collaborate with large firms rather than SMEs. The latter will often have the absorptive capacity to engage in R&D and also a longer time horizon.

On the industry side, obstacles and limited incentives to cooperate with academic and research institutions are also frequent. Obstacles to cooperation are particularly high for SMEs and, in most OECD countries SMEs are two to three times less likely to engage in such collaboration than large firms (OECD, 2011c). Firms, particularly SMEs, may be unclear as to the immediate added-value or benefits of collaboration. Companies, especially smaller ones, may also suffer from weak absorptive capacities, limiting their interest in collaboration with researchers. Finally, smaller companies often refrain from engaging in collaboration with research institutions because their time horizon is shorter and the results of research collaboration are both long-term and uncertain. Indeed, collaborative R&D projects may not end up as marketable new products or processes and – even when they do – the pay-off period tends to be long.

At a more basic level, interactions between businesses and research institutions are hindered by a lack of information on each other's activities and projects. The academic and the business spheres have widely differing operating modes, needs and professional cultures. For academia the quest for knowledge may be considered a higher value than the potential commercial benefit of research. In the business community, value creation is crucial and knowledge could be perceived as having value only if it can be successfully commercialised. In many cases it is possible to reconcile the two, if this is set as an objective for co-operation, since knowledge which has high impact on society can often also be commercialised. What is important is to find settings for businesses and academia to come together and explore such opportunities.

Figure 1. **Industry-science relationships: benefits and obstacles**



Source: OECD, 2000

Public policy tools are therefore very useful to bridge the gaps and stimulate science-industry collaboration. Competence centres and technology institutes play a crucial role in supporting competitiveness and strengthening national innovation systems by bringing together businesses and research institutions which would otherwise have limited interactions with each other. They provide businesses with an opportunity to go beyond their internal innovation capabilities and researchers with possibilities to apply their work in industry-relevant fields. Finally, competence centres and technology institutes increase the mobility of people between academia and industry – which is one of the most important mechanisms of enhancing technology transfer and capturing knowledge spillovers (OECD, 2011a) – and contribute to narrowing the cultural gap between firms and research institutions.

Existing competence centre and technology institute models

As mentioned above, OECD countries have set up different types of centres to stimulate academia-industry interactions, including competence centres (Table 1) and technology institutes (Table 2).

Competence centres have been modelled after the American Engineering Research Centres (ERCs). They bring together academic and business partners to jointly work on research projects. Competence centres generally run a multi-annual research programme in a specific field for which they receive a mix of public and private funding. Most competence centres also offer PhD education and organise seminars and workshops for broader business and academic audiences.

Table 1. **Examples of Competence Centre Programmes in OECD countries**

Countries	**Programmes**
United States	Engineering Research Centres
Australia	Cooperative Research Centres
Canada	Networks of Centres of Excellence
Austria	K1 and K2 Centres (formerly Kplus Centres)
Sweden	VINN Excellence Centres (formerly Swedish Competence Centres)
Norway	Centres for Research-Based Innovation
Hungary	Co-operative Research Centres
Ireland	Competence Centres
Netherlands	Leading Technology Institutes (LTIs)
Estonia	Competence Centres
Slovenia	Centres of Excellence

In contrast with these research-oriented centres, more business-oriented technology institutes have been established. Technology institutes perform different roles. First, they act as conduits or facilitators of knowledge transfer between universities and industry. Second, they constitute suppliers of knowledge by providing research services in a consultancy-like approach (Åström et al., 2009). The provision of such services is based on the idea that for some businesses, “a product test; advice on what material to use; applying a piece of software or providing a quality certificate is enough to enable them to innovate more and faster” (Andersen et al., 2009). Finally, these institutes or centres usually play a crucial role in providing equipment, which their customers may access indirectly by paying for services or directly by renting it (Åström et al., 2009).

Table 2. **Examples of technology centres/institutes in OECD countries**

Countries	**Institutes**
Denmark	GTS Institutes
Germany	Fraunhofer institutes
Spain	Technology centres
UK	Technology and Innovation Centres

How do competence centres and technology institutes operate?

Application procedures – Selection process

In competence centre programmes, participating businesses and research institutions form a centre as partners. The selection of competence centres usually occurs through a call for project proposals. Applications always require the collaboration between at least one R&D/higher education institution and private sector partners. Applications are often jointly submitted by all potential centre partners. Even when the host institution is the only actor to formally apply (e.g. Sweden, Norway), it does so in consultation with all user and research partners that wish to participate in the centre's activities and financing.

The selection of competence centres is typically based on several criteria:

- the scientific quality and industrial relevance of the research programme
- the track record of the researchers and industry members
- the quality of graduate education
- linkages to the business sector
- the attractiveness of partners for international collaboration
- the likely effects on postgraduate training and PhD production
- the availability of university equipment and resources
- the viability of the partnership
- cost and financing planning

The scientific and technological quality of applicants is generally assessed by an appointed national or regional group of experts from industry and research institutions. In some cases, applications are reviewed by international specialists. Expert opinions eventually inform the overseeing agency's decisions regarding the delivery of centre status and the allocation of funds.

Unlike competence centres, technology institutes act as service providers and do not impose any selection criteria on companies that wish to access services. Businesses are not considered as partners but as simple customers. The only obligation that some of these institutes face regarding their customer base is to target SMEs.

Activities and services

The activities undertaken in competence centres vary but usually encompass collaborative research and technology transfer programmes. In some centres, the general collaborative research programme, in which all centre partners are engaged, is divided into smaller applied research projects involving only a few firms and research partners (e.g., Sweden, Austria). In Sweden, each competence centre runs a research programme containing five to fifteen smaller projects.

Moreover, competence centres normally offer PhD education to students who are interested in working on industrial issues or wish to pursue a career in industry (Arnold et al., 2004b). In Australia, Cooperative Research Centres (CRCs) must undertake an education and training programme including at least one industry-focused PhD programme. Austrian and Swedish competence centres also provide industrial PhD training. Finally, most centres offer seminars and workshops directed at broader business and academic audiences.

By contrast, technology institutes are more focused on short-term services. The range of activities they provide is wide, but primarily includes applied R&D and testing-related services. In comparison with competence centres, technology institutes are characterised by a lower R&D intensity and a strong focus on services. The Danish GTS (Godkendt Teknologisk Service) Institutes are a good example of such institutes (see Box 2). In addition to services, technology institutes and centres organise seminars and conferences and host joint research projects co-funded by the government.

Box 8. **Danish GTS Institutes**

The GTS – Advanced Technology Group is a network of independent, non-profit research and technological organisations (RTOs) providing knowledge and competencies to Danish businesses, as well as to public authorities.

The services offered by GTS institutes range from knowledge, technology and consultancy, co-operation on technological and market-related innovation, testing, optimisation, quality assurance, certification and benchmarking. Services are offered on a commercial basis.

Apart from these services, GTS institutes are engaged in several other types of knowledge dissemination activities, including so-called “non-commercial” interaction with its customers. By paying a nominal membership fee, customers may participate in a range of activities, such as branch-specific networks, branch-specific and/or target-oriented newsletters, establishment of branch- and product-specific homepages, non-scientific publications, meetings and “open-house” events, as well as professional and technical committees attached to the institutes.

GTS institutes also have non-profit objectives and the government co-funds some of their activities and closely collaborates with the Danish Ministry of Science, Technology and Innovation.

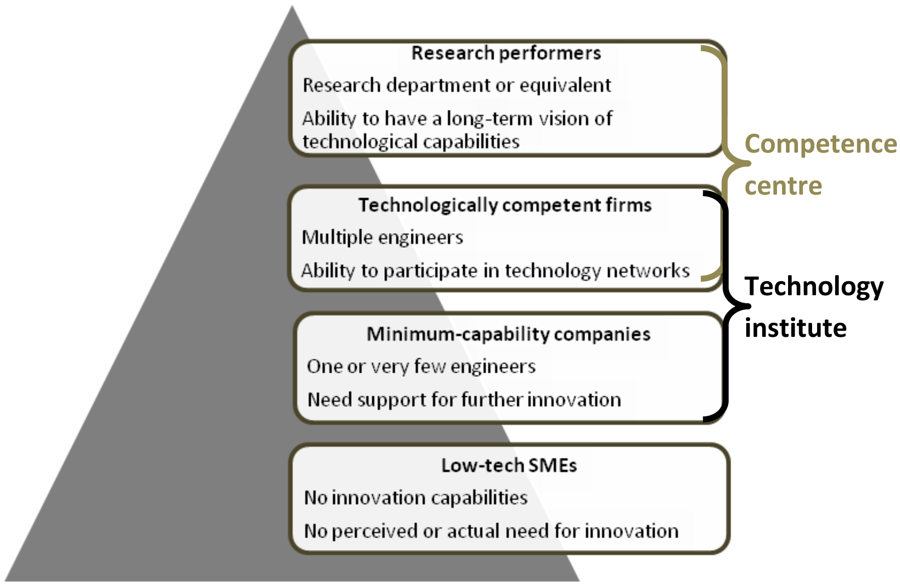
GTS institutes are encouraged to pay special attention to SMEs which receive a financial subsidy for their first-time use of one of the GTS institutes.

Box 2. **Danish GTS Institutes** *(cont.)*

An international evaluation of the GTS institutes in March 2009 found that the GTS system has done well in meetings its small and large customers' national and international needs for technological needs. The evaluation confirmed that the services provided by the GTS institutes allow its customers to go beyond what their internal technological capabilities allow (see A Step Beyond: International Evaluation of the GTS Institute System in Denmark).

Importantly, the activities of competence centres and technology institutes vary with the level of R&D sophistication of the companies they target. While competence centres play a role in strengthening the capabilities of companies in the upper levels of the competence pyramid (see Figure 2), technology institutes aim at taking 'technologically competent' and 'minimum-capability' companies 'one step beyond' their current innovation capability stage (Andersen et al., 2009).

Figure 2. **Company innovation capability pyramid**



Source: adapted from De Jager D. et al. (2002)

Organisational structure

Competence centres and technology institutes' organisational structures differ. Competence centres may be physical or virtual. Physical competence centres are in turn divided into centralised and decentralised centres. Centralised centres are characterised by the fact that all (or most of) their research resources and equipment are located in one core site (Sweden, Austria). Decentralised competence centres, on the other hand, use dispersed research infrastructure to perform collaborative research. For instance, the Estonian programme relies on infrastructure-sharing arrangements, and both university and company partners are invited to lend research equipment to their centres. Virtual centres are a sub-set of the decentralised model; they typically involve dispersed partners from industry and researcher working together on specific projects. The Dutch Leading Technological Institutes (LTIs) are an example of this kind of centre. The researchers in an LTI come from businesses and knowledge institutions. They work closely together for various lengths of time on programmes and projects. Once their work is complete, the external researchers return to the company or institution from which they came or they may be hired by an LTI.

Technology institutes are physical centres. While laboratories and research equipment are often centralised in one location, some institutes have different branches in different cities (e.g. Fraunhofer institutes).

Governance

At the national or sub-national level, competence centre programmes are overseen by ministries, innovation agencies, research councils or specifically dedicated institutions (Arnold et al., 2004b). Each centre is staffed at a minimum by a director. In Austria, most centre directors are PhD graduates or senior lecturers who have obtained some form of leave-of-absence allowing them to be devoted full-time to directing their centres. In Estonia, on the other hand, the majority of centre directors come from an industry background. In addition, each centre generally comprises a Supervisory Board representing both industrial and academic partners. The Supervisory Board usually acts as the legal and financial supervisor, appoints the director, and makes budget decisions. The Board is sometimes assisted by a separate scientific advisory group. In many cases, centres enjoy a relatively high degree of independence to set their research agenda and hire additional partners (Arnold et al., 2004b).

Technology institutes have very different governance and management models themselves, from coordinated groups to ad hoc institutes with limited networking between them (Åström et al., 2008). The Fraunhofer institutes are all part of and coordinated under the Fraunhofer Society. An Executive Board oversees the business activities of all the institutes under the Fraunhofer Society. The Executive Board also decides how funding should be distributed among the institutes. At the level of each institute, the budget and day-to-day operations are managed by a director appointed by the Executive Board. By contrast, the GTS institutes constitute a much looser network (Hauser, 2010), which is overseen by a Board of Directors consisting of the directors of all the individual GTS institutes.

While the governance modes for competence centres and technology institutes vary, a commonality between them is that the oversight bodies, or boards of directors, are typically a mix of representatives from the business community, research community and public officials. This mixed membership structure allows the agenda to be developed in a way that benefits both industrial and research partners.

Financing

For competence centres, the annual budget usually ranges from EUR 2 to 6 million in Europe (Table 3). While financing models differ across countries, all centres are funded through co-financing arrangements. In addition to public grants and subsidies, centres benefit from the contributions of participating industries and universities. Science and industry partners may provide part of their contributions in-kind, which typically include researchers' working hours, but may also encompass rooms, machinery hours, and material.

In Sweden, an individual competence centre typically receives annual contributions amounting to EUR 2.2 million, equally split between VINNOVA, industrial partners and the host university (Arnold et al., 2004a). In Austria, the Kplus programme contributed 35 per cent of eligible costs, local government 20 per cent, other public sources (universities, research institutes, etc) 5 per cent, and business participants 40 per cent. Eligible costs include personnel costs ; costs for instruments and equipment as long as they are used in the centre ; costs for contract research, technical expertise and patents purchased at market price from third parties as well as the costs of counselling services used for research activities ; other costs of operation incurred directly in the context of the research activity. In Norway, the business partners and the host institution must together contribute at least 50 per cent of the centre's annual budget. In Estonia, the share of public funding is larger – reaching about 70 per cent – while university and company partners are required to contribute 30 per cent of project costs.

Table 3. **Annual budgets of competence centres and co-funding arrangements**

Country	**Average annual budget (EUR million)**	**Govt share**	**Industry share**	**University share**
Sweden	2.2	33%	33%	33%
Austria[1]	2 to 4.5	55%	40%	5%
Norway	Approx. 2.5 to 4	50%	Combined: 50%	
Estonia	Approx. 2	70%	Combined: 30%	

Source: OECD based on Arnold et al. (2008), Arnold et al. (2004a), Arnold et al. (2004b) and OECD (2003).

[1] These figures are based on former Kplus centres and new K1 centres in Austria. K2 centres involve larger budgets.

The Swedish competence centre programme adopted a stepwise financing and follow-up approach: during the first two years of the competence centres, public money entirely covered centre funding; after two years, company partners were required to contribute at least 33% of total centre expenses (Rivera Leon and Reid, 2010).

For technology institutes, the level and type of funding vary widely (see Table 4). Nevertheless, funding generally comes from the three following sources (Hauser, 2010):

- Core funding from the government
- Research grants and contracts from public bodies, usually obtained on a competitive basis
- Research contracts from the private sector

Table 4. **GTS Institutes vs. UK Innovation and Technology Centres**

Technology Institute	**Institute turnover (EUR)**	**Core public funding**	**Public research contracts**	**Private research contracts**
GTS Institutes	2.5M – 135M	10%	10%	78%
UK Innovation and Technology Centres	24 – 36 M	33%	33%	33%

Source: OECD based on Andersen et al. (2009 and Hauser (2010)

Technology institutes may obtain additional income through licensing or the commercialisation of intellectual property, membership subscriptions, or subsidised access to facilities (Hauser, 2010).

To conclude, the support for greater linkages between academia and industry has become a priority in OECD countries. Different forms of support structures have been put in place to act as bridges between the two spheres. In addition to transferring knowledge, some structures have focused on generating new knowledge whereas others have aimed at strengthening knowledge diffusion and exploitation through the provision of research and technological services and infrastructure.

The table below summarises the key differences between competence centres and technology institutes. Interestingly, however, in some countries the differences between the two instruments have become more blurry. A number of competence centre programmes have evolved towards being more business-oriented (e.g.

Slovenia) while a number of technology institutes have adopted a more medium to long-term approach (e.g. Denmark, Spain).

Table 5. **Summary table: Competence centres vs. Technology institutes**

	Competence centres	Technology institutes
Role	Knowledge mediators Knowledge producers	Knowledge mediators Knowledge suppliers Infrastructure providers
Orientation	Science-oriented High R&D intensity	More business-oriented Low or medium R&D intensity
Work structure	Project-based work	On-demand service provision Contract research
Beneficiaries	Partners	Customers
Company participants	Large industrial firms with strong R&D capacities Small innovative firms in high-tech industry	SME focus

Chapter 2

Overview of Serbia's National Innovation System

The national innovation system has been defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies" (Freeman, 1987). The national innovation system approach stresses the role of a wide range of actors in innovation processes – including enterprises, universities and research institutes – and the flows of information and technology between them.

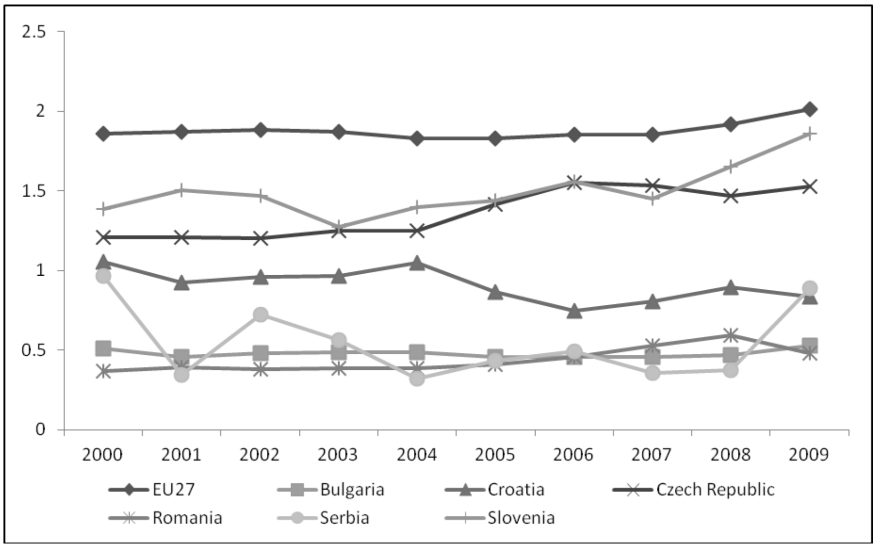
Based on this definition, the following chapter aims at providing an overview of the strengths and weaknesses of Serbia's approach to innovation. This section will help determine whether a centre could build upon existing strengths and bridge gaps in the national innovation system.

First, this section examines general innovation patterns in Serbian science and industry – based on R&D input and output indicators – and analyses the role performed by the different actors in the innovation system. The section then reviews the main innovation support instruments which are currently available in Serbia. It underlines the increasing focus of the government on innovation but also points to a number of policies which should be prioritised in order to enhance innovation.

Overview of Serbia's innovation performance

Serbia's total R&D intensity – the ratio of gross expenditure on research and development (GERD) to GDP – amounted to 0.89% in 2009, which was significantly lower than the EU-27 average of 2.01% for that year. The GERD figure for Serbia may be underestimated as there is no systematic measurement of R&D spending by businesses. According to UNESCO statistics, Serbia also significantly lagged behind other Eastern European economies including Slovenia (1.86%) and Czech Republic (1.53%) (see Figure 3). The main source of investments in R&D is the government budget. Indeed, about 84% of total R&D is funded by the government and higher education institutions (UNESCO, 2009). As part, of the Strategy for Science and Technological Development for 2010-2015, the government is planning to increase budget allocations to R&D to 1.05% of GDP by 2015.

Figure 3. **GERD as a percentage of GDP in selected countries**



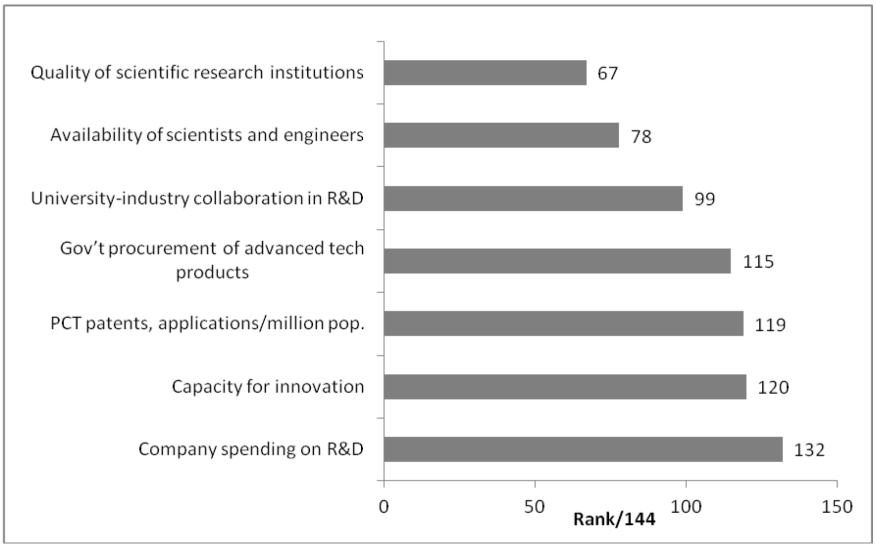
Source: UNESCO, 2010

Notable progress was achieved in the research sector but challenges remain

The Serbian research system is strongly oriented towards the public sector. The public sector accounts for the largest shares of both researchers and research activities: higher education institutions and public research institutes together employ 94% of Serbian researchers and perform 86% of total R&D (UNESCO, 2010).

The quality of Serbian public research is relatively high. According to the Innovation Union Scoreboard (IUS), while Serbia is a modest innovator with below-average performance, it has relative strengths in 'human resources' and 'research systems'. The quality of Serbian research institutions is also highlighted in the Global Competitiveness Index (World Economic Forum, 2012). Indeed, the 'quality of scientific research institutions' is the dimension in which Serbia performs best under the Innovation Pillar, ranking 67th out of 144 countries (see Figure 4).

Figure 4. **Serbia's performance on the Innovation Pillar of the Global Competitiveness Index 2012-2013**

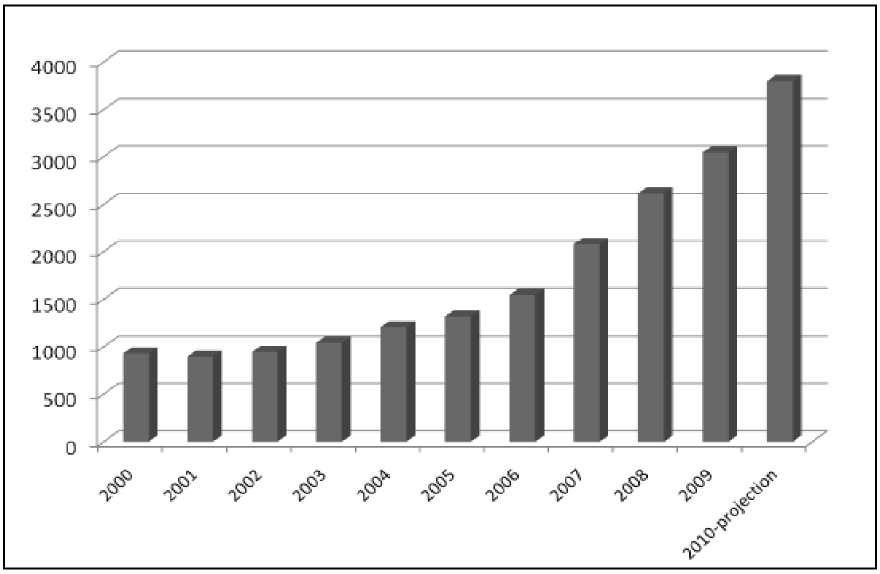


Source: World Economic Forum, 2012

The number of international publications by Serbian researchers is high for the region and reflects the high productivity and quality of research institutions in the country. Indeed, in 2010 Serbian researchers published over 3,500 scientific papers in international journals. Serbia was declared the global "rising science star" by Thomson Reuters in 2010 as the country experienced the highest growth in citations in 11 out of 22 scientific disciplines. Scientific publications in Serbia are dominated by four broad disciplines: clinical medicine, engineering and technology, physics and chemistry (Radosevic, 2010).

