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Strategic framework for IT education and research at Sofia University

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Abstract: *Purpose:* The paper focuses on the challenges for Faculty of Mathematics and Informatics (FMI) of Sofia University. It tries to provide an answer to the main questions – how to use the best practice of a leading universities in order to link the main research and academic faculty goals to specific problems to be planed and implemented; how to support the faculty executives for making better decisions, and resource allocation choices. The purpose of the paper is to present the FMI approach and the FMI strategy maps for research and education. *Design/methodology/approach*: The authors examined several scientific methods and techniques used in strategic management, and created their own approach for modeling, design and implementation in education and research environment, which is presented in the paper. *Findings*: The main findings of a SWOT analysis, modeling and environmental survey are given in the paper. It presents the strategic priorities and the challenges for FMI to keep its position as a leading research and education centre in ICT in Bulgaria and to compete in the global educational environment. *Practical implications:* The authors believe that the described model and strategy will support FMI and its staff to take strategic management decisions, to focus their efforts on the most relevant topics, and to create competitive educational and research environment. *Originality/value:* The paper shows how to develop the faculty strategy. It demonstrates clearly that academic research and education processes can achieve significant improvements in cost, quality and service using a strategic management approach. The added value of the FMI strategy is in integrating knowledge, experience, best practices and tools within one new master program design. The FMI approach described in the paper can be used for strategic management in universities and research organisations.

Keywords— higher education reforms, challenges for researchers and organizations, collaboration with stakeholders

I. Introduction

Information and communication technologies (ICT) have a strong impact on all economic sectors and spheres of life. Computer technology is embedded in several appliances, in equipment, process control, business and decision-making processes, etc. The ICT development and the pervasive use of technologies have caused enormous changes in all companies and organizations world-wide, both at macro and micro levels, and have increased the requirements for the skills and competences of their employees. Faced with the rapid technology changes, special focuses have deserved world-wide research and technology, innovation and education [21]. Knowledge and information have become important assets and a factor for companies' growth and competitiveness world wide. The GDP in most developed countries is increasingly generated by the sector of services and knowledge-intensive activities, whereas the service sectors account for more than 80% of the national incomes in most developed countries.

The pace of change in the economy and society and the fast technological developments have raised essential challenges for research organisations and universities as well. The latter need, first, to ensure the proper skills supply for the economy and society, second, to strengthen their role as knowledge providers and finally, to integrate new tools in their internal processes. In order to attract and keep their students, universities need to develop a strategy for continuous improvement of the scope and quality of services they provide to the students, industry and society [25]. The new strategic framework should integrate the opportunities, which ICT provide for management of universities [41], for ensuring new effective learning solutions [6] and for knowledge sharing [5], to take also into account the cultural challenges for managers, professors and students [10], and consider the necessary actions.

The transitional period in Bulgaria and the close-down of large enterprises negatively influenced higher education, and all universities have faced problems like ageing of staff and low interest by young people, lack of demand for research services by industry, and lack of investments in the material bases. This influenced the quality of education and reflected in low initiatives to change curricula for meeting industrial demands. In addition, the new private universities which are much more dynamic and entrepreneurial, the EU integration, and the emerging e-Learning global education market have increased the challenges to the state-owned Bulgarian universities and the need to change and adapt rapidly to the new highly competitive environment [23].

Sofia University (SU) is the first university in Bulgaria established more than a century ago, which is also an important resource bank of researchers for the country**.** Its Faculty of Mathematics and Informatics (FMI) has a leading position among Bulgarian research organizations working in the field of ICT [26]. It has achieved a number of successes in research and education, and is well integrated in a number of European research networks and project initiatives. However, FMI has experienced some serious problems closely related to the general socio-economic and research environment in Bulgaria. In order to overcome them and to strengthen its capacity, FMI has undertaken within the FP7 SISTER project several activities in order to determine its future strategy [24].