The high number of publications is also the result of changes in Serbia's science policy. In the early 2000s, the number of publications was still low (see Figure 5). In 2005, however, the Serbian Parliament adopted a Science Law which sought to promote excellence in R&D by imposing the publication of articles in ISI-referred scientific journals as a condition for career advancement in research. As a result, the number of publications considerably increased and is now higher than in Croatia and Bulgaria.

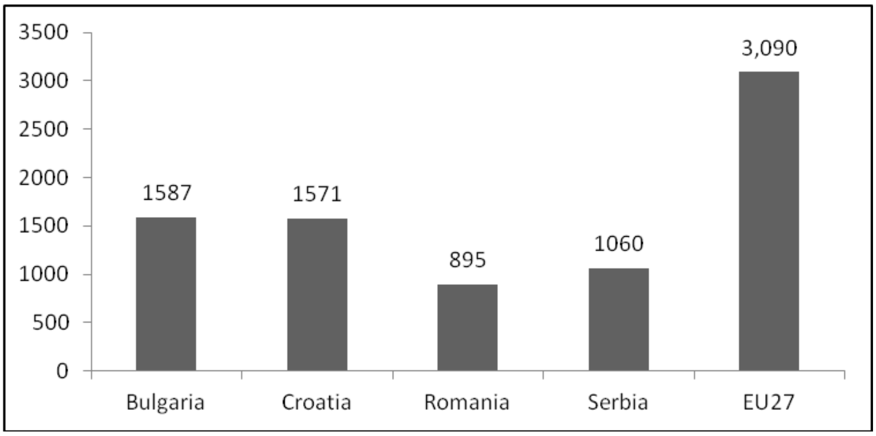
Figure 5. **Number of internationally recognised scientific publications in Serbia**



Source: Serbian Ministry of Education and Science

Despite its performance in the area of publications, the Serbian academic and research system is still suffering from a number of constraints. First, the number of researchers per million inhabitants in Serbia is low compared with other economies in the region (see Figure 6) and very low compared with the EU27 average. The situation is not likely to improve as the science workforce is ageing (EC, 2011) and affected by brain drain (Kutlaca, 2010). The fragmentation of the research community – partly resulting from the university governance system under which faculties maintain a high degree of autonomy vis-a-vis universities – is an additional weakness as it limits opportunities to pool resources for research, especially into new multidisciplinary areas. Finally, the quality of research institutions – although good relative to the region – could be further enhanced: Serbia does not have a single scientist listed among the 5,000 most quoted scientists in the world, and neither does it have a university among the top 500 in the world according the Shanghai ranking, in contrast with Slovenia and Croatia which both have their leading university on the list.

Figure 6. **Researchers per million inhabitants (FTE, 2009)**



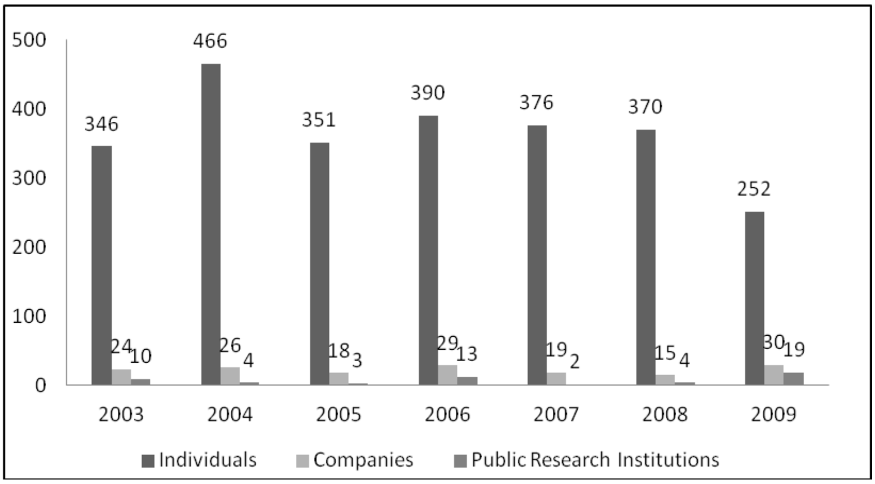
Source: UNESCO, 2011

The commercialisation of scientific and academic research remains limited

The good results achieved by academic and scientific research institutions in terms of publications have not translated into commercial applications. The majority of patent applications in Serbia over the past seven years were filed by individual applicants. Their share accounted for 95% of total resident filings in 2008 and 84% in 2009 (see Figure 7). By contrast, the national Intellectual Property Office received very few filings from public research institutions. In 2008, for example, applications filed by public research institutions accounted for only 1% of total resident filings. In 2009, however, that figure increased to about 6%[2].

[2] EIC Newsletter, No. 2, May 2010 available at: http://www.zis.gov.rs/upload/documents/newsletter/Newsletter-br.2-en.pdf

Figure 7. **Resident patent filings by applicant, 2003-2009**

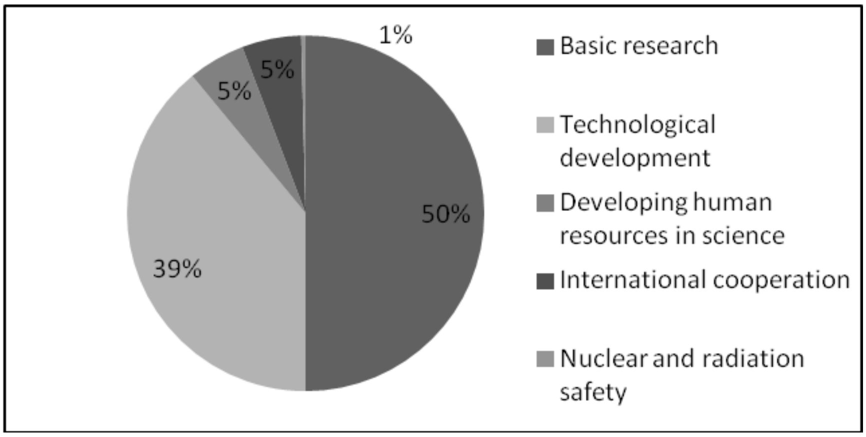


Source: Serbian Intellectual Property Office

Spin-off companies from universities are another indicator of research commercialisation. Although there are no official statistics, it is estimated that in the past five years about 100 spin-off companies have been set up in Serbia. The Universities of Novi Sad and Belgrade are the only two universities which have established support programmes for spin-offs.

As mentioned above, the limited commercialisation of academic and scientific research largely results from the reward system in public research. Scientific performance remains evaluated on publications to the detriment of patents and applied research. Half of the government's support to research is channelled to basic research, while technological development receives a share of 39% (see Figure 8).

Figure 8. **Distribution of budget funds for R&D**

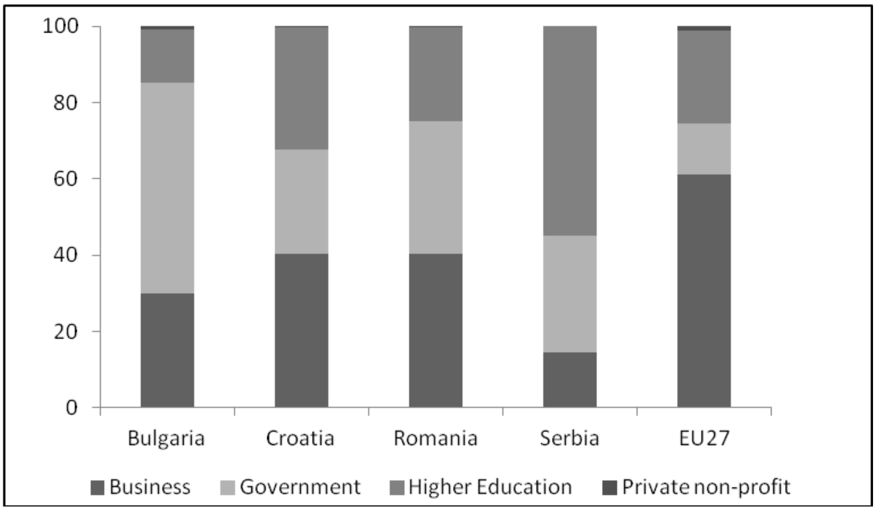


Source: Serbian Ministry of Education and Science

Businesses continue to play a marginal role in R&D

R&D activities in the business sector tend to remain marginal. Indeed, only 14% of R&D is undertaken in the business enterprise sector. This figure may not capture the entire R&D performed by the business sector. By contrast, a total of 55% of R&D is carried out in higher education institutions, which makes higher education institutions the largest R&D performers in Serbia (see Figure 9). In comparative terms, the business sector plays a much more limited role in innovation in Serbia than in other economies. For instance, in Croatia, the business enterprise sector is the largest R&D performer, carrying out more than 40% of R&D in 2009. Serbia is also in stark contrast with trends in the EU27 where the business sector is the main R&D performer and accounts for more than 60% of R&D performed.

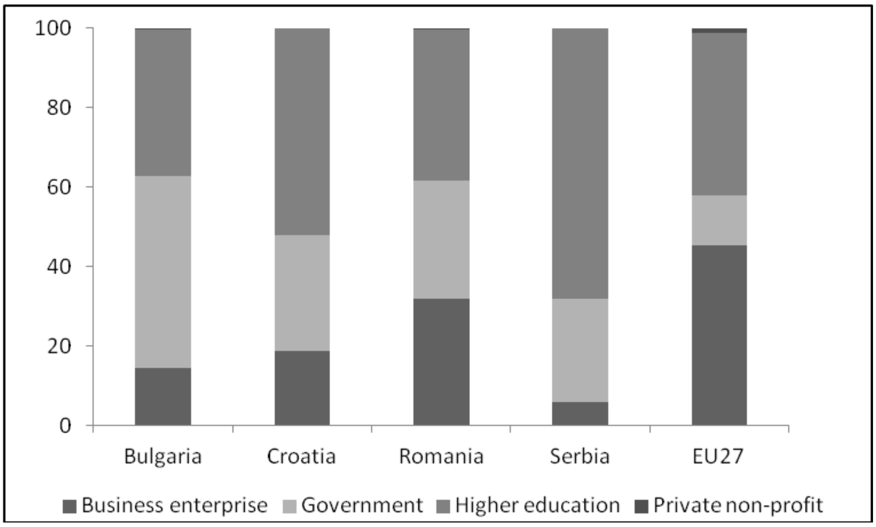
Figure 9. **GERD by performing sector, 2009 (%)**



Source: UNESCO and Eurostat

The share of researchers employed in the business sector is another indicator of the business sector’s limited role in R&D. The graph below shows that only 6% of researchers are employed in the business enterprise sector (see Figure 10). In comparative terms, about 32% of Romanian researchers are employed in the business sector while on average in the EU27 45% of researchers work in firms.

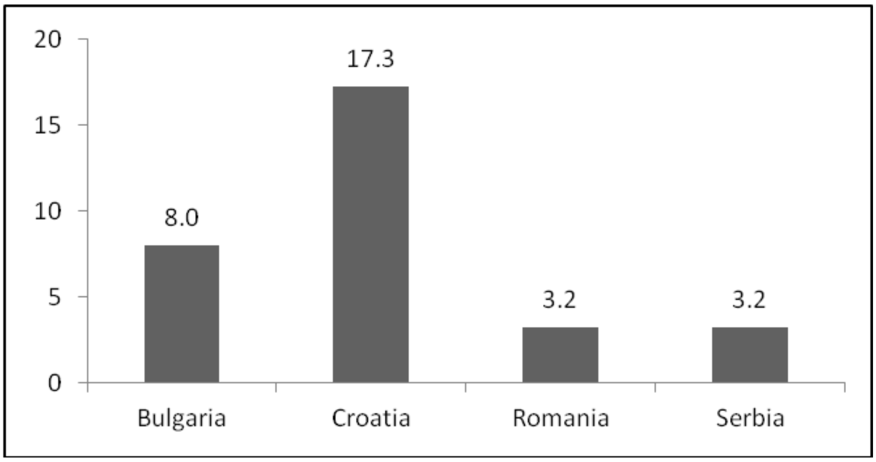
Figure 10. **Researchers by sector of employment in 2009**



Source: UNESCO

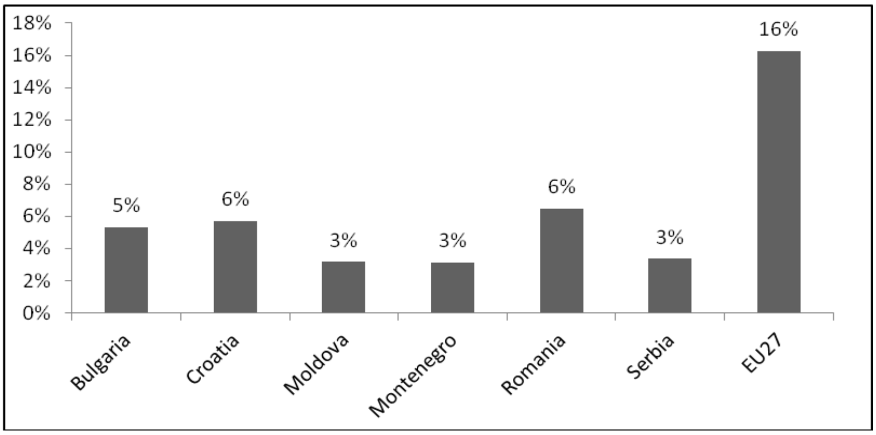
With regard to innovation outputs, Serbia is characterised by a low number of patent applications, particularly with the European Patent Office (EPO) (see Figure 11). With around three patent applications to the EPO per million inhabitants between 2008 and 2011, Serbia stands at the same level as Romania but below Bulgaria and Croatia, which respectively applied for 60 and 76 patents in total between 2008 and 2011.

Figure 11. **Patent applications to the European Patent Office 2008-2011 (per million inhabitants)**



Finally, the weak R&D and innovation performance of Serbian businesses is reflected in the low share of high-technology exports. According to OECD calculations, only 3% of Serbia's total manufacturing exports are high-technology products, which is lower than in Croatia, Bulgaria and Romania, and much lower than the EU27 average of 16% (see figure 12). Serbian exports are dominated by products of a lower processing stage, mainly raw materials and semi-finished products (MSTD, 2010).

Figure 12. **High-tech exports as a share of total manufacturing exports**



Source: OECD STAN Bilateral Trade Database by Industry and End-use and based on OECD classification for high-technology industries

As is the case for all South East European (SEE) economies, Serbia is characterised by a large gap between the demand for and supply of R&D (Radosevic, 2010). On the supply side, Serbia inherited significant R&D capacities from the centralised Yugoslavia era (Radosevic, 2007). However, several obstacles have prevented the demand for R&D from increasing. First, the economy is composed of traditional and non-knowledge intensive industries which do not depend on investments in R&D. Second, the structure of Serbian industry – dominated by SMEs primarily oriented to the domestic market with low absorptive capacities – generates only limited interest and demand for new technologies.

Overview of the national innovation support system

Key actors in innovation policy

The highest political level of research governance is the Serbian National Parliament and the Committee for Science and Technological Development which reviews and proposes to parliament the laws regulating the areas of science, technology and innovation (Kutlaca, 2010).

At the ministerial level, science and research policy are under the authority of the Ministry of Education and Science (MES – formerly Ministry of Science and Technological Development). The MES is responsible for the implementation of national priorities in the areas of science and technology. It is also the major source of public funds for R&D. Finally, the MES is in charge of preparing all laws related to science, technology and innovation to be adopted by the Parliament. To fulfil its different roles, the MES cooperates closely with other relevant ministries, the Vojvodina Provincial Secretariat for Science and Technological Development, the National Council for Scientific and Technological Development and the Academy of Sciences and Arts (Kutlaca, 2010).

In parallel, the National Council for Science and Technological Development acts as an independent advisory body. It was in charge of submitting the Strategy for Science and Technological Development to the government and will now monitor its implementation (Kutlaca, 2010). Reformed in 2010, the National Council is currently made up of 16 members representing the scientific, academic and business communities.

With regard to SME policy, the main institutions responsible for policy making are the Ministry of Finance and Economy (formerly Ministry of Economy and Regional Development) and the National Agency for Regional Development. Other agencies including the Development Fund, the National Employment Service (NES) and the Serbia Investment and Export Promotion Agency (SIEPA) play a crucial role in the implementation phase. An SME Council was also set up in 2006 by the government with a view to better coordinating and enforcing SME Policy. Finally, the Business Council - established in March 2010 - brings together representatives of SMEs from across the country (EC, 2011).

The strategic and legal framework for innovation

Strategic orientations towards innovation

National strategic documents strongly emphasise the need to focus on innovation and enhance collaboration between academia and businesses. For instance, the National Strategy for Economic development, which lays down the country's development priorities for 2006 - 2012, lists 'knowledge-based development' as one of its main objectives.

Similarly, the Strategy for the Development of Competitive and Innovative SMEs (2008 – 2013) seeks to promote innovation. This Strategy is largely in line with the principles contained in the EU Small Business Act. The fourth pillar, dedicated to 'Competitive Advantages for SMEs in Export Markets', targets greater investment in innovation, better cooperation between SMEs and R&D organisations, improved cooperation between Serbian SMEs and international companies on technology transfer, and the development of relay centres and networks to connect Serbian innovation institutions with their EU counterparts.

The Strategy for Scientific and Technological Development for 2010-2015 was adopted in February 2010. It aims at turning Serbia into an innovative country by increasing investment in research, modernising infrastructure, increasing human capital and building innovation capacity (EC, 2011). The Strategy also identifies seven priority sectors towards which support for R&D will be channelled. These sectors include biomedicine and human health; new materials and nano-sciences; environment protection and climate change; agriculture and food; energy and energy efficiency; information and communication technologies; the improvement of public policy-making processes and the affirmation of national identity.

The legal framework for innovation and R&D activities

Over the last few years, the government has sought to improve the legal framework for innovation. The Law on Innovation Activity was adopted in March 2005 and amended in March 2010 to regulate the overall innovation support system and strengthen the role of innovation as a driving force of economic development. This Law specifies the requirements institutions need to fulfil to be accredited by the MES as organisations undertaking innovation activities and receive financial support from the government. The Law on Innovation Activity also includes provisions for the establishment of an Innovation Fund to further support innovative projects.

With regard to the regulation of scientific research, the Law on Scientific Research Activities was approved in 2005 and amended in March 2010. It delineates the scope and objectives of scientific activities, outlines the research programmes to be carried out, and lays down the general principles for the establishment, organisation, management and supervision of public research organisations.

In addition to the two framework laws described above, the 2005 Law on Higher Education, amended in 2008 and 2010, provides an important basis for the expansion of the national innovation support system. Indeed, it enables the creation of innovation centres, technology parks and other organisations aimed at the commercialisation of R&D results to establish themselves within higher education institutions (HEIs).

Finally, in March 2010 the Serbian Parliament reinforced its legal framework in the area of intellectual property with a view to building a more reliable innovation system and in October 2010 Serbia became a member of the EPO.

Key innovation support instruments

Main government funding schemes for research and innovation

The Serbian government supports innovative projects through a number of funding programmes. Competitive funding is the only way to obtain budget funds for R&D. Institutional funding is only available for teaching activities in public universities (Kutlaca, 2010).

The MES support research projects through national project cycles. The last call was recently launched (see Box 3). Funding for R&D projects is divided into three different programmes: (1) programme for basic research; (2) technological development programme; and (3) integral and interdisciplinary research programme. Basic research and technological development programmes cover all research fields from a pure and applied research standpoint, whereas the integral and interdisciplinary research programme targets large-scale research projects which draw together several research institutions and industry representatives in priority research areas. When a call for any given programme is announced, all certified R&D institutions under the Law on R&D activities can apply for grants under the conditions of the call (minimal number of research, institutions, previous results, etc.). Grant applications are then reviewed by domestic and international experts. Selected projects are financed for the duration of the project cycle, with annual check-ups and reports after two years and upon project completion.

Box 9. The National Research Project Cycle 2011-2014

The National research project cycle 2011-2014 has started. 780 out of 878 projects were accepted for financing (89%). There are a total of 11,615 researchers on the accepted projects (increase of 30%); 1,714 young researchers (under 30) will for the first time participate in projects; 1,024 researchers from abroad will be partners on projects.

A third of the nation's scientific capacity will be engaged in large interdisciplinary projects (interdisciplinary projects 28%, technological development 28%, and basic research 44%).

Box 9. **The National Research Project Cycle 2011-2014** *(cont.)*

The best young researchers will have the opportunity to lead their own projects (25 young researchers applied and 24 received financial support from the Ministry in the next four years).

Within the public call for projects, researchers asked for a total of 136 million EUR worth of equipment. A database of the requested equipment was prepared and researchers were given a chance to correct their requests. An expert committee examined the database and rationalized the purchasing of equipment based on the following criteria: the team score within the public call, the project total ranking, the size of the team, the defence of the request in front of the committee, rational usage of equipment for the entire scientific community.

In addition to supporting research projects, the MES provides grants for innovation projects. Based on the Law on Innovation Activity, potential grant beneficiaries have to register with the Ministry to become eligible for financial support covering up to 50% of their R&D projects. Eligible institutions include R&D centres, innovation centres, business incubators, and science and technology parks. Individuals can also apply for these grants if they are registered as innovators. Two types of projects are eligible: the development of new products, technologies, processes and services; and building infrastructure for the successful implementation of an innovation project. Grants are limited to the amount of 4 million RSD (approximately 35.500 EUR) for firms and 800.000 RSD (approximately 7.000 EUR) for individual projects.[3]

Since 2005, the MES also holds the 'Best technological innovation' competition in Serbia. It has been a successful national initiative involving scientists, inventors and students in a competition to propose project ideas and provide assistance to their development. Out of 5360 participants, 970 innovations received support and a total of 44 enterprises were established. Inventions were presented in public events and broadcast on national TV.

In parallel, the Ministry of Economy and Regional Development (now Ministry of Finance and Economy) launched in 2009 a grant scheme for SMEs supporting Enterprise Investments in Innovation (now called Measures for supporting innovations in SMEs). Initially, eligible activities under the scheme covered both technological and non-technological innovations. In 2011, the focus of the grant scheme was modified to only include technological innovations. SME activities that are eligible for support now encompass new or significantly improved

[3] A EUR-RSD exchange rate of 112.4210 on 19 November 2012 was used to convert the RSD value of the grants.

product/service development, the introduction of a new production process, new product design, patent right purchasing and marketing plan development for new products/services. One of the main conditions for eligibility is to cooperate with R&D organisations, faculties, laboratories or consulting companies. Through this scheme, SMEs can apply for grants ranging from EUR 1.000 to EUR 15.000 and covering up to 50% of total activity cost.

Lastly, the Innovation Fund was established under the Law on Innovation activities to provide financing for innovation and participate in co-financing programmes with other international financial institutions and the private sector. The Innovation Fund secured the amount of EUR 8.4 million from Instrument for Pre-Accession Assistance (IPA) funds. In a first stage, the Innovation Fund will provide financing in the form of grants. In fact, the calls for the mini-grant and matching grant programmes have already been launched. Other financing instruments, including loans and equity capital, will be developed in a later stage. In addition, the Innovation Fund is working in collaboration with international financial institutions, the European Investment Fund and the European Bank for Reconstruction and Development (EBRD) on the establishment of the Western Balkan SME Platform. The project to be financed through the Western Balkan Investment Framework will offer a broad range of financial services to SMEs in the region.

The Serbian R&D infrastructure investment initiative

The Serbian government considers that investment in infrastructure is a pre-condition for the success of the National Strategy for Scientific and Technological Development. In this regard the Serbian government is investing in infrastructure and equipment renewal to facilitate integration into international projects and increase the attractiveness of local partners (MSTD, 2010). The main sources of financing for the infrastructure projects are international financial institutions, specifically the European Investment Bank, European Commission, the European Bank of Reconstruction and Development, the Development Bank of the Council of Europe in combination with other international donors and local institutions. This infrastructure investment initiative, worth EUR 400 million covers the 2010-2015 period (MSTD, 2010).

The types of projects which are being supported include the following:

1. Upgrading existing research facilities (about 70 million EUR) by:

- Renovation of existing buildings and laboratories
- New capital equipment for research

2. The development of human capital (about 33 million EUR) through investments in:

- Human resources program (program to encourage return of Serbian researchers from abroad)

- "Petnica" Research Station
- Mathematical High School Campus
- Centre for promotion of sciences in Belgrade

3. Development of centres of excellence and academic research centres (about 60 million EUR) in:

- Energy and Environment (National Institute of Energy and national laboratories for the quality of water, soil and air).
- New materials and nanoscience (National Laboratory of Physics, Materials and Nanotechnology).
- Agriculture and Food (Network of Institutes and faculty who are engaged in research in the field of agriculture).
- Biomedicine (a new campus for biomedical research and biotechnology companies in the area of the Clinical Centre of Serbia and School of Medicine, University of Belgrade).

4. Development of technology infrastructure and information and communications technology (50 million - 80 million EUR) through building:

- A campus for faculty in the field of ICT, Belgrade University
- Infrastructure for a supercomputing initiative "Blue Danube"

5. Supporting knowledge-based economy through the construction of science parks in Belgrade, Novi Sad, Nis and Kragujevac (about 30 million EUR)

6. Basic infrastructure projects (80 million EUR)

- Residential buildings for researchers in Belgrade, Novi Sad, Nis and Kragujevac

The design and construction of infrastructure projects are being led by the Serbian government's project implementation unit (PIU). To date, the PIU has completed or initiated construction of the following: Science and Technology Park Zvezdara (Belgrade), Science centre "Petnica", Natural science centre (Svilajnac), Science and Technology Park (Novi Sad), main building of the University of Novi Sad, repair of the foundation of the faculty of chemistry (Belgrade), and construction of apartments for young researchers in New Belgrade[4].

[4] See the website of the Project Implementation Unit (www.piu.rs)

Tax incentives

The only R&D-related tax incentive in Serbia targets R&D organisations registered as non-profit organisations. These organisations are not required to pay taxes for the R&D services they provide to customers under non-profit contracts (Kutlaca, 2010).

Under the Strategy for Scientific and Technological Development, the MES put forth a number of proposals regarding incentives for investment in research and innovation:

- The investment by corporations into the projects involving science research organisations, which are co-financed by the MES, shall be free of corporate profit tax.
- Employment of the young researchers registered in the projects of the MES in the private sector enables the private sector to pay salaries for two years free of contributions and taxes.
- If the enterprise chooses to fund an employee's doctoral studies, the MES would bear up to one half of the costs.
- Young researchers registered with the MES who incorporate their own enterprise would be exempt from paying income and profit taxes up to the age of 30.
- The MES would cover the costs of patent applications and other forms of intellectual property protection for projects co-financed by the Ministry".

Instruments for public-private knowledge transfer and cooperation

To support technological entrepreneurship in the higher education system and in public research institutions, the government introduced changes in the Higher Education Law and Innovation Law which legally approve the creation of university and research institute spin-offs. The University of Novi Sad has established the first Intellectual Property Right (IPR) Liaison Office within the university, in cooperation with the national IPR Office. A similar support programme was established at the University of Belgrade (Kutlaca, 2010). The involvement of the private sector in the governance of HEIs and public research organisations (PROs) is also encouraged as representatives of the business sector may be elected to managing boards of public faculties and universities and PROs (Kutlaca, 2010). Finally, the S&T Strategy and the last public call for new R&D projects for the 2011-2014 period also provide financial support to cooperation between PROs and SMEs (Kutlaca, 2010).

EU and international collaboration programmes

International cooperation, particularly with EU partners, is high on the national agenda. As a potential EU candidate country, Serbia has been associated with the Seventh EU Research Framework Programme (FP7) since January 2007.

Serbian research entities have successfully bid for research projects under the EU FP7. By the end of 2009, a total of 107 Serbian organizations and enterprises participated in the FP 6/7 programmes. While Serbia has shown a good take-up of FP7 projects throughout the programme, further efforts are necessary. In particular efforts are necessary to increase participation by SMEs.

Since 2009, Serbia has also been a full member of the Entrepreneurship and Innovation Programme under the EU Competitiveness and Innovation Programme (CIP), which seeks to support innovation in SMEs. It is also involved in key international research programmes (COST and EUREKA) and has recently become an associate member of the European Organisation for Nuclear Research (CERN). Finally, Serbia has concluded numerous bilateral research cooperation agreements with several neighbouring countries and other international partners (France, Croatia, Slovenia, Slovakia, Germany, etc.).

Supporting the national innovation system

As detailed above, the Serbian government has made efforts to foster an environment conducive to innovation. Strategic and legal frameworks for R&D have been passed and new instruments have been developed to provide increasing support to innovative projects and businesses. However, there remains scope for implementing additional policy reforms to boost the level of innovation activity in the economy.

Support the commercialisation of academic and scientific research

As noted in Serbia's National Strategy for S&T Development 2010-2015, the majority of public funding is directed towards supporting basic research. Nearly two-fifths is directed towards projects oriented around "technological development," however, it is unclear whether projects in this area contribute to the development of market-relevant research and commercialisable innovations. To address this issue, the government plans to gradually re-orient the portfolio of scientific activities towards increased market relevance by allocating additional funds for applied disciplines (Kutlaca, 2010). However, these efforts will need to go further and ensure that technological development and applied research projects are, in practice, downstream-oriented and industry-relevant.

Promote innovation in the business sector

Companies under-invest in innovation because of a lack of absorptive capacity and/or because they do not perceive the added value of innovation to improve their business. Therefore, enhanced business investment in R&D and innovation will only occur if both businesses' capacity to innovate and demand for innovation increase.

Businesses' capacity to innovate can be supported through direct policy instruments, such as block grants or competition-based funding. Soft support, such as assistance in firm creation, counselling and entrepreneurship measures can also be used to complement direct R&D support and encourage risk-taking attitudes. Tax incentives, which need to be carefully considered, may also be used. Finally, continuous improvement of framework conditions, such as competition policy and access to finance, enhance businesses' capacity to innovate (OECD 2010b).

On the other hand, business demand for innovation can be promoted through linkages programmes and information-diffusion measures. Business demand for innovation is higher when firms are aware of the demands of sophisticated buyers, anticipate future needs, and understand how their activities can benefit from research and innovation. Seminars on market trends or compliance with EU standards may be useful in this regard. Technology demonstration events may increase businesses' awareness of the benefits of innovation. SMEs' demand for innovation may also be stimulated by a voucher scheme which catalyses first-time innovations.

Finally, the business sector should be consulted more frequently in the design and implementation of innovation policy instruments. Closer consultation with businesses will ensure that innovation support instruments meet their needs and that they are aware of the instruments which are available to them.

Increase linkages between knowledge producers and knowledge users

The under-development of linkages between knowledge generators and firms, particularly SMEs, continues to hamper innovation in Serbia. Indeed, a wide divide still separates research from industry, limiting information and knowledge flows between the two spheres.

Some efforts (cf. instruments for public-private knowledge transfer) have already been made to foster greater linkages between research institutes and businesses but further efforts are needed to encourage information flows and technology transfers. Increasing the intensity of knowledge flows will be essential to ensure that businesses are aware of the existence and capabilities of local research institutions and to introduce gradual changes in the mindset of researchers towards greater commercialisation. Technology transfers between those who conduct research and those who transform it into products will boost the overall innovation performance of Serbian businesses and the potential for higher value-added production.

While linkages between education and science are one of the cornerstones of the Strategy for Scientific and Technological Development, the institutional frameworks that are commonly used to promote industry-science relationships should be further developed, particularly public-private partnerships for innovation between firms and research institutions and mechanisms to stimulate joint discussion on current and prospective technology needs.

Increase the critical mass of research capacities in certain fields

In Serbia, research funds are spread across multiple areas and the under-funding of individual fields and programmes may lead to inefficiencies, i.e. a large number of small research groups or projects at sub-critical levels in a broad range of fields (OECD, 2004a). For instance, in the area of technological development, apart from bioengineering and the agro-food industry, no fields receive more than EUR 5 million (MSTD, 2010).

In a resource-constrained environment, achieving critical mass in certain sectors should be considered. This is in line with the concept of "smart specialisation", which promote "efficient, effective and synergetic use of public investments and supports countries and regions in strengthening their innovation capacity, while focusing scarce human and financial resources in a few globally competitive areas in order to boost economic growth and prosperity."[5] In this regard, the new Strategy for Science and Technological Development identifies seven national research priorities:

- Biomedicine and human health
- New materials and nanosciences
- Environment protection and countering climate change
- Agriculture and food
- Energy and energy efficiency
- Information and communication technologies
- Improvement of decision making processes and affirmation of national identity

In addition, the Strategy plans to merge subscale public research organisations and establish new ones to achieve economies of scale and create a more adequate environment for competitive research (Kutlaca, 2010).

Provide non-technological innovation support

The Serbian government places a very strong emphasis on science and technology. However, the OECD Innovation Strategy clearly stresses that innovation goes beyond science and technology and encompasses all forms of innovation. For instance, the implementation of new organisational methods in firms, workplace organisation and external relations can play a major role in enhancing companies' competitiveness and value creation. Marketing innovations can also have a significant impact, generating changes in product design or packaging, product

[5] http://ipts.jrc.ec.europa.eu/activities/research-and-innovation/s3platform.cfm

placement, product promotion or pricing (OECD, 2010a). Therefore, a narrow high-technology orientation should be avoided in favour of a comprehensive approach to innovation which covers organisational innovation, marketing innovation and new business models.

To conclude, this section has highlighted that the weaknesses in innovation performance stem not so much from a lack of knowledge, but from its limited use in market-oriented innovation activities. Indeed, Serbia has shown encouraging results with regard to academic and scientific performance but so far these positive achievements have not led to a greater commercialisation of research and a stronger role for businesses in innovation. More generally, the evidence points to a significant gap between the nature, quality and orientation of R&D on the one hand and the production systems in Serbia on the other hand.

This section has also shown that the Serbian government has acknowledged the importance of innovation as a pillar of future competitiveness and sustainable growth as evidenced by the significant increase in public expenditure for R&D in 2011 and the priority given to the National Strategy on Science and Technological Development. In addition, a number of policy instruments – at the national and European levels – have been implemented to support research institutions and innovative businesses.

Despite progress, this section also indicates that there is room for instruments which further promote inter-connections between businesses and research institutions, particularly in sectors where Serbia has a strong potential. Innovation policy instruments have focused to a large extent on knowledge generation rather than on the diffusion and exploitation of this knowledge to increase industrial specialisation in value added activities. Strengthening and extending the mechanisms for knowledge exchange and transfer will be crucial to stimulate the commercialisation of scientific research and encourage business innovation.

Chapter 3

Needs assessment for a competence centre

This chapter assesses whether there is a need for a centre in Serbia. The objective is to determine whether and which type of centre would most appropriately respond to both businesses and researchers' demands. From a policy perspective, this section also gauges the potential 'additionality' of a centre, i.e., whether a centre could generate innovation activities that would not be carried out otherwise.

The chapter presents full needs assessments for both agro-food and biomedicine, as these two sectors were identified as priority sectors by the Serbian government. The analysis is based primarily on the results of sector-specific business and research surveys. These surveys serve two useful functions: first, they provide a glimpse into the current behaviour of research institutions and businesses; and second, they explore the potential changes in behaviour in those same actors.

Needs assessment in the agro-food sector

The agro-food sector in Serbia

In recent years, the global agro-food industry has experienced significant changes. On the demand side, there have been increased market expectations for higher quality and more diversified products. In addition, standards and food safety have become central. On the supply side, the internationalisation of food retailing and manufacturing that occurred in industrialised economies is now moving into the region. In addition, there is a trend of growing concentration in the retail, processing and production segments of the value chain (OECD, 2011b) and SME producers, processors and retailers are struggling to keep up with new demands from large food manufacturers and retailers.

Agro-food has traditionally been a strong sector of the Serbian economy. Indeed, Serbia has excellent natural conditions for the development of a diversified agriculture. The agro-food sector currently accounts for about 20% of GDP and 26%

of total exports[6]. Major exports products include yellow corn, beet sugar, frozen raspberries. They are followed by sunflower cooking oil, wheat, fresh apples and crushed raspberries.

However, the Serbian agro-food sector is facing a number of challenges to remain competitive and keep up with the evolution of the global agro-food industry. First, sector productivity needs to be enhanced. Indeed, labour and land productivity in the Serbian agricultural sector remain much lower than in EU countries (Tomic et al., 2010) partly because of a high level of fragmentation in primary production[7], but also because of a limited introduction of new technologies in production. Second, the agro-food industry needs to improve the quality of its production and increase compliance with international standards, which will in turn boost Serbia's export potential. Third, the Serbian agro-food sector needs to consider how to increase the value-added of its products. Its main agro-food export products continue to be from low processing stages rather than technology-intensive products with high unit value (Milojević et al., 2011). This could involve either cultivating higher-value added crops or increasing the productivity of firms in food and beverage processing. The latter is difficult and would require attracting FDI in this sector.

Innovation can play a crucial role in increasing both quality and productivity in the Serbian agro-food sector. Key investments are needed in the transfer of know-how and technologies to agricultural producers, which would improve safety and quality standards. The introduction of new technologies across the value chain would also enhance overall productivity and help the sector specialise in more knowledge and technology-intensive segments of production.

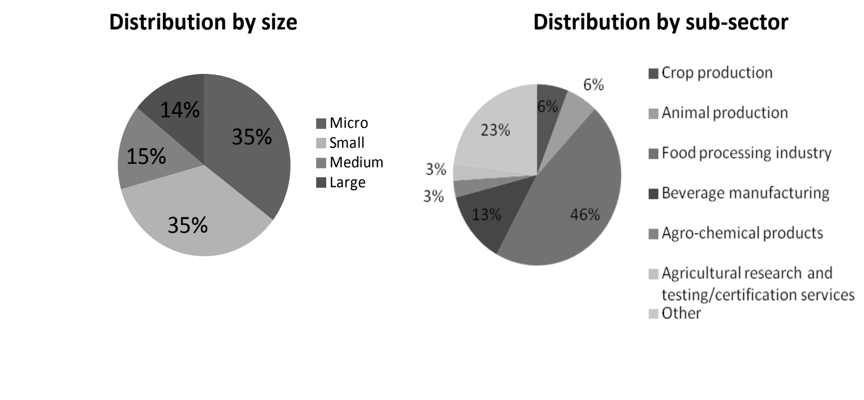
Businesses' innovation activities and needs

This section is primarily based on the results of the agro-food business survey which covered a total of 181 companies, including 100 companies which innovate and 81 companies that do not innovate. Companies were not selected on an entirely random basis. Indeed, the OECD team chose to primarily target companies that conducted some innovation activity as one of the main objectives of the survey was to understand innovative companies' needs. The definition of innovation throughout the survey included substantive product or service innovation, process innovation, marketing innovation and organisational innovation. The survey methodology is explained in greater detail in Box 4. Overall, the companies surveyed were fairly representative in terms of company sizes and sub-sectors (Figure 13).

[6] http://usz.gov.rs/files/publikacije/VegetableIndustryInSerbia.pdf

[7] The average farm size is less than 3 ha and only 5.5% of agricultural producers cultivate over 10 ha of land (SIEPA).

Figure 13. **Distribution of surveyed companies by size and sub-sectors**



Box 10. Business survey methodology

The OECD team carried out two business surveys in the agro-food and the bio-medicine sectors. The surveys first aimed at understanding companies' innovation behaviour, needs and capabilities. The second objective was to evaluate their potential interest in a competence centres.

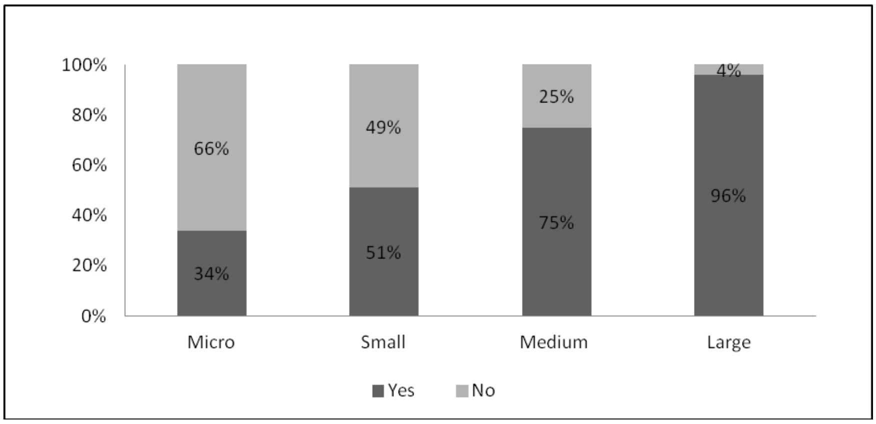
The OECD team prepared the business questionnaires on the basis of four areas: 1) companies' general characteristics; 2) their innovation behaviour; 3) their scientific and engineering activities and, 4) their potential interest in a competence centre. The questionnaires were reviewed internally as well as by the Serbia project team.

The business surveys were carried out by GfK Belgrade using the Computer Aided Telephone Interface (CATI) method. Once the data was collected, the OECD carried out the analysis. Most of the answers to the survey were split by company sizes in order to uncover the possible links between company size and innovation behaviour.

Innovation tends to be non-R&D intensive and concentrated in large companies

The survey indicates that larger companies undertake more innovation activities than SMEs (Figure 14). This point is in line with innovation patterns found in other countries where large firms are also more frequent innovators than small firms. SMEs tend to feel less pressure to innovate and often face larger constraints to engaging in innovative activities.

Figure 14. **Companies that conduct innovation (per company size)**



Although a relatively large number of companies innovate, only a limited proportion (23%) of innovative companies declared that they conduct scientific and engineering activities. Even for large firms which tend to undertake more science and engineering than SMEs, the proportion (36%) of companies that perform scientific and engineering activities remains low (Figure 15). This may indicate that R&D activities in the agro-food sector are informal and occasional in nature and that innovation is largely non-R&D intensive. The low number of patent applications is another indication of the relatively low R&D intensity of innovation in the agro-food sector (Figure 16).

Figure 15. **Scientific and engineering activity (as % of companies that innovate)**

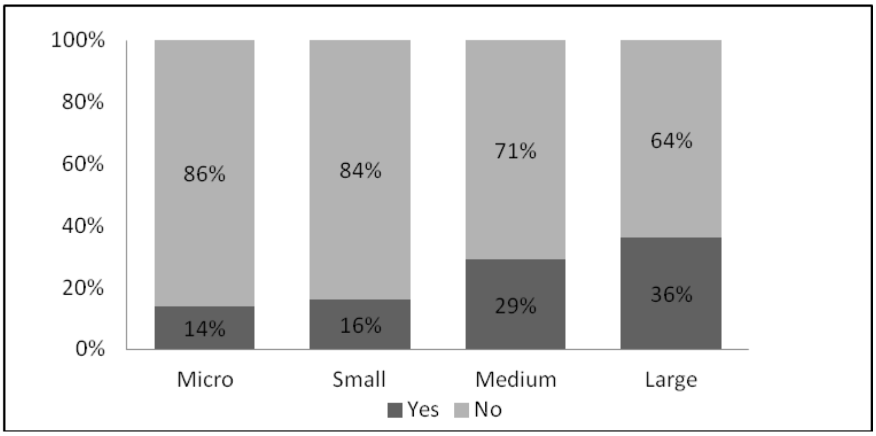
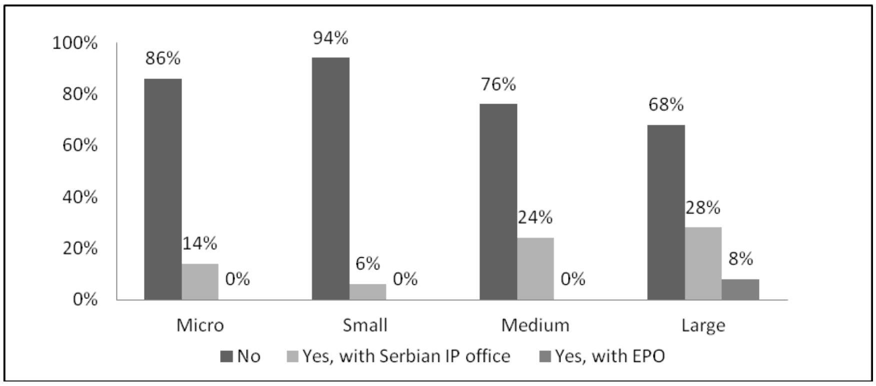


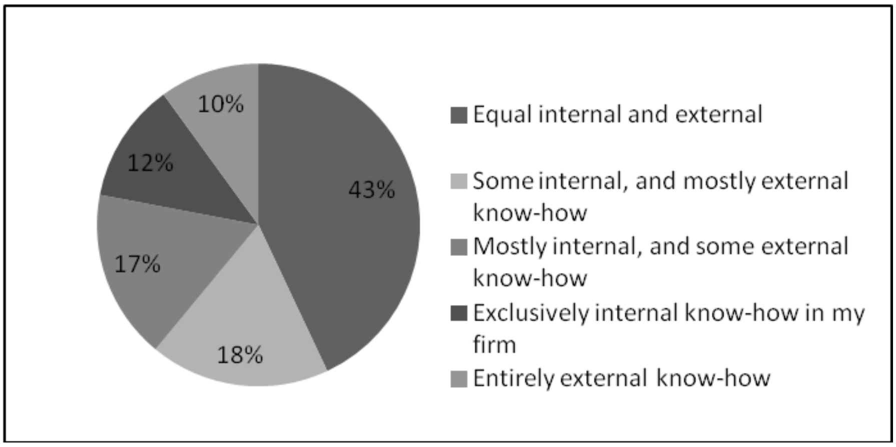
Figure 16. **Patent applications (as % of companies that innovate)**



Knowledge exchange and collaboration with scientific institutions play an important role in innovation

When seeking access to specialised knowledge or know-how, the survey results as well as the focus group responses suggest that most companies use both internal and external knowledge providers, and that the level of dependence on external know-how is generally high (Figure 17). The dependence on external know-how does not significantly decrease for larger companies (see Annex B).

Figure 17. **Sources of know-how (as a % of companies that innovate)**



According to the survey results, agro-food businesses are highly involved in co-operation along the value chain. In fact, businesses' main external partners in innovation activities are suppliers and buyers (Table 5). This does not necessarily mean that value chain partners are the main source of knowledge for companies but that they are key partners in the implementation of innovation.

The survey also reveals high levels of collaboration between businesses and universities/local research institutes, particularly for medium-sized and large companies (Table 5). Indeed, as shown in the table below, 33% of medium-sized companies that innovate have collaborated with universities and 38% have already cooperated with local research institutes. More than half of the large companies that innovate have collaborated with local research institutes. Even for micro companies, the level of collaboration appears fairly high: about one fifth of micro companies that innovate have collaborated with universities and/or local research institutes. These high figures point to companies' dependence on services offered by R&D and technical infrastructure organisations.