The paper is expanding the WSEAS conference report of the team [14] and presents the methodology of SISTER

project for preparing a strategic framework for FMI in research, technology development and innovation (RTDI) in ICT, and the main results achieved.

II. Methodology for the FMI strategy

A. Project background

The ICT research staff of FMI has a high potential, great experience and a large number of publications in a wide spectrum of areas [25]: software architectures, computer networks, embedded systems, parallel architectures and systems, information security, information systems, knowledge based systems, machine learning, data mining, information retrieval, user modeling, bioinformatics, robotics, image processing, e-learning, digital libraries, software engineering, IT services, e-business, e-government, knowledge management, technology entrepreneurship, etc. FMI has well-established contacts with leading research organizations in Europe and in Bulgaria, and a significant experience in international project activities.

However, after joining the EU in 2007, the gap between the education and research environment in Bulgaria and those in the older EU Members States became clearly visible. Similar to many research organizations and universities in Bulgaria, FMI has experienced serious problems:

- Emigration and migration to industry of highly skilled professionals
- Insufficient research funding
- Lack of sufficiently stimulating research environment
- Lack of youth staff
- Lack of stable and multiple bridges between research, development, education and training
- Lack of traditions in university-industry-government cooperation
- Fragmented nature of research activities and not effective use of limited resources.

In order to overcome these problems and to decrease the gap separating it from EU leaders, FMI is building its vision and strategy for research and education within the SISTER project. The main project goal is to strengthen the FMI capacity and to develop it as a Leading Centre in South-East Europe (SEE) in research, innovation and higher education in the area of ICT [24]. Therefore, the first SISTER objective is to elaborate a strategic framework for FMI future development and to outline where to make strategic investments. Some strategic questions are taken into account:

- Where is the university now, not where do we hope that it is?
- If no changes are made, where will the university be in three years time?
- If the answers of first two questions are unacceptable, what specific actions should be taken?
- What risks and payoffs are involved?

The RTDI strategy development activities were carried out in three phases:

- Analysis of the technology trends and research needs in ICT in Europe and Bulgaria, and identification of FMI potential;
- Preparation and validation of the RTDI strategy for FMI;
- Development of scenarios and elaboration of a detailed action plan for research and training in ICT.

B. Strategy development background

The global race for knowledge in the last decades, the acceleration of the technology development and the emergence of a number of interdisciplinary scientific areas, increase the challenges for research and industry organizations. Long-term strategic planning becomes important for staying ahead of competitors. In a small country like Bulgaria with limited financial resources for RTDI, it is essential even for a university faculty to determine:

- areas of strategic importance and present strengths, where to concentrate more resources and strengthen local capacities
- areas where to keep a small potential or withdraw
- how to use the best available practice
- how to integrate much better into the European research, innovation and higher education activities.

Foresight provides today a powerful instrument for priority-setting and selection of areas on which to concentrate human and financial resources. Foresight studies use various methodologies including Delphi, scenario setting, trend analysis, critical technology analysis, SWOT analysis, brainstorming and panel discussions, etc. [21] In an organizational context, foresight could be considered as an important aspect of strategic thinking (exploring options), strategic decision making (making choices) and strategic planning (taking actions), as shown on Fig. 1 [7].