Table 6. **Collaboration with external partners (as a % of companies per company type)**

	Micro	**Small**	**Medium**	**Large**
Suppliers	73%	63%	81%	76%
Buyers	82%	63%	57%	68%
Competitors	32%	28%	19%	24%

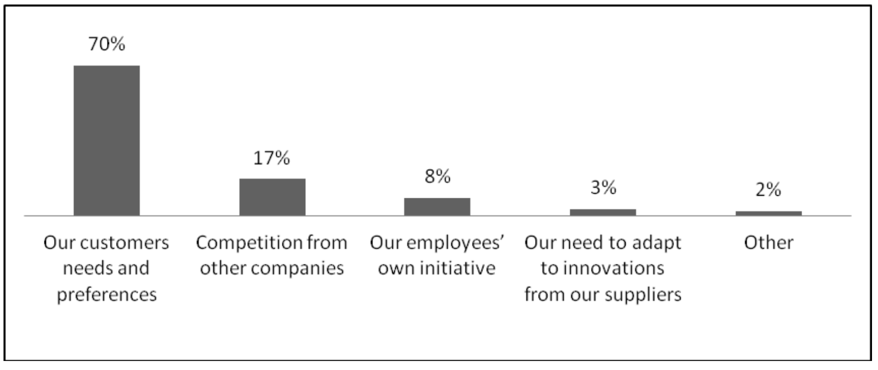
Table 6. **Collaboration with external partners (as a % of companies per company type** *(cont.)*

	Micro	Small	Medium	Large
Other businesses	36%	16%	19%	16%
Universities	18%	28%	33%	48%
Local research institutes and organisations	18%	25%	38%	56%
Foreign research institutes and organisations	9%	25%	14%	28%
Not interested in collaboration	9%	13%	0%	0%

Innovation is driven by market pressures but constrained by the lack of access to finance and market risk

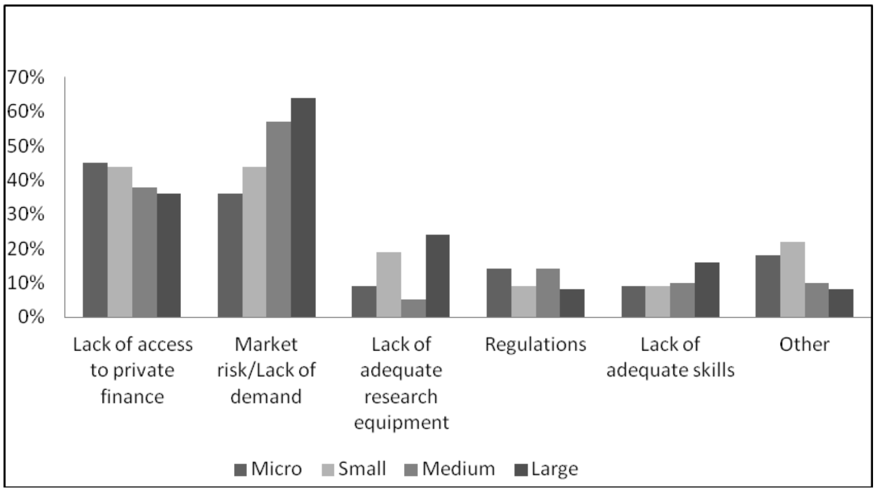
The survey and the focus group both showed that innovation in the Serbian agro-food sector is market-led and pushed by customer needs (70%) and competition (17%) (Figure 18). This suggests that innovation is largely near-market oriented. Other factors including employees' initiatives or the need to adapt to innovations from suppliers appear as marginal drivers of innovation.

Figure 18. **Main factors motivating companies to innovate (as % of companies that innovate)**



On the other hand, businesses which conduct innovation activities perceive market risk, the lack of demand and the lack of financing as the most significant barriers to innovation (Figure 19). The lack of adequate research equipment appears as a minor barrier to innovation for SMEs. Large firms, on the other hand, tend to feel more constrained by the lack of adequate equipment. This may suggest that equipment shortage is closely related to the level or development ambition of Serbian firms. More generally, the survey results show that the obstacles to innovation vary with firm size.

Figure 19. **Main innovation constraints**

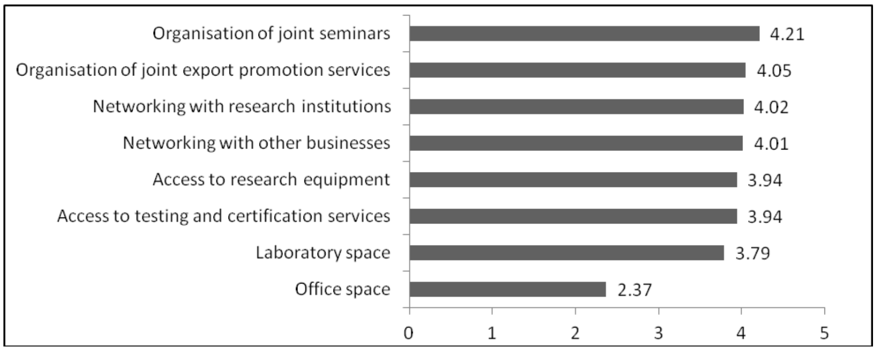


Businesses want networking and technological development services

Overall, business survey respondents expressed interest in a centre. This interest was confirmed in the two subsequent focus groups. The centre should have a number of specific characteristics to adequately respond to businesses' needs which are detailed below.

First, companies are particularly interested in a centre providing joint seminars, networking and joint export promotion (Figure 20). While the survey reveals high levels of collaboration between businesses and universities/local research institutes, the quality of this collaboration was questioned by focus group participants. Collaboration with R&D institutions was described as need-based and sporadic, often consisting of consulting services on specific issues. Focus group participants from faculties also mentioned that they have seen a significant decrease in the number of their contacts with businesses over the last three to four years. Thus, enhancing networking and collaboration through a centre was seen as particularly interesting to businesses in the agro-food sector.

Figure 20. **Average ratings of centre services**



The agro-food businesses that participated in the focus groups also expressed the need for technological development services. Several companies, including large ones, declared that they currently go outside of Serbia to get access to technological development services and specific facilities. For instance, the dairy company IMLEK uses services and facilities outside of Serbia when it wants to develop new products. A similar situation was described by Polimark which currently uses the services of a pilot plant outside of Serbia via its suppliers. Although in the survey access to equipment seemed to be more of a priority for large companies, in the focus group SMEs also expressed an interest in a centre which provides equipment to test new products.

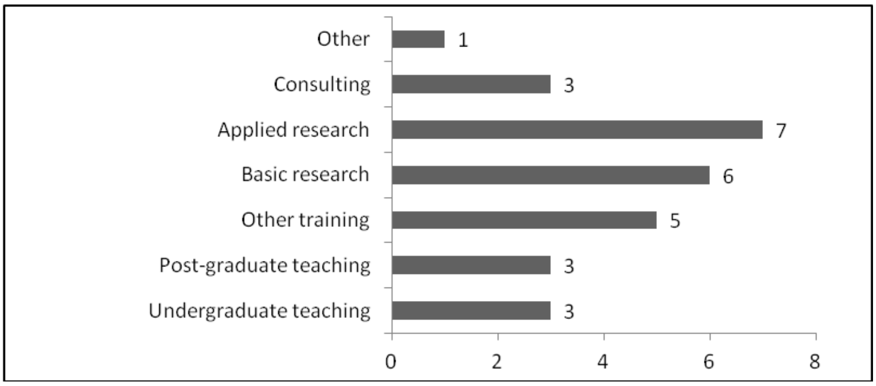
Research institutions' innovation activities and needs

The following section looks at the innovation activities and needs of research institutions in the agro-food sector. It is based on a survey which covered eight research institutions, including three university faculties and five institutes.

Scientific institutions are oriented towards basic and applied research

The survey results reveal that applied research is the dominant form of research in the agro-food sector, closely followed by basic research (Figure 21). This highlights that researchers are involved in both upstream and downstream-oriented research. As shown in the Figure below, surveyed researchers also participate in training and consulting activities.

Figure 21. **Activities of research institutions**



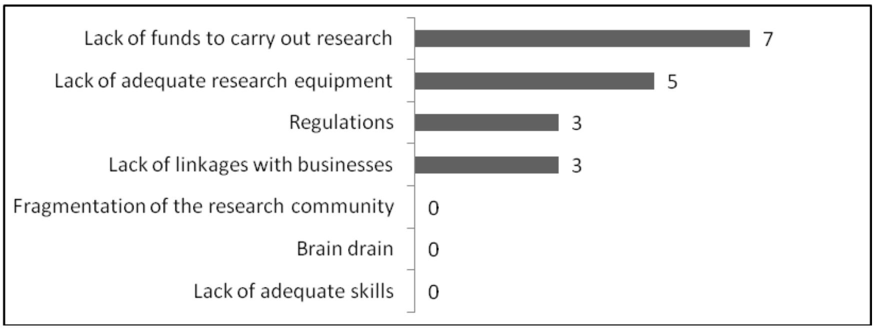
The main factor determining research priorities are the Ministries' priorities (Figure 22). This partly reflects research institutions' strong dependence on Ministry funding. Other driving factors include scientific interest and the possibilities for international collaboration. Interestingly, the potential for commercial applicability and the needs of the private sector seem to play as much of a role in orienting the research agenda as scientific interest. This is in line with the downstream orientation of some of the research conducted by science institutions in the agro-food sector.

Figure 22. **Research motivations**

Main constraints for researchers are lack of funds and adequate research equipment

The surveyed research institutions perceive the lack of funds and adequate research equipment as the major constraints to their research activities (Figure 23). Interestingly, the lack of linkages with businesses was cited by three out of the eight institutions surveyed as a major obstacle to research. This confirms that greater linkages with businesses are considered a priority by research institutions. Greater collaboration with the private sector would actually enhance their research work.

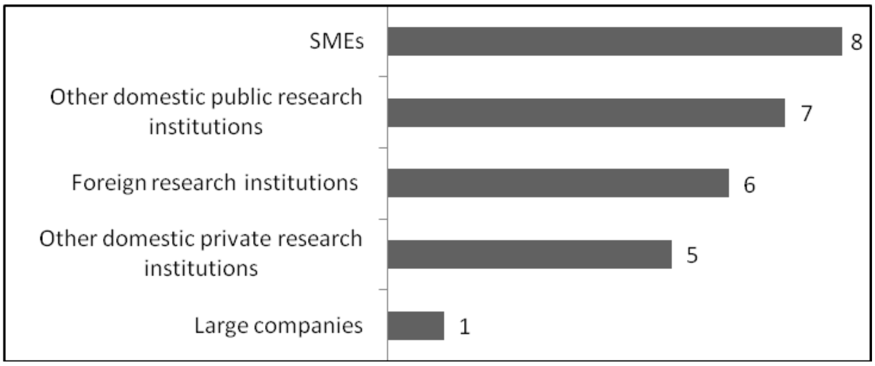
Figure 23. **Research constraints**



SME collaboration is evident, but there are still obstacles to the commercialisation of research

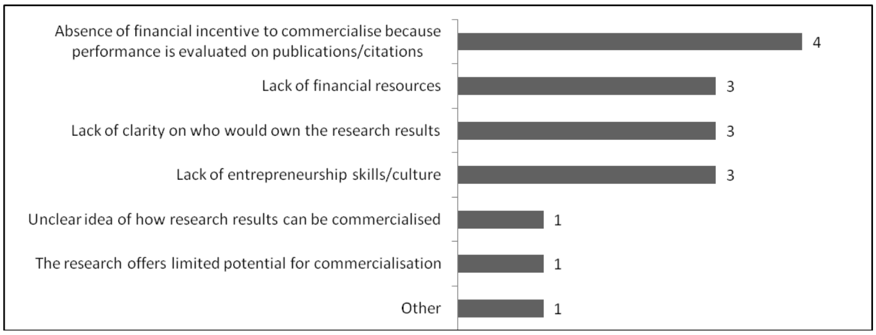
All of the research institutions surveyed reported collaboration with SMEs (Figure 24). Interestingly, only one institution reported collaboration with a large firm. This may reflect the capacity of large agro-food firms to conduct R&D internally. More generally, these survey results show that there is a good degree of proximity between science and industry, particularly with SMEs. These institutions also indicated strong collaboration with domestic public institutions and foreign research institutions.

Figure 24. **Collaboration with external partners**



With regard to commercialisation, five institutions out of eight responded to the survey that they had commercialised some of their research results, primarily through research contracts with the private sector. However, only three institutions reported financial benefits from their commercialisation efforts. More generally, a number of obstacles continue to hinder research commercialisation. According to the survey results, the fact that research performance is evaluated on publications constitutes the main obstacle to the commercialisation of scientific and academic research (Figure 25). Other obstacles include the lack of financial resources, the lack of clarity on who would own the research results and the absence of an entrepreneurial culture.

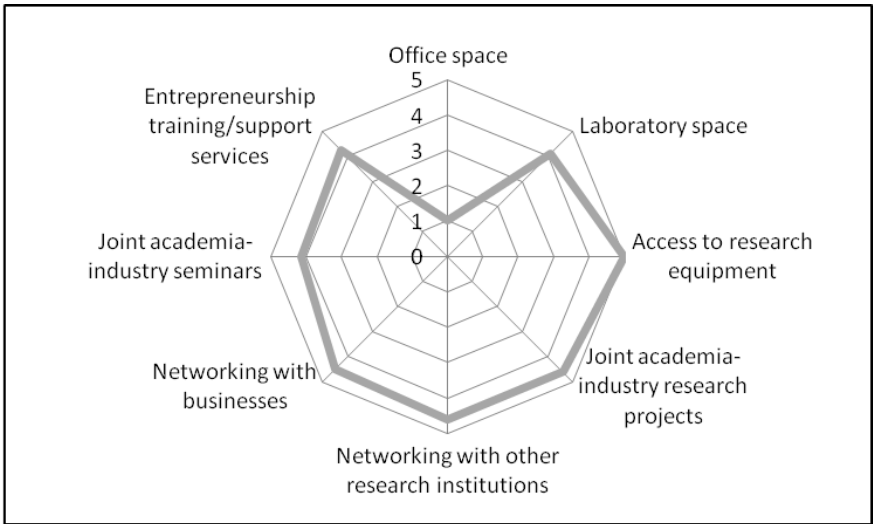
Figure 25. **Obstacles to research commercialisation**



Research institutions want a centre that provides research equipment and supports joint research projects

The survey shows that agro-food research institutions would be particularly interested in access to research equipment (Figure 26). A very high interest was also expressed in joint academia-industry research projects and networking with both businesses and research institutions. These demands generally overlap with the private sector's demand. These results more generally reveal that a centre providing these services would generate high demand and participation.

Figure 26. **Average ratings of centre services**



Needs assessment in the biomedicine sector

Biomedicine sector in Serbia

The biomedicine sector has been undergoing significant changes. On the demand side, the cost of healthcare has become a major concern, particularly in European economies where the population is ageing. Businesses are pressured to reduce manufacturing costs and provide affordable drugs (SIEPA, 2005). On the supply side, competition to develop new drugs and therapies is increasing. Many international pharmaceutical companies are seeking to grow through mergers and acquisitions or joint-partnerships with small and dynamic firms (SIEPA, 2005).

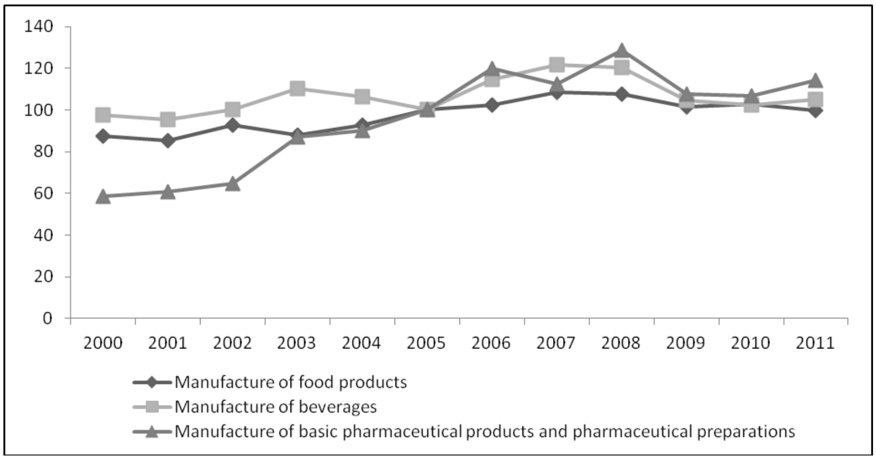
More recently, with the expiry of patents on major drugs and the pressure to provide lower cost drugs, generic drugs have started playing a much greater role. The growing market for generic drugs is generating business opportunities for pharmaceutical companies who serve ‘the bottom of the pyramid’ (SIEPA, 2005) and the growing power of generic drug producers is progressively threatening established pharmaceutical companies (Gassmann et. al 2008).

Serbia has traditionally had a relatively strong pharmaceutical sector. The Serbian pharmaceutical industry represents 3.24% of total GDP and accounts for 50% of the total production of the chemical industry[8]. In terms of turnover, the pharmaceutical industry reached a total of about EUR 390 million in 2010

[8] http://siepa.gov.rs/en/index-en/key-industries/pharmaceutical.html

(Statistical Office of the Republic of Serbia). The pharmaceutical sector has also shown significantly higher vitality relative to other sectors in the last decade (Marković, 2010). For instance, Figure 27 shows that industrial output in the pharmaceutical sector has grown more rapidly than in the food and beverage industries.

Figure 27. **Base industrial production indices**



Source: Statistical Office of the Republic of Serbia

In addition to its traditional pharmaceutical industry, Serbia has a dynamic herbal drugs sector. Serbia's export share in the EU's total imports of medicinal herbs has increased over the last decade, highlighting the dynamic growth of this sector (Dajic Stevanovic, 2011). In contrast with the pharmaceutical sector, which is dominated by three leading manufacturers – Hemopharm, Galenika and Zdravlje[9] – the herbal drugs sector largely consists of SMEs.

While Serbia benefits from its proximity with EU markets, relatively cheaper inputs and labour costs, the biomedicine sector is still facing important challenges to become competitive and take advantage of the recent changes in the global industry. Increased competitiveness in both pharmaceuticals and herbal drugs will largely be determined by investments in R&D and innovation. In the pharmaceutical industry, R&D expenditures have grown constantly worldwide over the last ten years (Gassmann et al., 2008), suggesting that R&D is critical to gain a competitive edge. In the herbal drugs sector, innovations will be needed to improve productivity and

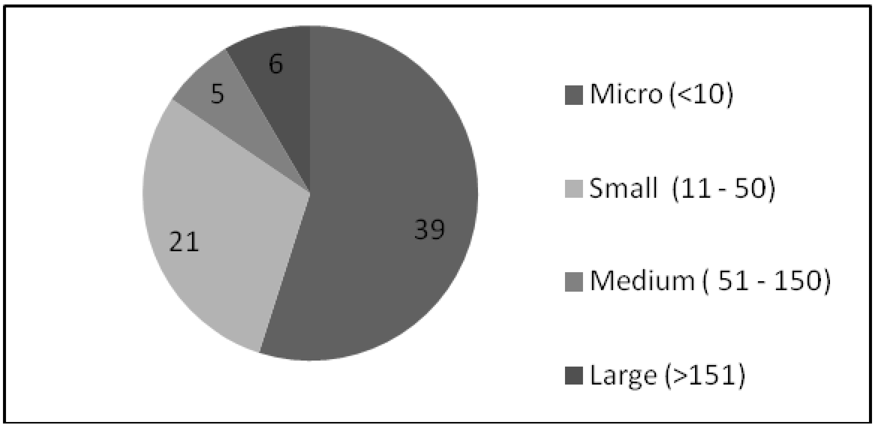
[9] Privatisation agency, Republic of Serbia: http://www.priv.rs/upload/company/document/e-teaser_240.pdf

raise the quality of production to meet increasingly stringent regulatory requirements.

Businesses' innovation activities and needs

This section examines the innovation activities and needs of businesses in the biomedicine sector. The analysis is based on a survey and consultations with local businesses through focus groups. The survey covered a total of 71 companies in the biomedicine sector, including 55 companies that innovate and 16 companies that do not carry out innovation activities. Companies were selected on a random basis. In terms of company size, the sample distribution was as follows (Figure 28):

Figure 28. **Distribution of surveyed companies by size**



Regarding sub-sectors, with about 46% of total companies, medical equipment and device production was by far the largest activity represented in the sample. Other important sectors included the production of cosmetics, the production of dietary supplements, generic drug production and herbal drug production.

Companies innovate, but innovation is not highly R&D-intensive

A large proportion of surveyed companies innovate (Figure 29). Indeed, most companies in the sample are technology-active. As in all innovation surveys, large companies tend to innovate more than smaller ones. However, the difference across groups is not very large. In comparative terms, Figure 30 highlights that the propensity to innovate is higher in biomedicine than in agro-food.

Figure 29. **Innovative companies**

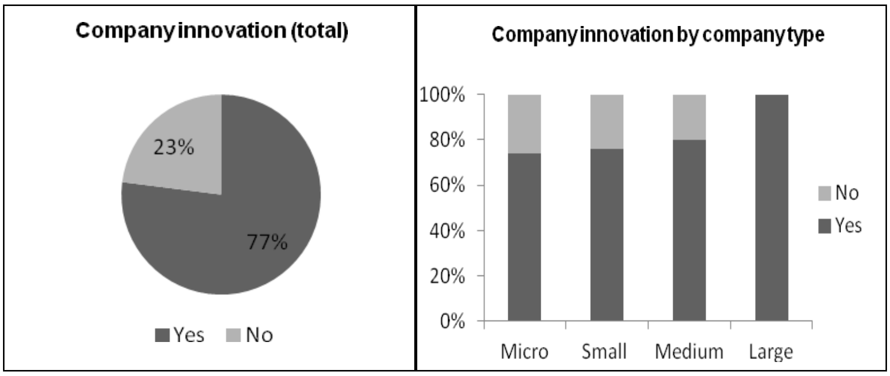


Figure 30. **Innovative companies in biomedicine and agro-food as a share of total companies by sector**

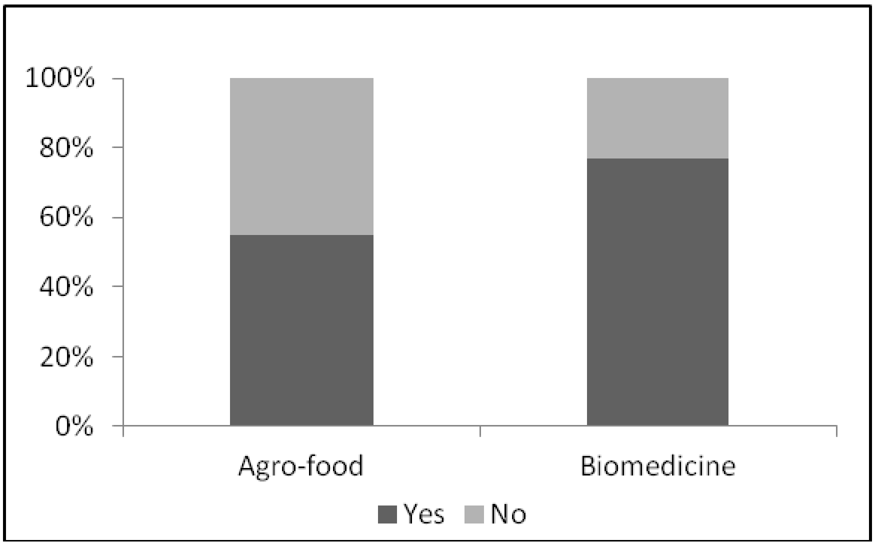
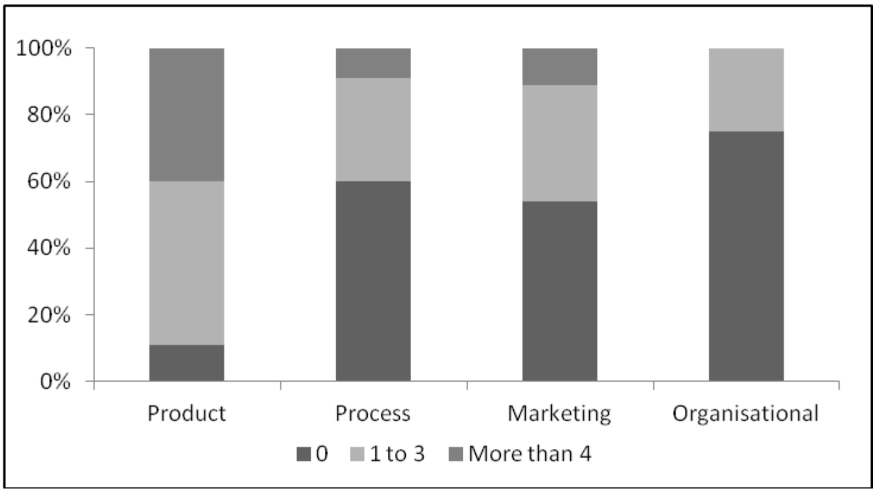


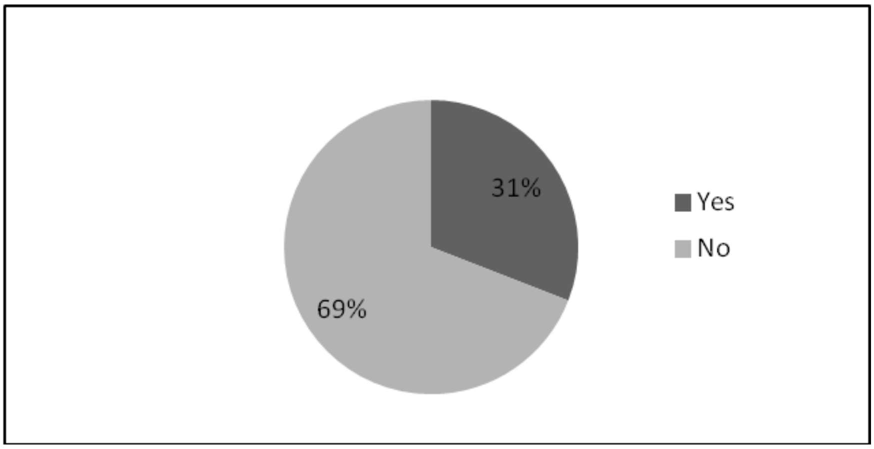
Figure 31 shows the share of companies that have introduced either zero, 1 to 3, or more than 4 innovations for each category of innovation. It reveals that innovation is mainly understood as product innovation. Indeed, about 40% of the companies surveyed have introduced more than four product innovations. However, focus group participants explained that product innovations are not that substantive as firms tend to modify or enhance existing substances rather than create new ones. The survey results suggest that other forms of innovation (i.e. process, marketing and organisational innovations) are much less common.

Figure 31. **Forms of innovation**



The survey results show that scientific and engineering activities are limited (Figure 32), even in large companies. This suggests that innovations are often incremental in nature and in most cases do not require R&D. These results also highlight that business R&D capacities are highly concentrated in a limited number of companies.

Figure 32. **Scientific and research activities (as % of companies that innovate)**



Innovative businesses depend on outside knowledge and collaboration with external partners

In the survey, companies indicated a heavy reliance upon external know-how and knowledge. Indeed, for 94% of innovative companies external know-how is at least as important as internal know-how (Figure 33). The level of dependence on external sources of knowledge seems homogenous across firm sizes (see Annex B). This is surprising as we would expect large firms to be much less reliant upon external actors than small ones. With regard to sectors, while enterprises in both biomedicine and agro-food are very dependent on external know-how, this dependence is somewhat higher in biomedicine (Figure 34).

Figure 33. **Sources of know-how**

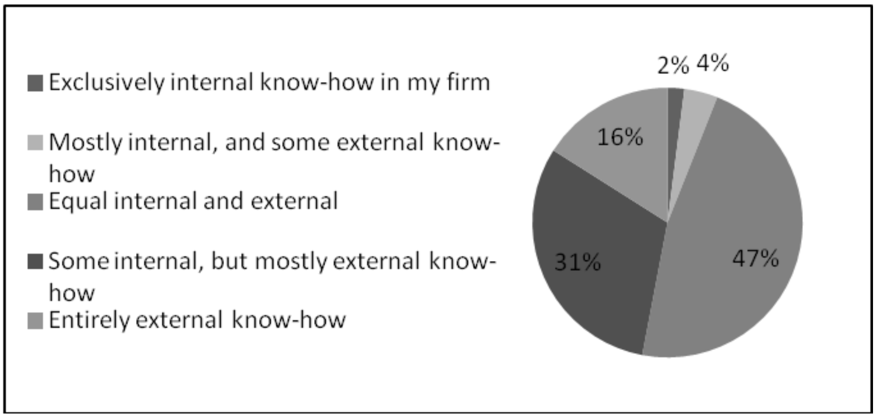
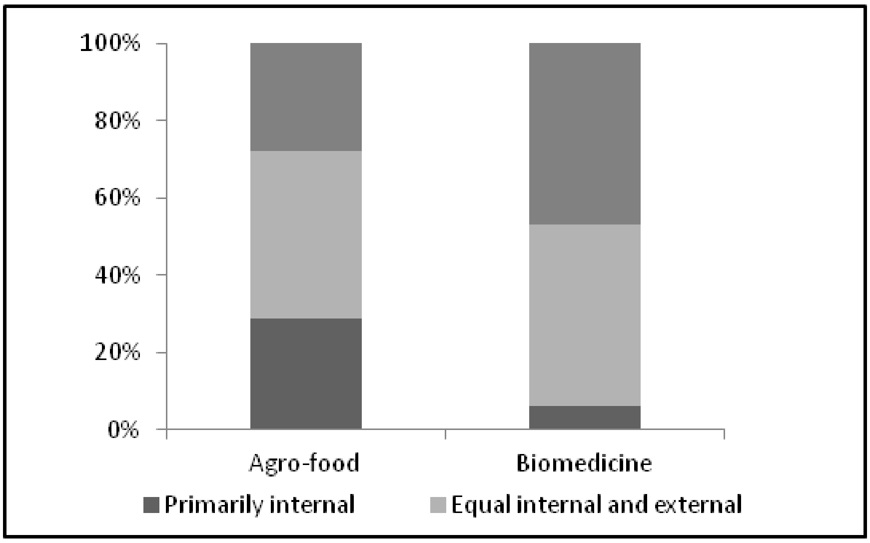
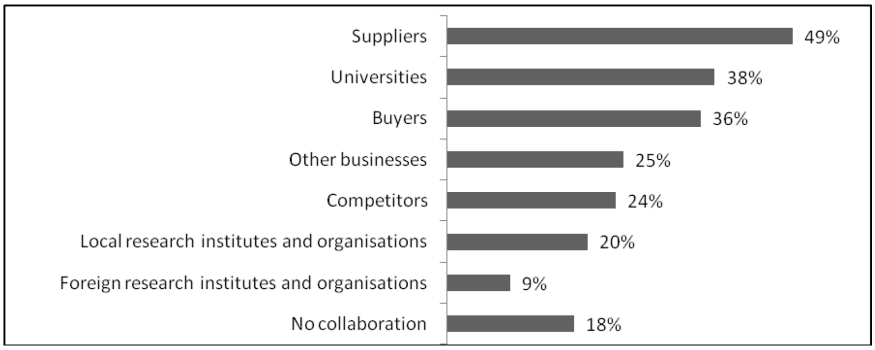


Figure 34. **Main sources of know-how by sector (as a share of innovative companies by sector)**



The survey results reveal that the levels of collaboration with external partners are relatively high (Figure 35). Innovation first requires collaboration along the value chain (buyers and suppliers). The share of innovative companies which reported collaboration with universities is also large (38%). In the focus group, business participants mentioned that they primarily relied on personal connections to engage in cooperation with external partners, which highlights the informal nature of existing collaborative relationships.

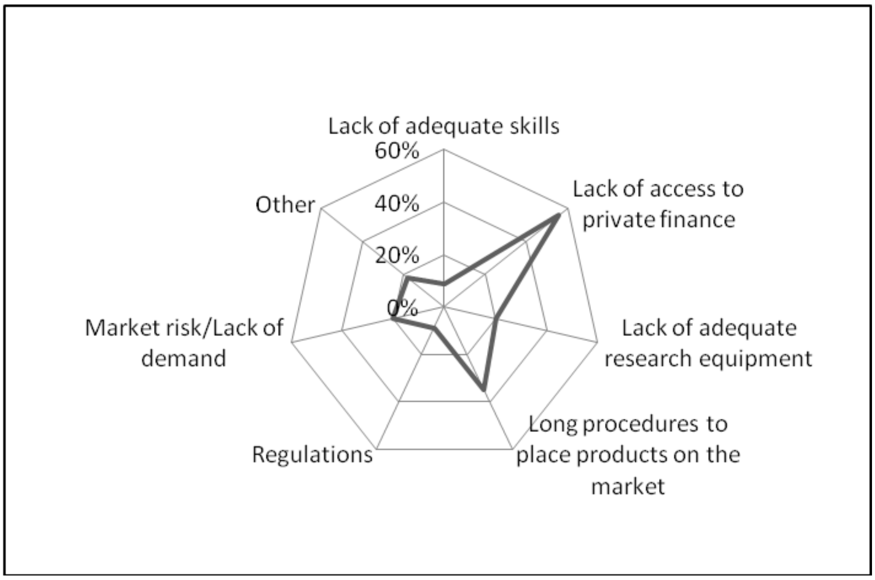
Figure 35. **Collaboration with external partners**



Innovation constrained by limited access to finance and procedures to place products on the market

According to surveyed businesses, the lack of access to private finance and the procedures to place products on the market are the main obstacles to innovation (Figure 36). In the focus group, businesses mentioned that one of the biggest constraints they face is that producers of raw materials (e.g. plants, herbs) in Serbia do not have appropriate certifications. Given that the process of adapting to international certification is new to some Serbian businesses, some (especially small ones) may encounter difficulties in finding accurate sources of information or assistance in meeting certification requirements. Business participants also emphasised that, at the national level, the process to obtain certification can be slow and expensive and that there is a lack of information on the bodies which provide relevant certification and accreditation services outside of Serbia.

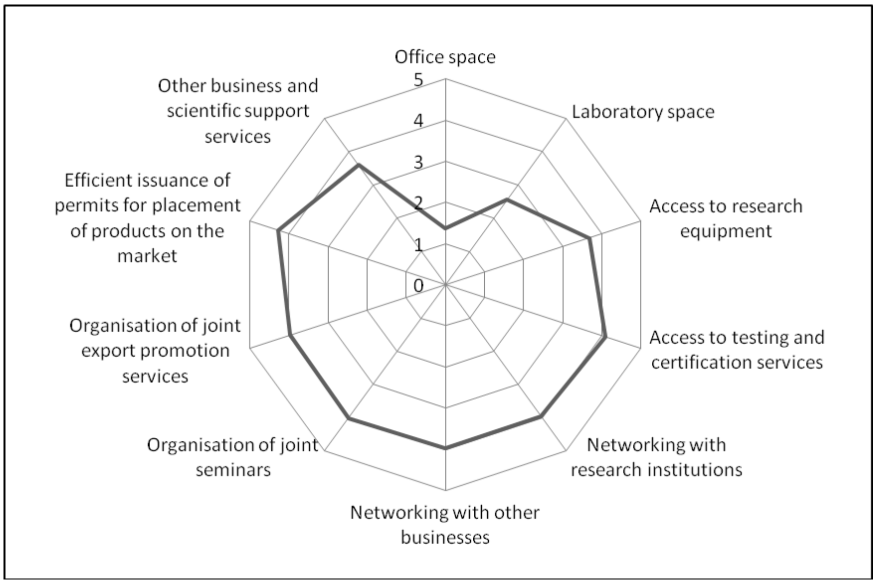
Figure 36. **Main innovation constraints**



Overall, biomedicine businesses have a high interest in centre services

Overall, the interest in services offered by a centre is high – with the exception of office and laboratory space (Figure 37). Access to equipment is also ranked lower than other services. Surveyed companies expressed a high interest in testing and certification services. As mentioned above, obtaining certification is difficult in Serbia: the process is slow and costly and information on foreign certification providers is lacking.

Figure 37. **Average ratings of centre services**



Surveyed businesses were also highly interested in greater networking with research institutions as well as with other businesses. This was confirmed by focus group participants who expressed an interest in a centre which would focus on networking and joint seminars. They agreed that research and industry remain two separate spheres in Serbia and stressed the importance of understanding what academic and research institutions do.

Finally, businesses attributed a very high average rating to the 'efficient issuance of permits for the placement of products on the market'. This highlights the need to further improve the business environment and public service in this area. However, this area is outside the scope of a centre.

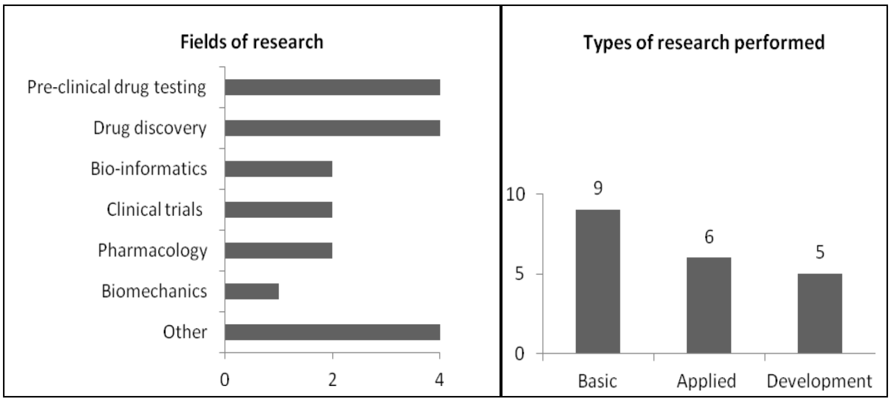
Research institutions' innovation activities and needs

This section assesses the innovation behaviour and needs of research institutions in the biomedicine sector based on a research survey which covered a total of ten research institutions, including seven university faculties/departments and three public research institutes.

Biomedical research is oriented towards basic research and driven by scientific interest

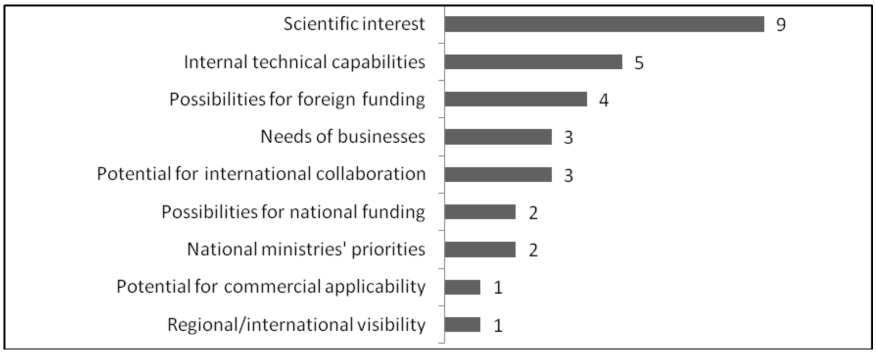
The surveyed research institutions specialise in different fields. The main fields identified were drug discovery and pre-clinical drug testing (Figure 38). Other fields included bio-informatics, clinical trials, pharmacology, biomechanics, molecular biology and biophysical chemistry. More generally, the survey results reveal that the research agenda of Serbian biomedicine research institutions is dominated by basic research. Nine institutions out of ten perform basic research. Applied research is performed in six institutions and development only in five.

Figure 38. **Fields and types of research**



Research is primarily motivated by scientific interest (Figure 39) unlike research in the agro-food sector where policy priorities play a more important role. Other driving factors include internal technical capabilities and the possibilities for foreign funding. By contrast, the needs of businesses and the potential for commercial applicability have a limited influence on the research agenda. This is in line with the basic science-centred mentality and reward system in Serbian research.

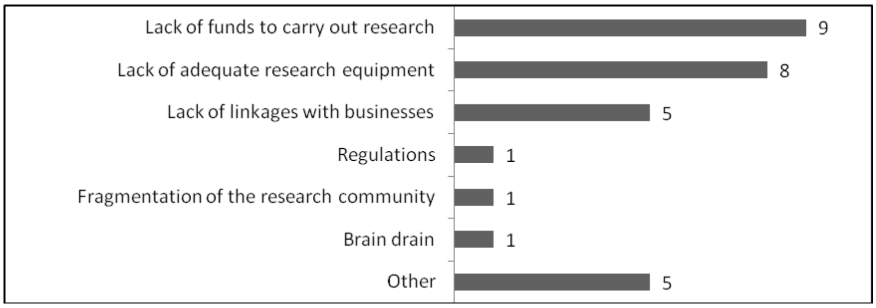
Figure 39. **Main factors determining research priorities**



Significant constraints for researchers are lack of funds, equipment, and linkages with businesses

Respondents to the survey perceived the lack of funds and adequate equipment as major research constraints (Figure 40). In the focus group, however, researchers explained that the survey results may have overestimated the importance of equipment. A third constraint highlighted in the survey was the lack of linkages with businesses. Indeed, half of the research institutions indicated that the lack of linkages with businesses was an obstacle to research. This suggests that for the research community the centre's added value is its ability to establish collaborative relationships between researchers and businesses.

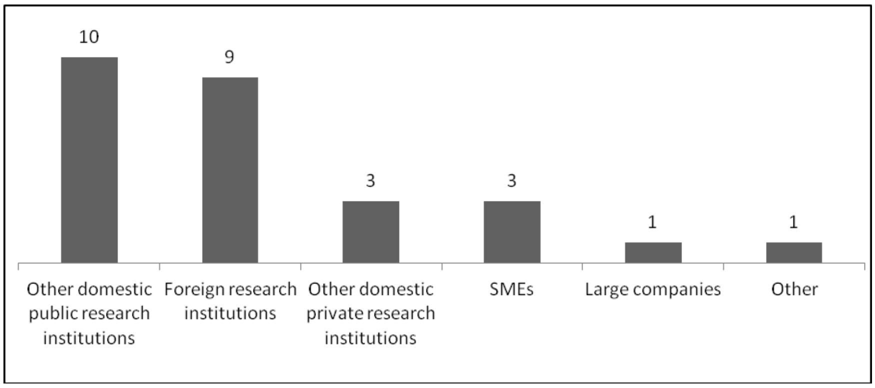
Figure 40. **Main factors constraining research activities**



Researchers collaborate more with other research institutions than with businesses

In the biomedicine sector, collaboration with external partners is clearly oriented towards academic research, both at the national and international levels (Figure 41). All but one institution have collaborated with foreign research institutions. Collaboration with research institutions included basic research, applied research, joint publications, joint conferences and the use of equipment.

Figure 41. **Collaboration with external partners**



Cooperation with companies appears much more marginal. Only three institutions reported collaboration with businesses, primarily in the form of training provision and the examination of new products. Only one joint R&D project was reported in the survey. This shows that even when science institutions engage in collaboration with businesses, technology transfer remains limited.

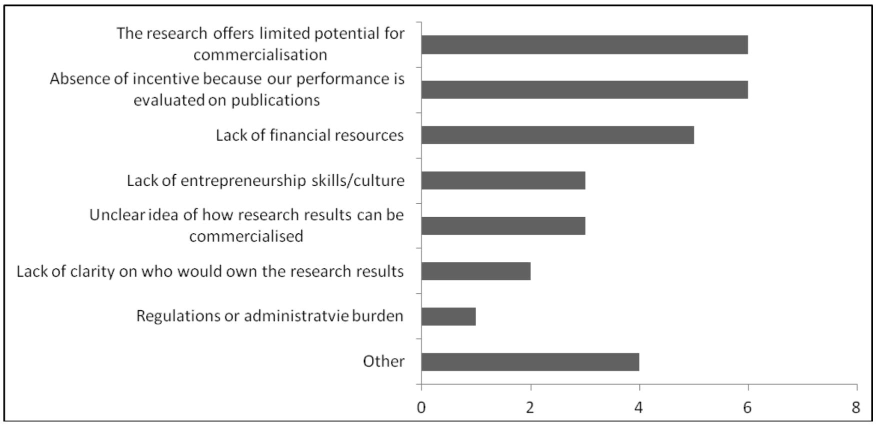
A number of explanations were offered in the focus groups by research institutions for the limited collaboration with businesses: first, academic institutions have an unclear idea of how they can benefit from collaboration with the private sector; second, academic institutions think that the private sector has a limited interest in collaborating with them. This last point was also highlighted in the survey. However, the companies which participated in the focus group expressed their willingness to collaborate with researchers. This may suggest that the problem stems more from a lack of communication and information between science and industry.

More incentives are needed to strengthen existing commercialisation efforts

There have been some efforts by research institutions to commercialise the results of their work. Indeed, eight out of the ten institutions that were surveyed declared that they had already engaged in research commercialisation. Commercialisation has taken different forms including research contracts with companies and patents or licensing agreements. However, none of the institutions reported the creation of spin-offs.

The commercialisation of research is constrained by a number of barriers. According to the survey results, the research often offers limited potential for commercialisation (Figure 42). Another major barrier identified in the survey and the focus group lies in the absence of financial incentives because scientific performance is evaluated on publications. The general mindset in science was also mentioned as a key obstacle: researchers do not think in terms of marketable products. Finally, in the focus group researchers explained that spin-offs are less likely in the biomedicine sector than in (Information and Communication Technology) ICT for example, where innovation projects tend to be shorter.

Figure 42. **Obstacles to research commercialisation**



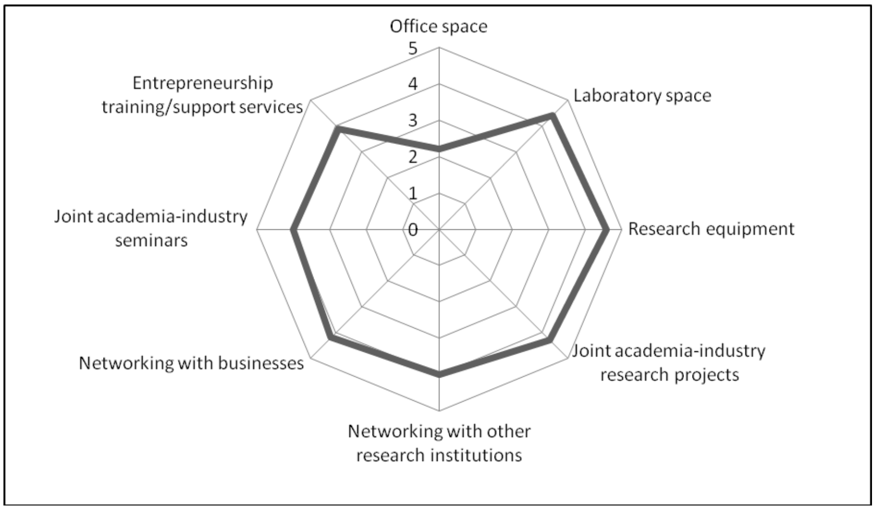
Biomedicine researchers want a centre which provides equipment, stimulates cooperation with industry and offers entrepreneurial support

Surveyed researchers expressed a high interest in laboratory space and research equipment (Figure 43). They differ from businesses which do not view access to laboratory space and research equipment as a priority. However, in the focus group researchers challenged the survey results on the importance of equipment and said that the lack of equipment was not a major issue to them. Indeed, many of them recently received or will receive new equipment as part of a government programme to improve the Serbian research infrastructure whereby approximately EUR 50 million will be invested in research equipment.

Surveyed research institutions also seemed very interested in networking and working jointly with industry. This was confirmed in the focus group: researchers explained that networking, joint seminars and joint projects would be the most important features in a centre. They mentioned that the main objective should be to have a clear meeting point where industry representatives and researchers could meet on a consistent basis to learn about their respective projects. In other words, there seems to be a high interest and demand from science institutions for a centre focusing on networking and collaboration with the private sector.

Finally, surveyed institutions attributed high ratings to entrepreneurship training/support services. Indeed, as mentioned above, a major obstacle to further collaboration with the private sector and the commercialisation of research results lies in the absence of an entrepreneurial culture within Serbian scientific institutions.

Figure 43. **Average ratings of centre services**



Conclusion

The main conclusion of this section is that there is a strong rationale for the establishment of a centre in both sectors. In light of the competitiveness challenges that Serbian companies face, an instrument bridging the science-industry gap, increasing technology transfers and strengthening the technological capabilities of businesses in the form of a centre is needed. Indeed, the survey results in both agro-food and biomedicine show that:

- Enterprises are very much dependent on external know-how from suppliers, other firms, R&D organisations and buyers to innovate. This dependence is somewhat higher in biomedicine than in agro-food sector. These results confirm that innovation is an open process which requires interactions between a diverse set of actors.
- However, linkages between research organisations and businesses need to be enhanced. While there are some interactions between research organisations and businesses, science-industry collaboration remains sporadic and informal. In other words, science and industry continue to largely operate as disconnected spheres.
- On the business side, companies tend to have limited absorptive capacity. Companies reported innovation activities but only few of them indicated R&D activities. This also suggests that innovation tends to be incremental. Given their dependence on external know-how, firms' innovation capabilities could be increased by strengthening their links with external partners.

- There is an important cultural gap, particularly a lack of an entrepreneurship mindset in the science system. The science system remains focused on basic science and there are disincentives to cooperation with the private sector. This limits the translation of research outputs into economic benefits.