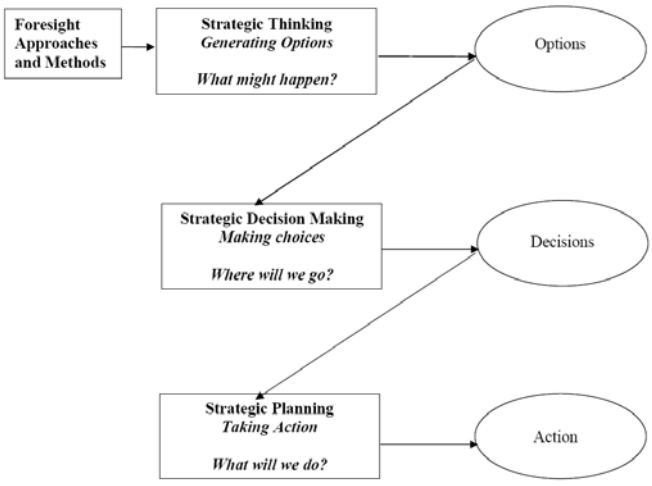


Fig. 1 Three level framework for implementing strategic foresight

Scenarios are especially useful for development of strategy and policy of an organisation as they stimulate critical thinking, intuition and creativity, and challenge assumptions within the organisation. Scenarios are used as a tool for

decision-making, mainly to highlight the discontinuities from the present and to reveal the choices available and their potential consequences. They are similar to simulations of some possible futures as they offer a non-linear and dynamic way of thinking, require ability to deal with complexity, to consider multiple variables simultaneously, and with 'different interpretation' over time [21], [39]. When developing a scenario, it is important to take into account all drivers of change in the external environment that will affect the organisation. For educational organisation, the drivers of change are related to its internal environment, and the broader social and economic environment (Fig. 2) [8]:

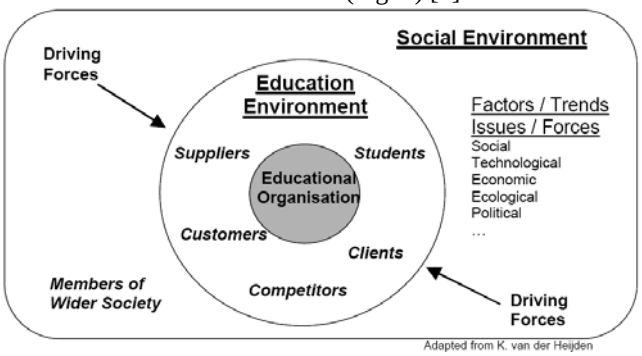


Fig. 2 The environments of an educational organisation

The SWOT (**S**trengths **W**eaknesses **O**pportunities **T**hreats) analysis is also a widely used strategic management method. It combines analysis of external drivers and of internal resources of organizations. The idea of the SWOT analysis is to determine to what degree the actual strategy is suitable and appropriate to meet the challenges and changes in the organizations' internal and external environment [21], [36].

In order to provide the necessary background for strategic planning as well as to monitor and control future strategy implementation, it is important also to integrate in the process suitable metrics. In strategic management, for measuring the performance of organisations are used a number of recent approaches such as Balanced Scorecard (BSC) of Kaplan and Norton, Baldrige, Six Sigma [4], [27], [29]. For the aims of the FMI strategic development is used the Balanced Scorecard methodology which evaluates four different perspectives [16], [17], [18]:

- Financial
- Stakeholders
- Internal processes
- Learning and growth.

A number of approaches exist for developing and implementing balanced scorecards. There are three essential options from which to choose [32]:

1. *Top-Down*. It starts at the highest possible level and then continues down the hierarchy through the University, Faculty and departments. It works well in operating organization and organizations where products and services are established.

2. *Middle-Top-Down*. It is suitable for organizations whose units have a high degree of autonomy and authority and tend to do better with a middle-top-down approach. The units are customer facing and directly manage a value proposition. It can be used for academic institutions with shares of education and research which play key strategic roles in the organization.

3. *Bottom-Up*. In this approach, leaders of the University develop the strategic agenda or allow to the departments alone to initiate the process. This approach is suitable for knowledge-intensive organizations such as professional service companies and Universities where the main organizational assets are people.

The main aspects of BSC strategy management are [26]:

- Explain the strategy in a strategy map that connect key objectives in four BSC perspectives for R&D and in five BSC perspectives for education
- Measure the strategy follows described objectives, measures, targets, and strategic initiatives
- Align the faculty with the strategy by cascading the BSC strategy map
- Manage the strategy in a continuing process that includes cyclic strategy review sessions, established links of the strategy with budgeting, human capital policies and practices, and ICT.

C. The FMI strategy development approach

The FMI team has considered the following prerequisite steps for developing the RTDI strategy [32]:

- *Define the broad strategic agenda*. The strategic agenda describes a set of high level priorities that signal the critical areas for alignment across the organization. It serves as a foundation for developing scorecards at all levels. It is the responsibility of the organisation to set the strategic agenda. How specifically the strategy can be described depends on the type of organization.
- *Assess the current organizational structure.* Since strategy should dictate organizational structure (not vice versa) each unit must be viewed through the lenses of the strategic agenda in order to determine if the organization is currently configured in a way that optimally supports strategy execution.

The stage of formulation and planning of the FMI strategy starts with assessment of the environment and the definition of a strategic environment. After it the following tree steps are considered [32]:

I step: Strategy formulation and strategy planning

1. Strategic Planning
   - Development of the strategy
   - Defining mission, vision and values
   - Conducting strategic analysis
   - Formulating strategy
2. Translation of the strategy
   - Defining strategic objectives and themes
   - Selecting measures and targets
   - Selecting strategic initiatives

3. Budgeting allows making stronger effectiveness of the strategic plan by allocating resources appropriately. It recognizes the need to link the planning process closely to the annual budgeting cycle. BSC promotes a culture of continuous improvement by encouraging collaboration and aligning

faculty resources around strategic priorities. A transparent optional budgeting process with clarity on priorities should be followed.

II stage: Strategy implementation

This stage is more important for FMI than all others, because it shows how the faculty creates value for its stakeholders. The statistics show that between 85% and 90% of organizations fail to execute their strategies. In order to succeed at this stage, it is necessary to have clear answers to the following questions:

- How engaged is the faculty and its staff?
- Do they understand how employees' level of engagement affects their productivity and performance?
- How well do managers understand employees' views about the organization's leadership, their own supervisors, and their reward programs?
- How much do they know about their stakeholders' view of the faculty — and how do the faculty and the staff attitudes and actions influence customers' views?

After that the strategy implementation should focus on:

- BSC Performance Coordination and Reporting
- Initiative Management
- Strategic Communications
- Personal Scorecards
- Strategy Review

III stage: Strategic learning

The stage of strategic learning includes:

- Conducting strategy correlation analysis
- Benchmarking
- Best Practice Sharing
- Internal Coaching and Change Management
- Presenting the BSC strategy
- Examining emerging strategies

The FMI team used business process management tools [34] and created a BSC system as a value-added chain process (Fig. 3) [30].

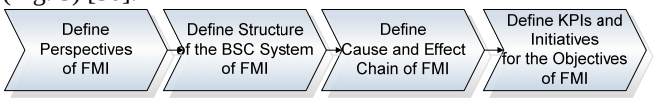


Fig 3 BSC Value-added chain diagram for FMI

For the purposes of the FMI strategy are developed two strategy maps – the first one is for education and consists of five perspectives:

- Student education
- Financial
- Stakeholders
- Internal processes
- Learning and growth

The second strategy map is of FMI R&D and consists of four perspectives:

- Stakeholders
- Internal processes
- Learning and growth
- Financial

The strategy maps for education and R&D of FMI consist of a specific number of strategic objectives, that are related to each other in a hierarchy and the main objective can thus be broken down into sub-objectives. After creating the strategic objectives and critical factors in the cause-and-effect diagrams, a Key performance indicators (KPI) allocation diagram is assigned to each separate objective. The KPI serve as a benchmark for measurement [31].