The second key conclusion is that in order to generate strong interest and demand, the centre should have a number of features more closely aligned with a technology institute than a competence centre (see section 1). Indeed, in both sectors, at the current levels of science-industry cooperation and absorptive capacities on the business side, problem-solving expertise in the form of short-term consultancies and small projects should be preferred. This is confirmed in both sectors:

- The results of the agro-food survey point to the needs for support services which include technological development services as well as networking services. The survey results point to a need for near-market innovation services rather than R&D-intensive support. Indeed, the pool of R&D performing companies is small, and for innovative companies, innovation is largely market-driven.
- In the biomedicine sector, interest in a similar type of centre was expressed. The only difference was the greater support for joint projects. This is in line with the higher R&D intensity and more upstream orientation of the biomedicine sector in comparison with agro-food.

Table 7. **Summary table: Interest in a centre**

	Agro-Food	**Bio-medicine**
Businesses	Networking/Knowledge sharing Problem-solving research services Access to equipment	Networking/Knowledge sharing Joint research projects Problem-solving research services
Research institutions	Access to equipment Networking and working jointly with industry Entrepreneurship support	Access to equipment Networking and working jointly with industry Entrepreneurship support

As the case for a centre can be made in both the biomedicine and agro-food sectors, the issue becomes identifying the sector where such a centre is feasible. The feasibility of the centre is assessed in the following chapter and is based on two considerations: i) the degree to which key success factors are satisfied; and ii) the presence of risks affecting the centre’s operations. The chapter concludes with a recommendation on which sector best meets the key success factors and minimizes risks.

Chapter 4

Assessment of the feasibility of a competence centre

The preceding chapter found that a case exists for the establishment of a centre in either agro-food or biomedicine. Firms and researchers in both sectors would benefit from tighter co-operation, greater knowledge transfers and mechanisms to support technological absorption. The chapter concluded by arguing in favour of centre that more closely mirrors a technology institute than a competence centre and focuses on providing networking services, problem-solving expertise, and opportunities for joint research.

This chapter examines whether such a centre is feasible. In this regard two considerations will be explored: i) the degree to which the key success factors for the establishment of a centre are satisfied; and ii) the presence of risks to the centre's operations. The chapter concludes with a recommendation on which sector best meets the key success factors and minimises risks.

Key success factors for the establishment of a centre

This section reviews the key factors as identified in best practice reports and evaluations in OECD countries which could affect the operation of a centre in Serbia.

Critical mass of industrial and research capabilities

Best practice shows that centres should not be created ab initio but built on pre-existing resources and capabilities. To be specific, centres should look to support existing research groups, a significant pool of PhD students, and technology-active businesses, for instance. In Norway, the competence centre programme explicitly selects industrial fields in which research is already on the cutting-edge. Conversely, the selected sectors do not need to be high-tech or on the 'research frontier'. In Estonia, one of the most successful competence centres has been the Bio Competence Centre on Dairy Products, which builds on university and industry strengths in a field where Estonia was already recognised as a strong producer (Arnold et al., 2008). In other words, the more successful centres have been in areas which combine both industry and science strengths.

Identifying a sector in which the country has recognised scientific capability is essential to assure quality research and services. It also provides higher external visibility for the centre. A pool of technology-active businesses in the sector is another pre-requisite for the success of a centre. Indeed, the technology gap between businesses and researchers should not be too wide for companies to be able to successfully exploit the work of the centre. There should be enough technology-active companies to generate a minimum level of demand for the centre's research work and services (Arnold et al., 2008). More generally, identifying a sector in which there are simultaneously recognised research capabilities and a sufficient pool of technology-active firms raises the likelihood that there are enough partners on both sides who can co-operate in a productive way.

Table 8. **Critical mass in science and industry**

Regional-leading capability in research	**Sufficient pool of technology-active businesses**
Quality	Demand for services and technology
Visibility	Ability to successfully exploit technology

In Serbia, both sectors have a critical mass of researchers. As noted in the Strategy for Science and Technological Development for 2010-2015, in the biomedicine sector approximately 1500 researchers from 22 institutions participate in over 167 national projects. In agro-food, over 1300 researchers from over 20 institutions (faculties and research institutions) participate in 117 domestic projects. Serbian researchers from these two fields enjoy visibility at the national, regional and often international levels, as evidenced in the research surveys by collaboration with foreign research institutions.

As noted in section four, agriculture and food processing comprise about 20% of GDP and 26% of total exports. Although biomedicine per se is not an economic sector tracked by the office of statistics, data on the pharmaceutical sector shows that it contributes just over 3% of GDP and over 50% of total chemical production. A closer analysis of the heterogeneous composition of the biomedicine sector itself (e.g., pharmaceuticals, herbal and natural remedies, and medical devices) would lead to a clearer picture of the demand for the centre's services. This could be obtained by looking at various indicators such as exports, sales, and turnover of firms in this sector.

The agri-food and biomedicine businesses who participated in focus group meetings organised for this project expressed demand for technological services and enhanced cooperation with research institutions; confirming results from earlier surveys. However, technological activities and R&D remain concentrated in a few, large companies in both sectors. Therefore, the objective of the centre should not only be to service technology-active firms but to help the larger pool of non-technology-active companies to move into more innovative activities. This supports the notion that the centre should more closely resemble a technology institute than a highly R&D-intensive competence centre, at least in the initial development stages.

Consensus on the centre's objectives

Experience has shown that businesses and researchers tend to have different interests and time horizons with regard to the goals and operation of a centre. These diverging interests may lead to discrepancies in the design of programmes of work. On one hand, disproportionate industrial control may limit the research horizon of centres to the short-term, leading businesses to effectively use the high level of subsidy as economic rent (Arnold et al., 2004b). A strictly industry-relevant work programme also carries the risk that the best researchers will not want to get involved in its activities. Conversely, if academics dominate, the centre's focus might move towards more basic research, causing companies to lose interest. A consensus between the different stakeholders about the centre's objectives should be sought before the implementation phase starts.

Agreement and balance between academic and industrial interests is possible, and has been achieved in different ways. In Austria, the Kplus programme was designed with the help of the private sector. The programme was presented to an assembly of 70 people from industry prior to its adoption. Similarly, in Estonia, preliminary consultation with the private sector was established in the feasibility study phase. In most countries, researchers were also consulted early on to take their interests into account and build trust with the scientific community.

In Serbia, while there is general agreement in the agro-food sector on the necessity of an institution like a centre, there is an open question as to which sub-sector it should target. This is not surprising given the diversity of the agro-food industry. Two options which were discussed in a focus group format included having a centre support the dairy sub-sector or the fruit and vegetable processing sub-sector. The conclusion was that either sub-sector would be a good starting point. There are differing views, however, among science and industry representatives as to whether the centre should be an independent entity separate from existing research institutions with its own professional staff and management (i.e., the industry perspective) or remain attached to an existing institution (i.e., the science and academia perspective).

In the biomedicine sector, industry representatives and researchers agreed on the importance of having a centre focus on activities like joint seminars and networking events between science and industry. Both sides agree on the organisational structure and management of the centre as being autonomous from existing institutions. Science and industry representatives also shared the opinion that the centre should be developed in two phases: the first one involving a few people working on seminars, networking events, database development, including training, while the second phase would concentrate more on joint industry-research projects.

Coherence with the national innovation system

A centre should be closely aligned with national strategic priorities and clearly embedded in the national innovation system. For instance, the Kplus programme in Austria and the LTIs in the Netherlands were incorporated in wider government public-private partnership approaches, which reflected a consensus between public and private actors on ways to reach common strategic objectives. By contrast, there have been some inconsistencies between the Canadian Networks of Centres of Excellence programme's rationale and the country's overall S&T Strategy, limiting the potential opportunities and outputs of the programme (Bertrand et al., 2009).

In Serbia, the establishment of a centre is consistent with the National Strategy for Scientific and Technological Development's emphasis on innovation and increased partnerships between science and industry. The project's focus on innovative firms is also in line with government priorities to support the development of competitive SMEs. Both agro-food and biomedicine have been identified as priority areas by the government in the National Strategy for Science and Technological Development.

Potential risks affecting the centre

This section explores the risks that might affect the operation of a centre in Serbia.

A lack of SME participation

One of the risks for the centre is insufficient SME participation. The recognition of SMEs and their links to innovation has increased. Rising incomes, more 'niche' market demand and changing technologies have reduced the structural disadvantages of small firm size stemming from their more limited economies of scale. However, SMEs still face higher constraints than large firms in terms of access to finance, skills, absorptive capacities and linkages with external knowledge networks (OECD, 2010a).

In addition to small firms, the promotion of new firms – particularly spin-offs – is crucial for innovation. New spin-off ventures play a significant role in enabling the commercialisation of knowledge that would otherwise remain un-commercialised in large firms, universities and research organisations (OECD, 2010a). Newly created firms can be very inventive, and they account for a large share of patenting in OECD countries.

Given their importance in innovation processes, SMEs and new firms should be specifically included in the centre's programme of work. In practice, targeting SMEs through a competence centre or a technology institute usually implies a public subsidy. Indeed, few SMEs can afford to buy a technology centre's services at market cost. SMEs' access to a centre's services can also be facilitated through a voucher scheme, as is the case in Denmark. A voucher scheme might be particularly helpful to target SMEs that have no or very limited experience in engaging in innovation. Finally, membership fees or fees for specific events hosted by the centre could be reduced for SMEs. For example, annual membership fees at the East Bavarian Technology Transfer Institute are proportionate to the size of the enterprise.

Inadequate funding

Best practices indicate that sources of funding should be secured before the implementation phase. Public funding is typically needed for at least a few years to help the centre develop a good reputation, build trust among participants, and eventually start earning revenues from its services thus becoming less reliant upon state or European support (Arnold et al., 2008).

In Serbia, the lack of public funding was perceived as the biggest risk to the establishment of a centre by business survey respondents in agro-food and biomedicine. While the government seems prepared to support innovation activities through the establishment of competence centres (MSTD, 2010), the amount and duration of public financing is not clearly specified. The total estimated operational costs for a biomedicine centre over a five year period is 725 000 EUR (see chapter five for further details).

In addition to government funding, Serbia could promote the centre to international donors as a means of finding additional resources to cover its operating costs. EU resources – particularly national instrument for pre-accession (IPA) funds – could be used as a means to provide capacity building support for staff of the centre, but not necessarily to fund operating expenditures. The possibility of using resources from the Serbian R&D infrastructure investment initiative to support the operational costs should be explored.

Finally, as is the case in many similar programmes in OECD countries, contributions from the private sector and research institutions should be envisaged. In fact, companies, particularly larger ones, seem open to the notion of co-financing the centre's activities when surveyed. Science and industry participants could provide resources as 'in kind' contributions including conference rooms, laboratory equipment, other materials and human resources. User fees could be charged for seminars and other forms of networking or technology demonstration events.

Unqualified human resources in research and management

The availability of highly-qualified research and management staff is crucial to the success of the centre. The staff should have the right qualifications and be motivated to work for the centre. At Bioneer (Denmark), research staff are motivated by the opportunity to help businesses solve short-term or longer-term problems and the opportunity to participate in long term innovation projects (e.g., 3 to 5 years in duration) funded by FP7 or Danish funds. Approximately 50% of Bioneer staff time is spent on R&D. Staff are also encouraged to publish as much as possible which is a way of attracting business interest in services. In both agro-food and biomedicine, these conditions are largely satisfied. PhD candidates in both sectors are highly qualified – the lack of skills was not reported as a constraint by research institutions. The centre should have a small core of staff of 6 individuals who are fully employed. The centre should offer part-time opportunities for PhD and master level candidates. There appear to be no regulatory obstacles to PhD or master-level students working part-time for a centre, and research institutions view the exchange of students as a valuable opportunity for them to acquire industry-relevant expertise. Encouraging PhD students to work part-time at the centre could be the basis for developing an industrial PhD programme in Serbia.

One obstacle to researchers' participation in a centre is the current incentive structure whereby research performance is evaluated and then awarded based on publications. As a consequence, researchers have few incentives to engage in collaboration with the private sector and other technology transfer activities (see Section 2 and 3). Encouraging researchers' participation in a centre would require either new incentives or a re-design of existing ones.

The availability of highly-qualified management personnel is another important resource for the establishment of a centre. The companies surveyed in both agro-food and biomedicine viewed poor management as one of the most serious risks to its establishment. The lack of qualified management, especially with the experience, knowledge and skills to build consensus between business and research partners has been an issue in many competence centre programmes in OECD countries. In Serbia, given that science-industry projects are limited, it is likely that few people have experience in managing such projects. Therefore, strengthening management capacities should be made a priority before the centre begins its operations. The types of management capabilities that need support are related to: R&D management, project management, as well as the management of research commercialisation. The executive director of the Serbian centre should have the opportunity to be trained or 'intern' with a competence centre or technology centre in an OECD country in order raise his/her management capabilities and skills.

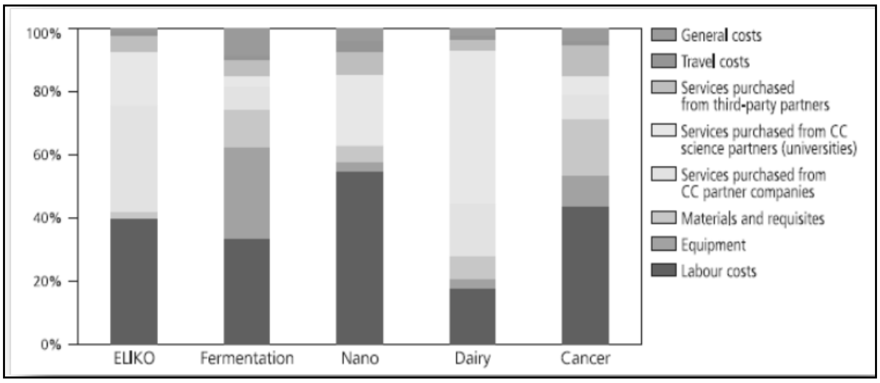
Poor location and an over-emphasis on infrastructure and equipment

The physical space hosting the centre should be located near a "knowledge hub" – i.e. an area with high concentration of research institutions and businesses. The competence centres and technology institutes reviewed for this study are typically located near the companies, universities, and research institutes they serve. This reduces travel costs for potential clients of the centre. Locating the centre near a "knowledge hub" would facilitate access to equipment in nearby university departments or R&D institutes, making it easier for researchers to travel to the centre, thus increasing its visibility and enabling it to benefit from knowledge spillovers from the research and innovation activities being performed in proximity to its location. One illustration of this is Bioneer A/S, a Danish technology institute focussed on biotechnology and biomedicine. Bioneer is a subsidiary of the Technical University of Denmark and is approved by the Danish Ministry of Science and Technology as an authorised provider of technological services - a GTS entity (see box 2). Bioneer itself is located in a knowledge hub, more specifically the DTU Science Park in Copenhagen. Although some locations have been discussed by

Serbian government officials, a decision on where to locate the centre has yet to be taken.

Using existing infrastructure and equipment is a common practice in successful competence centre programmes in OECD countries. It allows the centre to channel most of its programme funds into activities linking industry with research such as workshops or joint R&D projects. In Austria, for instance, the emphasis has been placed on renting existing buildings and using existing equipment. In Estonia, equipment costs have also generally been limited relative to other expenditures (see Figure 44). Using existing equipment also limits the risk of purchasing equipment that might already exist in another institute or public body. However, the centre's equipment should be open to third parties and not just those partners who sit on the board of directors.

Figure 44. **Cost distribution in Estonian competence centres**



Source: Arnold et al. (2008)

Surveys of businesses point to a fear that some partners might push for infrastructure and equipment support through the centre. However, a centre providing solely infrastructure and equipment would not meet significant demand from businesses. The agro-food business survey results show that a lack of equipment constitutes a minor barrier to business innovation, particularly for SMEs.

In the biomedicine sector, the lack of adequate infrastructure and equipment also appeared as a secondary obstacle to business innovation. Even for research institutions, the lack of adequate equipment appears over-estimated in the researcher survey. When asked about infrastructure and equipment needs in focus group settings, participating researchers noted that they received or were about to receive new equipment as a result of investments made by the MES.

These results confirm that the centre's approach should be to encourage sharing of existing facilities and equipment. Once the centre demonstrates its sustainability by meeting the demands of both industry and research communities, could there be attention given to acquiring or refurbishing specific equipment as part of the centre. An alternative approach could involve the centre having some of its own in-house equipment from the outset with agreements to share equipment found in partner organisations.

Duplication of existing support instruments and institutions

A concern raised in the agro-food sector focus groups was the potential overlap with existing or future institutions and innovation support programmes. It was pointed out that the proposed models had features similar to the scientific-technological park (CTTI) Radmilovac being developed with the Agricultural Faculty in Belgrade[10]. The plans for Radmilovac CTTI include a technology transfer centre providing services to new or existing businesses (e.g., enterprise incubation, legal services, market analysis, management, branding, technology transfer, pilot production, chemical and microbiological analysis, quality and safety certification) and a business incubator to support the development of early phase technological ideas. However, it is unclear to what extent the business community will be involved in the management and operation of Radmilovac CTTI.

An additional institute which an agro-food centre might duplicate or overlap with is the Food Institute of Novi Sad (FINS). FINS is an important institution in food and feed research and development in Serbia and the Western Balkan region. FINS laboratories conduct analysis of food and feed using sensory, physical and rheological, chemical, microanalytical and microbiological methods. FINS has sophisticated laboratory equipment and makes it of the best equipped laboratories in the region. FINS also has experience in providing different services to the food and feed industry in the region, including development of products and processes, staff training, consultation and support. There are several pilot plants at FINS for development of new technologies and products, testing of raw materials, training and demonstration. However, FINS might have a visibility issue as several large agro-food businesses in Serbia who participated in focus groups indicated that they were unfamiliar with FINS.

Agro-food focus group participants suggested the risk of overlapping with certification bodies. Focus group participants argued that the centre should not provide certification as other bodies have already been set up to offer such services (i.e. national laboratories, a programme conducted under the authority of the Ministry of Agriculture).

In a similar focus group setting for the biomedicine sector, both researchers and industry representatives indicated that centre-like institutions or services did not exist in Serbia. The only public research institution which has some experience in successfully generating commercial activity is the Institute for the Application of

[10] The centre is still in its conception phase. Some buildings are already in place.

Nuclear Energy (INEP). It has developed medical diagnostic devices which have been introduced to the market.

Poor visibility

In the various focus groups industry participants warned that the lack of visibility could be a risk and emphasised the need to actively promote the centre. In fact, some of them explained that they were not always aware of the existence and capabilities of local research institutions in Serbia.

Promotion is essential to generate demand from companies, particularly from SMEs which may not be involved in innovation activities. For instance in Denmark, most non-users feel that GTS institutes have little to offer them (Andersen et al., 2009). This indicates that there is a need for more active marketing and an enhanced interface connecting potential beneficiaries with institutes. By contrast, the Fraunhofer institutes have successfully advertised the Fraunhofer 'brand' and increased the network's national and international visibility (Hauser, 2010).

A centre can be promoted through different channels including local and national press, regional and national development agencies, universities, and a specifically-dedicated website which provides general programme information, details on services provided and costs. Examples of successful service provisions or research projects may be posted on the website. This would allow SMEs to get a better idea of how they could benefit from research services. If additional centres are set up in the future, a successful strategy could include common branding for all centres, as was done with the Fraunhofer brand in Germany.

Complementary measures

In addition to a direct innovation support instrument such as a centre, complementary measures which tackle the structural barriers to innovation and the commercialisation of research are needed. Serbia should focus on improving the framework conditions for innovation, including: access to finance and human capital development.

Access to finance

Access to finance is a key constraint for business-led innovation which is inherently risky and may require a long-term horizon. Financial constraints are especially high for small firms and new entrants. The survey results for agro-food and biomedicine confirm that the lack of access to finance is particularly acute for small firms. However, an additional issue could also be the lack of bankable projects. For new entrants, access to finance is constrained by their limited operating history and the difficulty to value their assets.

Policy makers can take steps to ease new and small firms' access to both debt finance (prevalent source of external funding for all enterprises) and equity finance. Enhancing access to finance may involve risk-sharing schemes with the private sector. Other steps could include the securitisation of innovation-related assets (e.g. intellectual property).[11] The establishment of the Serbian Innovation Fund and its efforts to invest in innovative activities is an encouraging sign.

Seed capital and start-up funding by individual investors/business angels, play a key role in enabling entrepreneurial individuals to turn new ideas into new products. Access to these sources of funding can provide more than just financial resources, such as giving advice and on-the-ground management expertise.

In Serbia, the government plays an active role in stimulating SMEs' market development via credit and guarantee facilities. A first Business Angel network was created at the end of 2009. At the regional level financing is available through the Western Balkan Enterprise Development and Innovation Facility (EDIF). EDIF is a EUR 141 million regional facility financed through the Western Balkan Investment Framework where beneficiaries and the international financial institutions will provide a range of risk-financing instruments essential to the development of high-tech companies. EDIF will also aim to support the venture capital market in the region.

Although progress has been achieved, further efforts are needed including improving the design and impact of credit guarantee schemes (EC, 2011), putting in place adequate legislation for venture capital/private equity investment funds, and increasing financial literacy through improved financial education programmes.

Human capital development

Innovation depends on people who are able to generate and apply knowledge and ideas in the workplace and in society at large. From the survey results, Serbia suffers from a horizontal – rather than a vertical – skills mismatch (see Table 8). A lack of adequate skills was not reported as a major barrier to innovation. It is the lack of incentives to engage in knowledge exchange activities coupled with perceptions of scientific research as an activity which should be divorced from commercialisation. Furthermore, technological problems that industry is facing are not seen as being scientific enough. This ignores that contemporary science is very much issue-driven and that often frontier R&D cannot be separated from its application. A system for promotion and evaluation of researchers should recognise not only scientific excellence through publications but also knowledge transfer activities like co-operation with industry.

[11] The World Intellectual Property Organisations (WIPO) notes that lending partly or wholly against intellectual property (IP) assets is a recent phenomenon even in developed countries and especially in the music business, Internet-based SMEs and in high technology sectors. Thus securitization is possible for future royalty payments from licensing a patent, trademark or trade secret, or from musical compositions or recording rights of a musician (www.wipo.int/sme/en/ip_business/finance/securitization.htm).

Table 9. **Vertical vs. Horizontal Skills Mismatches**

Vertical skills mismatch	**Horizontal skills mismatch**
The level of education or skills is less or more than the required level of education or skills	The level of education matches job requirements but the type of education or skills is inappropriate for the current job
Issue: **LEVEL of skills**	Issue: **TYPE of skills**

Source: OECD Skills Strategy

Therefore, more should be done to promote an entrepreneurial culture in secondary and tertiary-level education systems through:

- Labour mobility schemes and a greater emphasis on internship programmes to narrow the cultural divide which persists between academia and industry. They would also be particularly useful to increase the commercialisation of academic research results.
- Developing an industrial PhD programme whereby PhD students spend half their time at a university and half their time in a company. The focus of PhD research is on solving industrial problems as opposed to conducting basic research.
- Increasing the presence of the private sector in the management and direction of higher education institutions and research institutes
- Continued efforts to support university spin-offs with initiatives for proof-of-concept (i.e. testing the technical and commercial viability of early-stage innovation ideas), pre-competitive research and seed funding (OECD, 2010a)
- Evaluating the incentive structure for researchers. If the policy goal is to orient more scientific activity toward the market and commercial application, the existing system of incentives and rewards should be evaluated to see whether they can meet new policy objectives. It should also examine whether new criteria to evaluate scientific performance could be integrated with current ones to take into account and reward collaboration with the private sector.

Another issue with human capital is the ageing population in science and academia in Serbia. To entice young people into science and research, a priority should be to make science studies and careers more attractive. A centre might be a way to increase the attractiveness of science by strengthening links with businesses.

Recommendation

On the basis of input received from stakeholder surveys, focus group meetings and discussions with international and local experts, this study finds that a pilot centre shoud be initiated to support the biomedicine sector provided some near-term risks are addressed. A centre in the biomedicine sector meets three key success factors identified in this chapter. First, there is a critical mass of firms and researchers in this sector. For example, there are many SMEs in pharmaceutical development, natural herbal remedy production and medical/therapeutic device development that have the capacity to innovate. Serbia also has a solid biomedicine research base with strong public R&D institutes and university faculties. Clinical medicine, for instance, is among the top four sources of scientific publications in Serbia. Second, representatives of firms and researchers in the biomedicine sector who participated in OECD organised focus groups agreed on the centre's objectives and functions. They shared the view that the centre could have some links to existing institutions, but that its governance and organisation framework should be autonomous. Third, the centre's establishment is in alignment with national strategic priorities. In this regard, both agro-food and biomedicine are identified as priority areas by the National Strategy for Scientific and Technological Development.