D. Survey Methodology

The first phase of the RTDI strategy development focused on analysis of the state-of-the art in ICT, the needs and available resources. More specifically, it was undertaken [25]:

- *Environmental scanning* of European and national reports, web sites, scientific literature, media publications, etc.
- *SWOT analysis of FMI* – its strengths and weaknesses, positioning in the area of ICT in Bulgaria and the region, and the opportunities and threats for its further development and integration into the European Research Area (ERA) and the European Higher education area.
- *Issue survey* in a large number of enterprises, policy makers and local authorities in Bulgaria, among FMI researchers and ICT end-users in order to determine the large societal and economic needs for research and training in ICT.

The studies conducted during the first phase provided the basic inputs for the preparation of the RTDI strategy. The reports based on environmental scanning, SWOT analysis and issue survey outlined above, were used for identifying the short term (achievable within the project) and long term (for strategic development and partnership) research, innovation and education priorities of FMI in ICT.

E. Panel activities

At the second phase was used external expertise. In order to support the vision creation process at FMI, an Expert panel was composed of experienced researchers, representatives of EU partners, industry and public authorities. The panel work followed two stages [25]:

- A *brainstorming session* during the first Expert panel meeting provided FMI staff with external inputs for identifying its strategic priorities and the related actions for RTDI in ICT in Bulgaria.
- The second panel meeting focused on *validation* of the first draft of the FMI RTDI Strategy in ICT. At this meeting were presented the draft action plans for implementation of the strategy in selected areas and by the participating experts were *developed scenarios* for FMI future development.

III. Results of FMI surveys

A. ICT-related trends in the European Union (EU)

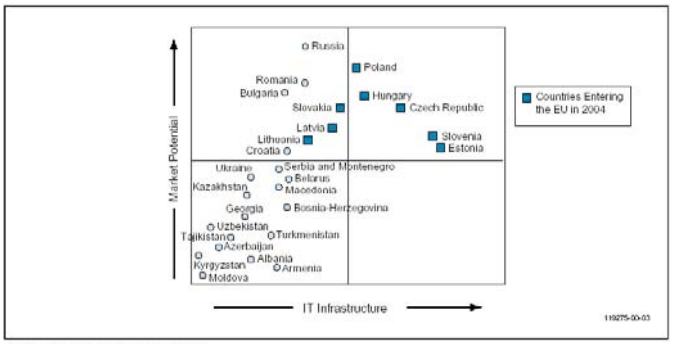
The Information Society (IS) development focuses on several interrelated issues such as further developing technology infrastructures, digital content, electronic services

and ICT skills; utilizing more the technology convergence; improving security of the communication networks and building thrust and confidence in using them [25].

The Lisbon Summit in 2000 provided a new long-term direction of the EU policy towards building the knowledge economy and society in Europe. It set a basis of several actions in telecommunications, education, research, culture, economic and public policy towards integrating ICTs in public, business and personal life and practices, thus providing some basic building blocks for bridging the Digital Divide in Europe. The EU policy has been supported by a number of measures in the different areas [15], [25]:

- The objective of *building a Single European Information Space* has been implemented in three interrelated areas – networks and services, their security and the development of high quality content. The convergence of technology, the need for interoperability and technical regulation have become corner stones of the new framework for building the technology basis of the IS in Europe. On the side of the Content industry, the Commission has focused on the transfrontier broadcasting, the copyright issues and privacy.
- The strong emphasis of the EU on building *ICT and e-business skills, entrepreneurial and innovation skills and creativity* has gained particular attention. For bridging the skills gaps have been used different paths – formal education, training on-the-job, self-learning, working experience, etc. ICT education was introduced in the formal school agenda in Europe, and several training actions have been launched for employees and adults' continuous education, supporting the concept of life-long learning.
- In *research and development (R&D)*, ICTs have taken traditionally an important place. It is acknowledged that their development should support, first, the world competitiveness of the European ICT sector, second, facilitate the wide technological spread in other sectors of the economy, and last but not least, contribute to building an inclusive IS in Europe. Subsequently, in the Specific Programme Cooperation of the Seventh Framework Programme for Research and Development (FP7) more than one forth of its overall budget is devoted to ICT research and development. In addition, ICTs exist as a horizontal line in the other 9 thematic priorities of the Cooperation programme.
- Several action lines have focused also on *e-business trends and in particular the ICT adoption and usage* by the European small and medium enterprises (SMEs). The eBusiness Support Network has contributed to the exchange of best practices, while the eCommerce regulation has facilitated the ICT take-up by businesses. In addition, the *e-Government and e-procurement actions* have focused on providing citizens and businesses with reliable public services, and encouraging them to go on-line.