While the handbook finds that businesses and researchers in agro-food would benefit from initiatives to facilitate greater collaboration, it does not recommend the establishment of a new centre in this sector. The biggest risk of proceeding with a centre in the agro-food sector is that it could duplicate services offered by existing institutions such as FINS and NS SEME. An alternative option in the case of agro-food is reforming existing institutions to include greater private sector involvement in management structures and defining programmes of work. This would help strengthen knowledge exchange and technology transfer activities. A second option worth considering would be developing knowledge exchange services such as the Knowledge Transfer Partnerships (KTP) in the UK (see box 5).

Box 11. **Knowledge Transfer Partnerships (KTPs) in the UK**

Knowledge Transfer Partnerships (KTP) at Newcastle University function in such a way whereby a high performing graduate (called an "Associate") is placed within a firm full time, but they retain all the support and resources of Newcastle University. An academic lead from Newcastle University works with the Associate on projects for half-a-day a week, providing strategic direction (in the same way that they would with a PhD student), and liaising with the firm to ensure that new knowledge is being embedded into the organisation. KTPs last between 1 and 3 years but a shorter KTP is available for 10 - 40 weeks. The government covers 50% to 67% of the costs for the KTP, while the rest is expected to be co-financed by the business. The reported benefits of KTPs include: an increase of over £220,000 in annual profits before tax; the creation of three genuine new jobs per KTP; and, an increase in skills of existing staff in the participating firm.

In Serbia, calls for knowledge exchange services similar to the KTP could be introduced by the MES or Ministry of Agriculture focussing on thematic areas in the agro-food sector such as: UHT sterilisation services; new methods for freezing and extrusion; improving food safety; reducing allergens; or raising nutritional value. This type of measure could be an effective action to facilitate greater science and technology services to SMEs in the agro-food sector.

Source: Newcastle University, Services for business (www.ncl.ac.uk/business/knowledge/ktp/index.htm)

This chapter also finds that the biomedicine sector faces risks that could undermine the centre's implementation. There are four immediate risks which should be addressed prior to proceeding with the implementation of the centre. First, demand side considerations should be clarified in order to avoid a lack of SME participation. For biomedicine in particular, understanding the market for a centre's services could be obtained by looking at various indicators such as exports, sales and turnover of firms. Data exists for pharmaceutical companies, but less so for businesses involved in herbal remedies, natural products, and medical devices. In addition, national patent applications by non-residents could also serve as a proxy for this sector's growth potential. The danger is that not enough SMEs participate in the centre's programme of work and, therefore, undermine its sustainability. In Serbia most of the target beneficiaries are SMEs, so their participation could be supported through user fees proportionate to their size or voucher programmes. Second, the issue of financing to cover the operating costs over a five year period is unresolved. Although the centre has been identified as part of the government's National Strategy for Scientific and Technological Development, funds have not yet been specifically allocated for the centre itself. Third, the availability of experienced management staff, which have both industry and research experience, is an issue. As there are few science-industry projects in Serbia, it is likely that individuals with the skills to lead a technology centre are limited. In this case, strengthening the management capacity before the centre begins operation will be important and could be accomplished through study visits to other successful centres in OECD countries. This type of human capital support could be financed through international donor resources. Fourth, the location of the centre has not been decided. Best practice examples indicate that it should be near a 'knowledge hub'. The main centres of research and business activity in the biomedicine sector in Serbia are in large urban areas.

Poor visibility could also affect the centre's performance if it services are not promoted by all stakeholders in government, the research community and industry. This point was emphasised in focus groups and is cited as one of the weaknesses of many public R&D institutions. Lastly, the centre's management and governance bodies will need to be vigilant that the centre does not duplicate services offered by other institutions in Serbia. This is the lowest risk since there are no existing institutions in Serbia which offer similar services to businesses and researchers in the biomedicine sector.

The centre should also be seen in a wider policy context. The government will need to work on other interventions to support the innovation system, which will in turn feedback and help the centre meet its objectives. One of the constraints holding back innovative enterprise development is the lack of means to finance entrepreneurs. Initiatives such as the establishment of a Serbian Innovation Fund are a welcome start. The ability of firms or R&D institutes to support spin-offs will require accessible sources of financing. These spin-offs are the types of firms which would gravitate around a centre and its services. The second point is the broader system of incentives which could motivate individuals, especially those in the research community, to explore the commercial applicability of their research. In this respect a review and evaluation of existing incentive structures could be done to see to what degree they encourage greater collaboration with the private sector.

Chapter 5

Design and implementation plan for the centre

This chapter gives recommendations on how a centre might be designed and implemented in Serbia. It provides guidance on functions and activities, organisation and governance, staffing, and resources. This section concludes with an action plan for implementation. The action plan is outlined in two parts: a pre-implementation and implementation phase. The pre-implementation phase identifies what key decisions must be taken before the centre is launched (i.e., location, governance structure, organisation and financing). It also outlines steps to designate a board of directors, hire the executive director and staff, and develop the budget and programme of work. The implementation phase outlines when the centre should be launched, its mid-term review, renewal of programme of work and board of directors, hiring of additional staff, and full review and evaluation.

Logical framework for the establishment of a centre

The establishment of a centre in Serbia should be based on a logical framework which addresses the following: sector focus, identification of stakeholders, expected outputs, outcomes and impacts. The table below presents the logical framework for the centre.

Table 10. **Logical framework for the establishment of a centre**

Project rationale	Low level of academia-business collaboration Limited commercialisation of research results Limited R&D activity in the business sector Limited human capital mobility between academia and industry
Sector focus	Biomedicine

Table 10. **Logical framework for the establishment of a centre** *(cont.)*

Main project stakeholders	Government; Ministry of Education and Science (Leader), Ministry of Finance and Economy; SIEPA Private enterprises Research institutes Higher Education Institutions
Expected outputs	Creation of a network of businesses and research institutions which form the core of the centre supported by a small implementation unit.
Expected outcomes	Increased private sector competitiveness Accelerating application and commercialisation of new knowledge Higher employment growth through spin-off creation Stronger export growth Increased business demand for R&D
Expected impact	Increased level of technology input in production

Design of the centre

The design of a centre in Serbia includes the key functions and activities, sector focus, organisation and governance, management, staffing and resources.

Key functions and activities

1) Seminars/Networking events

One of the central functions of the centre should be facilitating greater interaction between businesses and researchers through networking events with the aim of building social capital among the participants and facilitating transfer of knowledge. These networking events can take the form of seminars and conferences to:

- Identification of common issues and topics of interest to both industry and researchers
- Disseminate knowledge on current market trends
- Demonstrate new technologies and innovations

- Connect potential buyers and suppliers

Seminars should focus on issues where companies do not feel they would be giving up proprietary information on new products they are developing. In this respect topics could be broad and seminars could be developed on:

- Technology trends
- Consumer preferences in the Serbian and EU markets
- New production methods
- Marketing strategies
- Promotional events such as fairs or exhibitions
- Management and organisational strategies
- Investment readiness: coaching would-be entrepreneurs in the elaboration of business plans, and their presentation to investors

Specific examples of potential seminars were suggested by members of the Herbal Pharma Net cluster, a newly emerging cluster comprising Serbian producers of herbal materials, herbal preparations (extracts) and finished products (pharmaceuticals, dietary supplements, cosmetics). Examples of seminars or events which the Herbal Pharma Net cluster suggested include the following:

- Visits of international experts and consultants from different fields (e.g., growing and harvesting herbs, production of extracts, production of finished products, etc.) to outline best industry practices.
- Audits of companies to improve production and achieving specific certification standards, such as Good Management Practices (GMP).
- Trainings and seminars in the area of EU regulatory requirements of herbal products (e.g., nutritional supplements, herbal medicines).
- Training in GMPs or other GxPs relevant for biomedicine companies.
- Training in project management skills.
- Visits of external experts to evaluate the present level of development of the Serbian biomedical sector. The experts should provide suggestions regarding the direction of development, having in mind resources in Serbia and market needs in the EU.
- The centre could organise study visits of Serbian producers to producers in EU area who have already achieved high levels of compliance with EU regulatory demands.

- Training and seminars on identifying domestic or foreign sources of finance.

2) Technology demonstration

The centre should host technology demonstration events. Researchers would be given an opportunity to present the technologies they developed and demonstrate their relevance for businesses. Technology demonstration will play an important part in stimulating business demand for innovation and technology. Technology demonstration is one of the core activities of the OTTI centre in East Bavaria (Box 6).

Box 12. **East Bavarian Institute for Technology Transfer (OTTI)**

OTTI was founded in 1977 by a group of Bavarian companies, chambers of commerce, public and government institutions, credit institutions and individuals as a registered non-profit organisation. OTTI's mission is to drive sustainable economic and technological development of companies, networks, regions and knowledge areas. OTTI creates networks between businesses and researchers and increases the competencies of its members through qualification and practice-oriented knowledge transfer. OTTI works with companies and researchers to design seminars, workshops and in-house projects to facilitate knowledge transfer related to technology, renewable energies, and management development.

OTTI organises over 200 workshops, seminars, conferences, and events per year involving over 7000 participants. One of OTTI's central activities is demonstration of new technologies and their uses in manufacturing. For example, under its seminars for materials and surface technology, OTTI offers seminars and events on topics such as bonding in micro-manufacturing, carbon nanotubes and grapheme – from research to application, energy efficient coatings for automotive and aerospace industries and others.

OTTI generates its revenue from charging various fees for specific projects, seminars and events, miscellaneous work and annual membership fees. For its business clients OTTI adjusts its annual fees depending on company size. Small businesses pay 153 €, medium-sized businesses 256 €, large companies 511 € and individuals 38 €. Between 1988 and 2011 OTTI's revenues increased from nearly € 1.5 million to almost € 4.5 million.

Source : Presentation by Dr. Thomas Luck, Managing Director, OTTI on 28 October 2011 at Agro-food focus group meeting in Belgrade and www.otti.de

3) Face-to-face brokerage and an electronic portal

The centre would also function as a one-stop shop, i.e. a single contact point between industry and science/academia. The centre will be in charge of orienting companies towards different research institutions depending on their needs for innovation support. The centre could also help research institutions and businesses prepare and submit projects to the Serbian Innovation Fund.

This activity could entail the development and regular updating of an electronic portal or digital inventory including all Serbian biomedicine oriented research institutions – including R&D institutes and higher education institutions – with detailed information on the research and technological services they could provide to businesses.

4) Technological development services

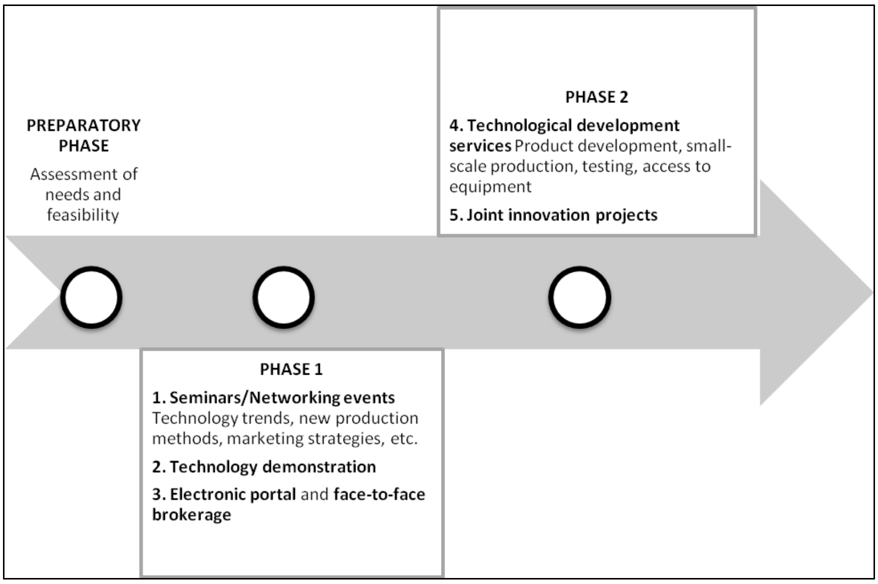
The centre would also provide technological, problem-solving and commercialisation services to SMEs and short-term contract research. The range of services would be broad enough to service technologically-capable and less technologically-capable firms. Based on consultations with potential beneficiaries these services could include:

- Product and process development
- Small-scale production
- Testing
- Access to equipment

5) Joint innovation projects

In a more advanced stage, the centre would host joint innovation projects between research institutions and businesses. This would enable the centre to compete for national and European funding. Joint innovation projects would also allow technology-advanced firms to engage in more R&D-intensive collaboration with research institutions.

Figure 45. **Centre activities from preparatory phase to phase 2**



The functions and activities described above should be launched in two phases (Figure 45). The first stage (Phase 1) would consist of the establishment of a network focused on a joint programme of activities and be run by a 'light' administrative team. In the second stage (Phase 2), the centre would broaden its scope of work to include more research-intensive activities focussing on joint projects and technology development. In Phase 1, activities 1, 2 and 3 would commence. These activities are less resource-intensive and easier to set up. In addition, these activities will pave the way for activities 4 and 5 in Phase 2. Indeed, the seminars, brokerage and technology demonstration activities will enable the centre's staff to determine which services and equipment is most needed and not provided by other institutions. The centre throughout phase 1 would build visibility, interest and trust among businesses and researchers. Overall, the five activities described above would help the centre achieve the three outcomes identified in the logical framework (Table 10).

Table 11. **Activities and expected outcomes**

Expected outcomes		CTC Activities
Increase firms' technological capabilities	⇦	• Technological development services • Technology demonstration • Joint innovation projects
Increase business demand for R&D	⇦	• Seminars/Networking events • Technology demonstration
Increase the collaboration between research institutions and businesses	⇦	• Joint innovation projects • Seminars/Networking events • Brokerage

Sector focus

Based on the conclusions of chapter four, the sector focus of the pilot phase should be directed toward biomedicine. Phase 1 activities could focus on businesses active in pharmaceutical production and/or medical devices. The former could also be expanded to include companies who produce natural herbal remedies.

In Phase 2, the activities of the centre should be intensified to focus on more R&D and technology development. This would help increase the long-term sustainability of the centre as sources of revenue would come from participation in domestic and international projects. The centre's potential client base would also expand as its offering of services and projects widens.

Organisation and governance

The centre should be organised as a non-profit organisation given it would be a recipient of public funding. Furthermore, it would benefit from being linked to an existing university in Serbia with a history of strong biomedical research. The link should be in the form of an autonomous centre. An illustration of this type of relationship is Bioneer (Denmark) and its relationship to the Technical University of Denmark as a subsidiary. The added benefit of being linked to a university would allow the centre to compete for project funding from several national sources, such as calls from the MES.

A strong governance structure which involves representatives from both industry and research is critical to the centre's success. In this regard the centre should have a board of directors to oversee its programme of work and ensure that resources are used effectively. The main responsibilities of the board would be the following:

- Approve the mission and vision for the centre.

- Approve the centre’s five year programme of work.

- Selecting the executive director. The board would need to agree on the executive director’s responsibilities and undertake a careful search to find the most qualified individual.

- Support the executive director. The board should ensure that the executive director has the moral and professional support he or she needs to further the goals of the centre.

- Review staff appointments to the centre as proposed by the executive director.

- Monitor activities and services. The board's responsibility is to determine which programs are consistent with the centre’s mission and monitor their effectiveness.

- Protect assets and provide proper financial oversight. The board must assist in developing the annual budget and ensuring that proper financial controls are in place.

The board should actively promote the centre’s mission, accomplishments, and goals to the Serbian public and internationally to build support from industry and researchers.

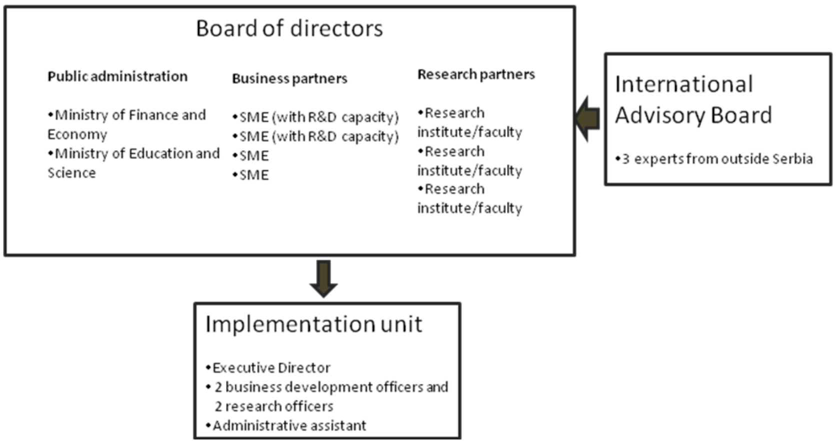
The members of the board of directors should be businesses and research institutions willing to take an active stake in the centre’s implementation. The business representatives should include four SMEs; with two of those SMEs having capacity to perform R&D. Three representatives from the research community should be from R&D institutes and/or university faculties; consideration should be given to both faculties specialising in biomedical research and those in business administration. Lastly, two public sector officials should be included on the board (e.g., Ministry of Finance and Economy and Ministry of Education and Science). A nine member board of directors is consistent with the number of directors found on boards of centre covered by this study, for example, EN-FIST Centre of Excellence in Slovenia, Bioneer in Denmark, and OTTI in Germany.

Selection of board members should be conducted through an open call for proposals whereby interested institutions and businesses explain what types of resources (either financial or in-kind) they could contribute to the centre. As explained in section on resources, at the outset the government contribution would cover 80% of the centre's operating costs while 20% would be expected from other partners through cash or in-kind contributions and revenues generated by the centre. The tenure of board member would be five years, with the option of stepping down after year three.

As illustrated in the figure below, the board would be tasked with identifying an executive director to implement the centre's programme of work. The executive director would be supported by a small management unit. The description of the executive director's profile and the rest of the management unit are provided in section on management and staffing.

To assist the board of directors and the management unit, the centre should have an international advisory board. The international composition of the board would provide the centre with access to skills and networks not available in Serbia. The advisory board would provide recommendations on hiring staff (e.g., executive director), programme development, technical assistance, and performance monitoring. The advisory board would also serve as an international public advocate for the centre. Members of the advisory board could include senior managers of similar centres in OECD countries.

Figure 46. **Governance structure - Phase 2**



Management and staffing

As noted in section on organisation and finance, the centre should have an implementation team led by an experienced executive director. The executive director should be someone who has private sector experience and an academic background in biomedicine. He/she should understand how the results of research can be used to advance commercial interests. This individual's profile should include a graduate level degree in a biomedical field (masters or PhD) coupled with at least 7 to 10 years of experience in the private sector, including managerial experience. From the review of OECD best practices and also from the study trip to Slovenia, the managers of competence centres or technology institutes are generally individuals who have previous experience performing R&D in the business sector. The executive director will be a critical interface between the business and research community in Serbia. Their actions will be the primary enabler of trust to be formed between industry and research. This trust will be the foundation for more intensive collaboration in the centre's second phase.

The executive director will have the responsibility of hiring the centre's support staff. In the first phase the executive director should hire two individuals to act as business development officers. These should be individuals with academic training in a field of biomedicine, and with some experience in the private sector (e.g., 3 to 5 years). As the centre's activities will concentrate on the organisation of conferences, workshops, and seminars in years 1 and 2, the business development officers will need to liaise closely with businesses and researchers to identify their respective needs. This study recommends that the centre organise at least 12 workshops (with attendance of 30 participants) and two larger conferences (attendance of 100 participants) per annum.

In addition to organising workshops, seminars and networking events, the executive director and business development officers will also need to allocate time to provide consultative support to businesses and researchers. This will be an additional revenue source for the centre and could include developing market research surveys, writing feasibility studies, preparing reports on EU regulations, or drafting project proposals for international or national calls for projects.

In the second phase of the centre (years 3 to 5), the staff should be augmented with two additional research development officers. These individuals should have an advanced degree in a biomedical field and three to five years of experience working on R&D or technology development projects. These individuals, along with the director and existing business development officers, will be responsible for developing joint R&D projects between industry and research. By the start of year five, the management team should aim to have the centre involved in at least two domestically financed projects, for example through a call from the Serbian Innovation Fund or the Ministry of Education and Science, and two international projects, such as those funded through Horizon 2020 (the follow up to FP7) or the new EU Programme for the Competitiveness of enterprises and SMEs (COSME); both Horizon 2020 and COSME will run from 2014 – 2020. The latter has a budget of 2.5 billion EUR while the former has 80 billion EUR.

The centre could also provide opportunities for PhD/master students or post-doctoral candidates to intern, work part-time, or even complete industrial PhDs at the centre. This is consistent with practices found at other competence centres or technology institutes in OECD countries and noted in the final report of the EU's Scientific and Technical Research Committee (CREST) working group on Industry-Led Competence Centres – Aligning academic/public research with Enterprise and industry needs in 2008. The benefit for the graduate student is that they acquire skills that improve their abilities to be hired by industrial companies following their studies, while the centre gains skilled individuals with an interest in solving industrial problems. The lending of the graduate or post-doctoral candidate would be counted as an in-kind contribution to the centre.

Resources

The general practice in OECD countries is that the resources dedicated to competence or technology centres in most cases requires a proportionately larger contribution from government (i.e., central and/or sub-national governments) at the inception phase. However, along with the government, the other partners - businesses, research institutes and universities – are also required to contribute resources. These resources can be either financial or in-kind. Examples of possible in-kind contributions could include[12]:

- Highly skilled and experienced managerial presence in the centre's governing structure
- Skilled and experienced sharing of staff between the partners and the Centre
- Lending of graduate level or post-doctoral candidates
- Invaluable contributions in terms of industrially related "know how"
- Direct cash funding
- Use of specialised equipment
- Office space
- Hosting of a website
- Other valuable other in-kind contributions

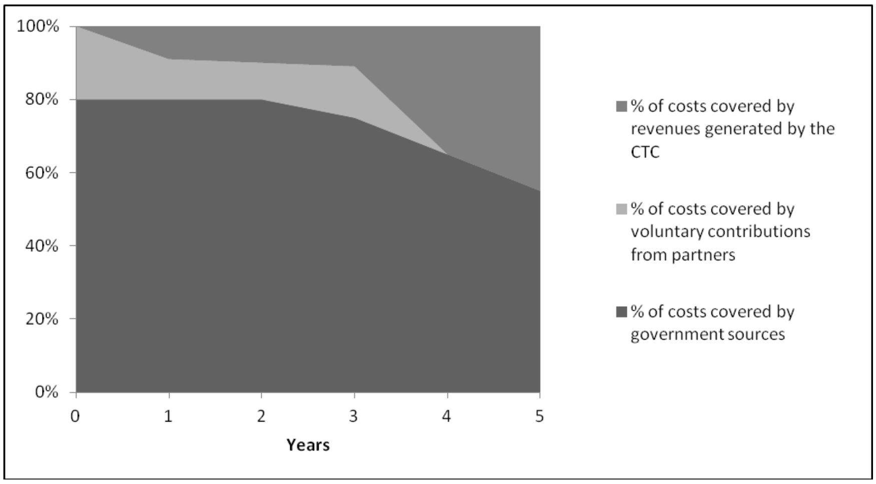
[12] See Report of the CREST Working Group on Industry-Led Competence Centres – Aligning academic/public research with Enterprise and industry needs (December 2008)

This study recommends that the physical infrastructure for the centre use existing facilities already in place. It would be best if the office space, computers, workshop/conference rooms and potential laboratory equipment be provided in the form of an in-kind contribution from one of the businesses or research organisations participating as partners. An option to consider is locating the centre in one of the science and technology centres being developed as part of Serbia's effort to renew its scientific infrastructure.[13]

It should be made clear at the outset that direct government financial resources for the centre will gradually decrease over the implementation period. The decrease in government contribution should be augmented by increases in revenues obtained through charging user fees for services and events on a cost-recovery basis. The estimated total cost for a biomedicine oriented centre over a five year period is approximately € 725 000.