Despite all efforts, the gap between the technology advanced countries and the less developed ones is growing. There is a multiple divide between countries and regions, between large and small companies, and between people of different age and social status [15]. The direct link between GDP and purchasing power on the one side, and ICT adoption and usage, on the other, seems to be the main reason for a continuous down spiral for people, companies and regions. As shown on (Fig. 4, quoted in [20]), the market potential is higher than the IT infrastructure current status in most South and East European countries, which shows a large still not explored potential. Despite the ICT adoption in several economic spheres (Internet usage, mobile phones penetration, e-government and e-health measures, B2B, etc.) their impact on growth in Bulgaria is still moderate. This causes a lot of challenges for public policy, industry, research and education.



Source: Gartner Dataquest (January 2004)

Fig. 4: Eastern Europe: IT infrastructure vs. Market potential

B. Building e-skills

Global trends towards a knowledge economy are influencing the composition of the workforce, and the knowledge and skills required for success. The competitiveness of companies appears increasingly dependent on the ability to develop, recruit and retain a technologically sophisticated workforce. Education and learning are key to Europe's competitiveness and underpin most other economic and social policy goals, according to the Lisbon strategy [25].

ICT will make a reality of lifelong learning for all. New eLearning technologies and tools offer learners greater flexibility, easier access to information and the opportunity to match learning to their specific needs and circumstances. The younger generation is adopting a new way of learning not being matched by traditional teaching methods in the school systems. Moreover, a need is emerging to extend the digital literacy concept to include not only basic ICT skills, but to focus also on retrieval skills, information seeking and sharing [11]. Individual commitment for ICT usage, group work, and intellectual and academic support in acquiring ICT skills could contribute to higher level of knowledge generation and communication.

For bridging the skills gaps could be used different paths – formal education, training on-the-job, self-learning, working experience, etc. The dynamic changes of technologies face learning providers with the requirement for periodic update of the learning content and enrollment numbers in order to

mitigate skills mismatches on the labor market [25]. There is a big challenge especially for universities and vocational schools to follow and predict the employment demands. On the other hand, higher education may be able to ensure e-skills supply in the middle and longer term. However, companies need to find solutions for labour shortages now. Rapid technological change requires continuous learning from citizens and employees world-wide [42]. Therefore, many initiatives are underway for building an open, flexible and transparent lifelong learning system, mainly related to encouragement of company-training activities, use of existing company-based training facilities or the building of regional training centres [13]. The focus in EU New Member States (NMS), for example, is primarily on areas where the demand and potential for economic gain are greatest – business, law, ICTs, foreign languages, etc. Experts estimate that around 80% of big company spending on training is on IT training. In addition to traditional forms of training, all European countries use more actively the opportunities that distance education offers to enhance the variety of training courses and facilitate accessibility of educational materials and training.

The availability of adequate skills for developing, implementing and using ICT is an important condition for the competitiveness and the innovation capabilities of the Bulgarian economy.