During the first two years (i.e., phase 1), the government contribution will likely need to cover at least 80% of the centre's projected expenses. The remaining 20% should be recouped through a combination of fees for services and voluntary contributions from partners (Figure 47).

Figure 47. **Percentage distribution of resources for the centre**

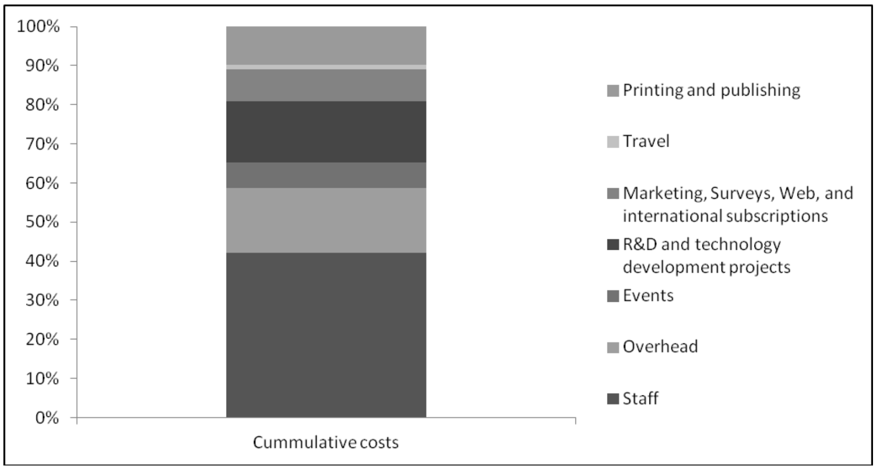


[13] See the various science and technology facilities under development throughout Serbia. www.piu.rs/projects.php?id=12

During the second phase, or year's three to five, the government contribution should be progressively reduced. By the end of the fifth year, the government contribution would cover 55% of the centre's operating cost. The remaining 45% would be covered through revenue generated from fees for services and domestic and international projects. The long-term financial goal for the centre should be to generate enough revenues on its own to cover its costs. An example of a successful technology centre in this regard is the East Bavarian Institute for Technology Transfer (OTTI) which manages to generate enough revenues from its activities to cover its expenses. Revenues are generated on the basis of charging annual membership fees, fees for conferences and workshops, and in-house projects (see Box 5).

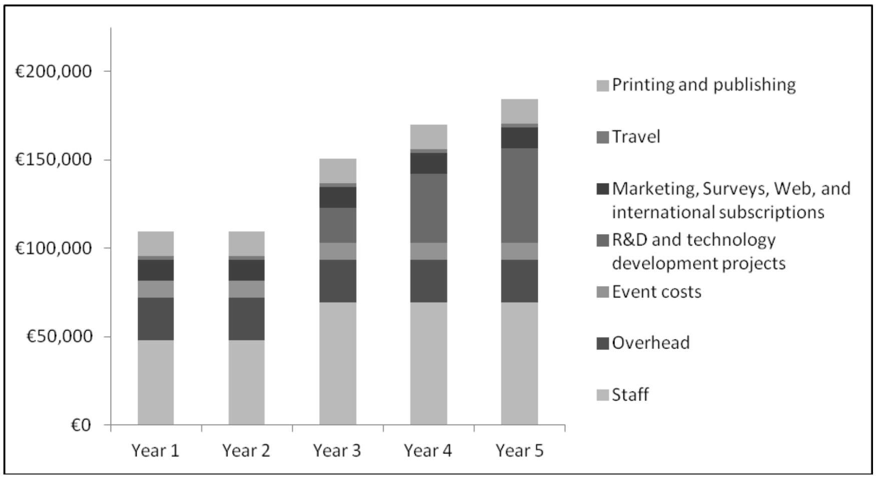
Estimates calculated for this handbook indicate that nearly 40% of the centre's cumulative five year budget would be allocated to staffing costs (see Figure 48). As a comparison, labour costs for the five Estonian competence centres ranged from just under 20% of budget to nearly 55%. The other cost segments would include 17% for overhead (e.g., office rental space); 7% for events (e.g., speaker fees and conference space rental); 15 % for R&D and technology development projects (e.g., renting equipment and technician time); 8% for marketing, surveys, website, and subscriptions to international journals and networks; 1 % for travel by staff; and 10% for printing and publishing.

Figure 48. **Percentage breakdown of cumulative costs for the centre**



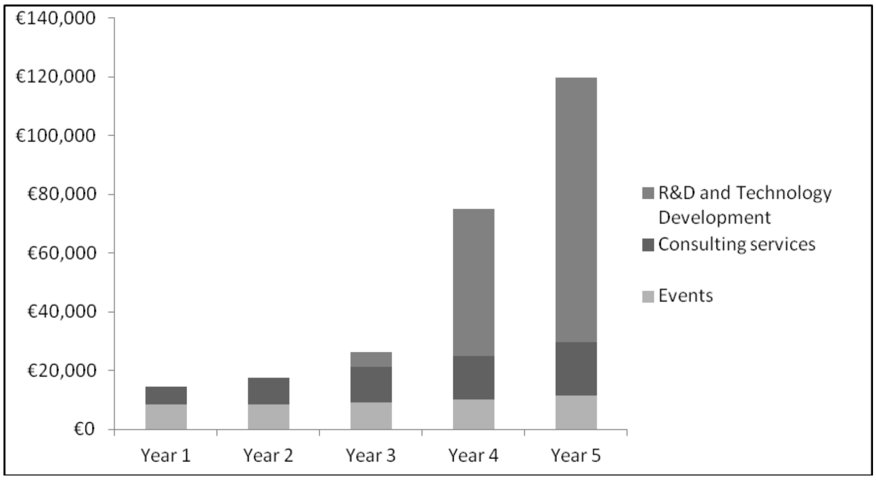
The centre's costs during phase 1 would amount to nearly €110 000 per annum for years one and two. During this period the centre would only focus organising workshops, conferences, training events and seminars. The second phase of the centre from year three to five would see the introduction of joint R&D and technology development projects between businesses and researchers. As these activities envision expenditures for contracting external senior researchers in Serbia, along with equipment and technicians to operate the equipment, the per annum costs incurred by the centre would rise to € 150 000 in year three, € 170 000 in year four, and € 185 000 in year five (see Figure 49).

Figure 49. **Estimated allocation of costs per year**



The revenues generated by the centre would come from a combination of charging fees for workshops, conferences, and seminars; consulting services provided by the executive director and staff to businesses and researchers; and funding for R&D technology development projects obtained from domestic sources (e.g. calls from the Ministry of Science and Education and Serbian Innovation Fund) or international sources (e.g. EU Framework Programme 7, Horizon 2020, or the new EU Programme for the Competitiveness of Enterprises and Small and Medium-sized Enterprises (COSME). As the centre will take time to establish, the necessary relationships between businesses and researchers in order for joint project proposals to be developed, the assumption is made that only in years three to five will there be a reasonable expectation of potential revenues from domestic and international sources (see Figure 50). The study projects that one domestically sourced project could be obtained in year three; one international sourced project and two domestic sourced projects in year four; and two domestic and two international projects in year five.

Figure 50. **Estimated sources of revenues per year**



Action Plan for the implementation of the competence centre

The following actions are meant to guide the establishment of the centre over five years (see figure 51). In parentheses is an estimated amount of time need to implement each action.

Preparatory phase

Prior to the implementation of the centre, five questions must be answered:

- Are demand side considerations sufficiently addressed (i.e., is the centre's market large enough)?
- Where will the centre be located?
- What will be its governance structure?
- How will the centre be organised?
- Have the funds to support its operation been secured?

If these questions can be sufficiently answered then the following actions could be initiated:

Action 1: Calls for membership on the board of directors and international advisory board (12 weeks)

As described in section on organisation and governance, a public call for membership on the board of directors should be organised. The board of directors should be a mix of representatives from the business, research and government. The number of board members should be kept to a manageable number, this study recommends nine. The board would identify its chairman. Among other criteria, board members would be selected on basis of providing in-kind resources for the centre.

In parallel with the identification of the board of directors, the international advisory board should be formed. The advisory board should be formed in time to assist with identification of the executive director in action 2.

Action 2: Hiring of executive director and staff (12 weeks)

The board of directors should be assigned the responsibility of hiring the executive director. In line with international good practices, the director should be an individual with experience in both the private sector and in research. Once appointed by the board of directors, the executive director should be empowered to hire his staff.

Action 3: Development of budget and programme of work (8 weeks)

The executive director should be assigned to develop a detailed programme of work and budget plan for the centre. As part of the programme of work, the director should actively engage businesses and researchers from outside of Serbia (either from the Western Balkans region or EU) to attend workshops and seminars organised by the centre. Given that many Serbian firms noted they acquire know-how from outside Serbia, this will be an important technology transfer mechanism. This will also help in stimulating demand for the centre's services.

The board of directors will ultimately be responsible for endorsing the programme of work. The international advisory panel should contribute to the development and vetting of the programme of work and budget.

Implementation phase

Action 4: Launch event for phase 1 (preparation time 4 weeks)

The official launch of phase 1 should be a public event in the form of an innovation conference to promote the centre and its activities. One specific action which should be completed in time for the launch event is the centre's website. One of the website's features should be an electronic portal which allows Serbian businesses to learn more about the types of projects the Serbian research community is involved in. The website would contain basic information on Serbian researchers and their current research interests. Likewise, businesses could post information on their R&D needs or topics of interest.

Action 5: Review of phase 1 (8 weeks)

The executive director should initiate a review of phase 1 six months prior to its conclusion. The review should assess to what extent the programme of work is being implemented. Key performance indicators of the centre's activities might include:

- Number of events and workshops organised
- Number of participants attending and composition (either research community or business community)
- Number of participants which are SMEs or large firms
- Costs and revenues associated with events
- Evidence of collaboration between industry and researchers (for example whether consulting contracts are being formed)

Action 6: Renewal of programme of work and budget for phase 2 (6 weeks)

On the basis of the review in action 5, the executive director should present to the board of directors an assessment of the centre's performance in phase 1 as well as a programme of work and budget prior to the start of phase 2. This will allow the board of directors to consider possible changes in the centre's activities as it will be moving to a more intensive phase of industry-research collaboration. The international advisory board should give its opinion on the centre's mid-point review and provide suggestions for the programme of work and budget in phase 2. The executive director's performance will also be assessed during this period by the board of directors.

Action 7: Hiring of additional staff for phase 2 (8 weeks)

As phase 2 will include intensification of technological development and joint-innovation projects, the centre will need to hire 2 additional research officers. As noted in the section on management and staffing, these individuals should have an advanced degree in a biomedical field and three to five years of experience working on R&D or technology development projects. The executive director should launch the process for hiring staff following the renewal of programme of work and budget in action 6.

Action 8: Renewal of board of directors (8 weeks)

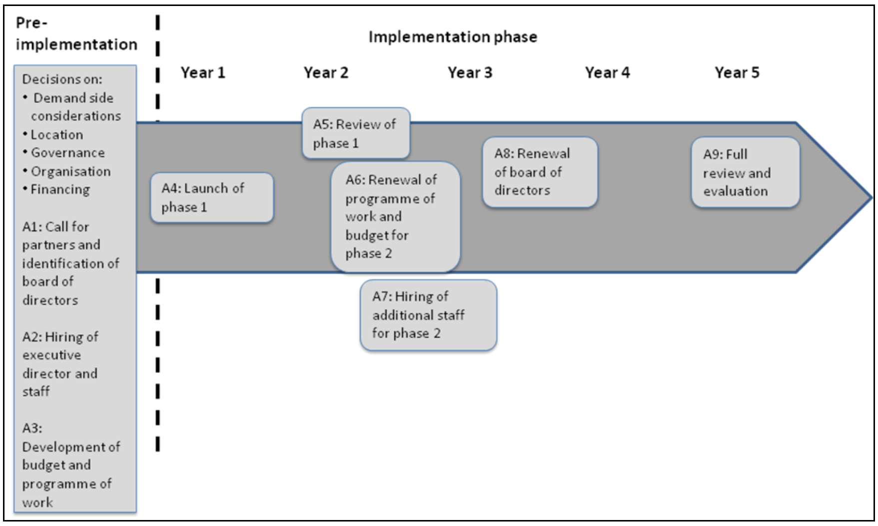
The board of directors should have an opportunity after the start of phase 2 to renew its membership should anyone of them wish to step down. Should a board member step down, his/her replacement should be found through an open call.

Action 9: Full review and evaluation (12 weeks)

The full review of phase 2 should take place at least six months prior to the end of year five. Similar to the full review in phase 1, the review should include both quantitative and qualitative performance indicators. The review should assess the satisfaction of businesses and researchers who participated in events or in technological development projects. The review should include an international or outside perspective. On the basis of this review, a decision can be made whether to extend the centre's activities, expanding this type of model to other sectors, or terminate this approach altogether.

Proposed Timeframe

Figure 51. **Proposed Timeframe**



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Annex A
List of experts and stakeholders interviewed

International experts

- Dr. Slavo Radosevic, Professor of Industry and Innovation Studies, University College London
- Alasdair Reid, Head of the Brussels and Tallinn offices, Technopolis Group
- Ene Tammsaar, Manager of the Bio Competence Centre in Estonia
- Itzok Lesjak, General Manager, Ljubljana Technology Park
- Janko Burgar, head of the 'Competitiveness and Industrial Policy' Unit of the Slovenian Ministry of Economy
- Dr. Maja Bucar, Slovenian correspondent for EU ERAWATCH and Trendchart
- Dr. Darja Piciga, former Head of the Office for the Coordination of Development Policies and Structural Funds, Slovenian Ministry of Higher Education, Science and Technology
- Dr. Michael Stampfer, Managing Director, Vienna Science and Technology Fund, WWTF
- Dr. Thomas Luck, Managing Director, East Bavarian Technology Transfer Institute (OTTI)
- Sven Faugert, Economist, Technopolis Group
- Dr. Lars H. Pedersen, Bioneer, Director of R&D and Operations

Stakeholders in the biomedicine field

- Dr. Olgica Djurkovic-Djakovic, Institute for Medical Research

- Dr. Nada Kovacevic, Head of the Faculty of Pharmacy, University of Belgrade

- Dr. Irena Homsek, R&D Department, Galenika

- Dr. Aleksandra Miric, Pharmanova

- Dr. Pavle Andjus, Institute of Physiology and Biochemistry, School of Biology, University of Belgrade

- Dr. Bojan Pavlovic, Ivancic i Sinovi (Invancic & Sons)

Annex B Additional results from the OECD IC business surveys

Additional results from the agro-food business survey

How many product/service innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	27%	28%	19%	8%
1 to 3	59%	59%	48%	44%
4 or more	14%	13%	33%	48%

How many process innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	64%	63%	48%	24%
1 to 3	36%	38%	48%	64%
4 or more	0%	0%	5%	12%

How many marketing innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	86%	78%	81%	28%
1 to 3	9%	22%	19%	56%
4 or more	5%	0%	0%	16%

How many organisational innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	64%	72%	48%	36%
1 to 3	36%	25%	52%	52%
4 or more	0%	3%	0%	12%

Where does your company get most of its new know-how from? (% companies per company type)?

	Micro	Small	Medium	Large
Equal internal and external	50%	41%	29%	52%
Some internal, and mostly external know-how	18%	9%	33%	16%
Mostly internal, and some external know-how	14%	16%	14%	24%
Exclusively internal know-how in my firm	9%	22%	10%	4%
Entirely external know-how	9%	13%	14%	4%

Additional results from the biomedicine business survey

How many product/service innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	10%	6%	25%	17%
1 to 3	48%	63%	25%	33%
More than 4	41%	31%	50%	50%

How many process innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	66%	50%	50%	67%
1 to 3	28%	44%	0%	33%
More than 4	7%	6%	50%	0%

How many marketing innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	59%	56%	25%	50%
1 to 3	31%	44%	25%	33%
More than 4	10%	0%	50%	17%

How many organisational innovations has your company introduced (% companies per company type)?

	Micro	Small	Medium	Large
0	72%	81%	75%	67%
1 to 3	28%	19%	25%	33%
More than 4	0%	0%	0%	0%

Where does your company get most of its new know-how from? (% companies per company type)?

	Micro	Small	Medium	Large
Exclusively internal know-how in my firm	3%	0%	0%	0%
Mostly internal, and some external know-how	0%	6%	0%	17%
Equal internal and external	41%	44%	50%	83%
Some internal, but mostly external know-how	28%	50%	25%	0%
Entirely external know-how	28%	0%	25%	0%

Annex C
Estimated costs and revenues for the centre

Revenues				Year 1				Year 2
Events	Fee charged per participant	# participants	# of units	Estimated revenues	Fee charged per participant	# of participants	# of events	Estimated revenues
Workshops	€10	30	12	€3,600	€10	30	12	€3,600
Conferences	€40	60	2	€4,800	€40	60	2	€4,800
Sub-total				€8,400				€8,400
Consulting services	Fee charged per day	Units	# of units		Fee charged per day	Units	# of units	
	€150	per day	40	€6,000	€150	per day	60	€9,000
Sub-total				€6,000				€9,000
R&D and Technology	Value of projects		# of projects		Value of projects		# of projects	
International R&D projects	€0		0	€0	€0		0	€0
Domestic R&D projects	€0		0	€0	€0		0	€0
				€0				€0
Grand Total				€14,400				€17,400

Revenues				Year 3				Year 4				Year 5	Total Revenues	
Events	Fee charged per participant	# of participants	# of events	Estimated revenues	Fee charged per participant	# of participants	# of events	Estimated revenues	Fee charged per participant	# of participants	# of events	Estimated revenues		
Workshops	€10	30	12	€3,600	€10	30	12	€3,600	€10	30	12	€3,600		€18,000
Conferences	€40	70	2	€5,600	€40	80	2	€6,400	€40	100	2	€8,000		€29,600
Sub-total				€9,200				€10,000				€11,600		€47,600
Consulting services	Fee charged per day	Units	# of units		Fee charged per day	Units	# of units		Fee charged per day	Units	# of units			
	€150	per day	80	€12,000	€150	per day	100	€15,000	€150	per day	120	€18,000		€60,000
Sub-total				€12,000				€15,000				€18,000		€60,000
R&D and Technology	Value of projects		# of projects		Value of projects		# of projects		Value of projects		# of projects			
International R&D projects	€0		0	€0	€40,000		1	€40,000	€40,000		2	€80,000		€120,000
Domestic R&D projects	€5,000		1	€5,000	€5,000		2	€10,000	€5,000		2	€10,000		€25,000
				€5,000				€50,000				€90,000		€145,000
Grand Total				€26,200				€75,000				€119,600		€252,600

Costs				Year 1				Year 2				Year 3				Year 4				Year 5	Total Cost
	Cost per unit	Units	# of units	Total cost	Cost per unit	Units	# of units	Total cost	Cost per unit	Units	# of units	Total cost	Cost per unit	Units	# of units	Total cost	Cost per unit	Units	# of units	Total cost	
Staff																					
Manager (per month)	€1,600	per month	12	€19,200	€1,600	per month	12	€19,200	€1,600	per month	12	€19,200	€1,600	per month	12	€19,200	€1,600	per month	12	€19,200	€96,000
Research development officer (per month)	€900	per month	12	€10,800	€900	per month	12	€10,800	€900	per month	24	€21,600	€900	per month	24	€21,600	€900	per month	24	€21,600	€86,400
Business development officer (per month)	€900	per month	12	€10,800	€900	per month	12	€10,800	€900	per month	24	€21,600	€900	per month	24	€21,600	€900	per month	24	€21,600	€86,400
Administrative support (per month)	€600	per month	12	€7,200	€600	per month	12	€7,200	€600	per month	12	€7,200	€600	per month	12	€7,200	€600	per month	12	€7,200	€36,000
Sub-total				€48,000				€48,000				€69,600				€69,600				€69,600	€304,800
Overhead																					
Office space rental per month (assumes 15€ per m2 at 100 m)	€1,500	per month	12	€18,000	€1,500	per month	12	€18,000	€1,500	per month	12	€18,000	€1,500	per month	12	€18,000	€1,500	per month	12	€18,000	€90,000
Utilities per month (water, heating, electricity, telephone)	€500	per month	12	€6,000	€500	per month	12	€6,000	€500	per month	12	€6,000	€500	per month	12	€6,000	€500	per month	12	€6,000	€30,000
Sub-total				€24,000				€24,000				€24,000				€24,000				€24,000	€120,000
Event costs																					
Fees for international experts to lead workshops and seminars (fees for speaker)	€400	per day	6	€2,400	€400	per day	6	€2,400	€400	per day	6	€2,400	€400	per day	6	€2,400	€400	per day	6	€2,400	€12,000
Fees for local experts to lead workshops and seminars (fees for speaker)	€150	per day	24	€3,600	€150		24	€3,600	€150		24	€3,600	€150		24	€3,600	€150		24	€3,600	€18,000
Conference space rental (100 person conference room for one day)	€250	per day	2	€500	€250	per day	2	€500	€250	per day	2	€500	€250	per day	2	€500	€250	per day	2	€500	€2,500
Workshop space rental (30 person conference room for one day)	€125	per day	12	€1,500	€125	per day	12	€1,500	€125	per day	12	€1,500	€125	per day	12	€1,500	€125	per day	12	€1,500	€7,500
Travel and accommodation costs for international speakers	€850	per visit	2	€1,700	€850	per visit	2	€1,700	€850	per visit	2	€1,700	€850	per visit	2	€1,700	€850	per visit	2	€1,700	€8,500
Sub-total				€9,700				€9,700				€9,700				€9,700				€9,700	€48,500
R&D and technology development projects																					
Senior researcher (per day)	€150	per day	0	€0	€150	per day	0	€0	€150	per day	15	€2,250	€150	per day	30	€4,500	€150	per day	50	€7,500	€14,250
Technician	€75	per day	0	€0	€75	per day	0	€0	€75	per day	30	€2,250	€75	per day	60	€4,500	€75	per day	80	€6,000	€12,750
Equipment rental (per day)	€500	per day	0	€0	€500	per day	0	€0	€500	per day	30	€15,000	€500	per day	60	€30,000	€500	per day	80	€40,000	€85,000
Sub-total				€0								€19,500				€39,000				€53,500	€112,000
Marketing, Surveys, Web, and international subscriptions																					
Advertisments in newspaper, magazines, tv	€500	per event	14	€7,000	€500	per event	14	€7,000	€500	per event	14	€7,000	€500	per event	14	€7,000	€500	per event	14	€7,000	€35,000
Surveys	€1,500	per survey	2	€3,000	€1,500	per survey	2	€3,000	€1,500	per survey	2	€3,000	€1,500	per survey	2	€3,000	€1,500	per survey	2	€3,000	€15,000
Website (Development, hosting, and maintenance)	€50	per month	12	€600	€50	per month	12	€600	€50	per month	12	€600	€50	per month	12	€600	€50	per month	12	€600	€3,000
Subscriptions to international journals and membership in international networks	€100	per month	12	€1,200	€100	per month	12	€1,200	€100	per month	12	€1,200	€100	per month	12	€1,200	€100	per month	12	€1,200	€6,000
Sub-total				€11,800				€11,800				€11,800				€11,800				€11,800	€59,000

Travel																						
Visits to other biomedicine competence centres by manager	€1,000	per visit	2	€2,000	€1,000	per visit	2	€2,000	€1,000	per visit	2	€2,000	€1,000	per visit	2	€2,000	€1,000	per visit	2	€2,000		€10,000
Printing and publishing																						
Printing of material for workshops and conferences	€500	publication	14	€7,000	€500	publication	14	€7,000	€500	publication	14	€7,000	€500	publication	14	€7,000	€500	publication	14	€7,000		€35,000
Publication of reports following workshops and conferences	€500	per event	14	€7,000	€500	per event	14	€7,000	€500	per event	14	€7,000	€500	per event	14	€7,000	€500	per event	14	€7,000		€35,000
Sub-total				€14,000				€14,000				€14,000				€14,000				€14,000		€70,000
Grand Total				€109,500				€109,500				€150,600				€170,100				€184,600		€724,300

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