Bulgaria joined the EU in 2007 after a difficult transition period towards a market economy. The EU membership influenced high growth rate of investments in Bulgarian economy and its consequent uptake. As priority sector of Bulgarian economy was recognised ICT, where Bulgaria has long traditions [40], and despite the collapse of former IT production facilities, in the last few years it has raised significantly its capacity to attract foreign investments in the sector and outsource ICT services. The industrial growth is related to increasing demand for highly qualified specialists. The significant 'brain drain' of highly-skilled ICT specialists, however, makes it very difficult to meet the challenges of industrial growth and higher competitiveness. The EU statistics [9] show that Bulgaria ranks very low in EU according to the ICT skills of employees, in particular ICT users and Internet related skills (Table I). Promising is that the professional ICT skills are at EU-average level. The latter is due to certain extent to the strong traditions in engineering education and informatics of the country, as well as the availability of several professional certification services.

Table I: ICT Skills of Bulgarian employees

Employment and skills	2004	2005	2006	EU25	Rank
% employees using computers connected to the Internet	8.8	9.1	14.5	36.1	27
% of persons employed with ICT users skills	11.7	11.6	11.5	18.5	26
% of persons employed with ICT specialist skills	2.7	3.1	2.9	3.1	13

As example of good practice in the area of ICT higher education in Bulgaria could be considered FMI. On the bases of Career Space curricula guidelines and the ACM/IEEE Computing Curricula 2001 at the Faculty were developed and started new specialties for Computer Science, Software Engineering and Information Systems. They found a high demand by the students and general appreciation by industry. In addition, taking into account the need for interdisciplinary skills and management competences of ICT specialists, in 2007 was launched a new MSc program for Technological Entrepreneurship and Innovation in IT. The result was higher than expected – there was an oversubscription by the students for this program [25], [30].

C. Research and innovation challenges

At EU level is acknowledged that for industry innovation is a crucial mean for creating a competitive advantage. Knowledge transfer from universities and research organizations is a major driver of innovation, competitiveness and growth. From the extra R&D efforts benefit most the high- and medium-tech sectors which conduct more R&D and have therefore higher productivity gains [12]. It is important, however, when considering innovation to take into account all of its sides, e.g. product and process innovation, service and organizational innovation. The latter is underestimated in many studies, but it is gaining increasingly of importance as there are a number of 'intangible factors' like company competence and performance which influence the quality, costs and innovation ability in general [3].

Many measures are taken at the EU and national levels in Europe for boosting innovation, but there are still a lot of challenges related to the knowledge transfer from universities to industry, building of networks between academia and SMEs, as well as training of researchers to obtain skills necessary for work with industry. The general picture of innovation in Europe provided shows that there are four groups of countries – leaders (mainly the Nordic countries), followers, catching up and trailing. Bulgaria has scores below that of the EU25 and the innovation leaders, but shows faster than average innovation performance improvement and belongs to the group of catching-up countries (Fig. 5) [28].

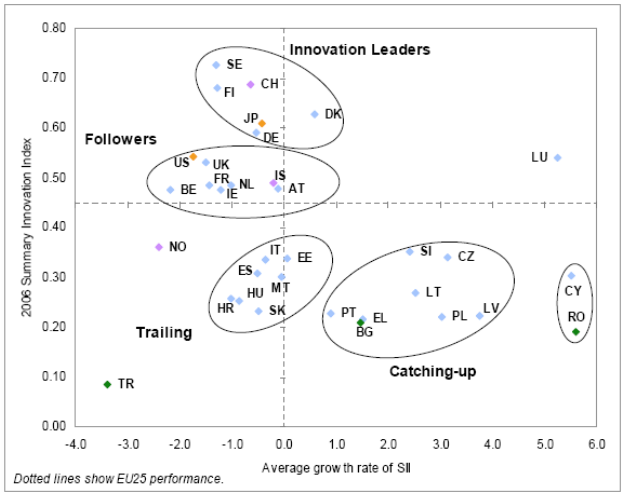


Fig. 5 Summary innovation index and trends in Europe

The situation in Bulgaria is one of the worst in the EU according to the European innovation and R&D statistics. Although the total amount spent for R&D is increasing in the last few years, it takes a very low share from GDP – the public R&D expenditures are 0,38% (by 0,65% EU25), and only 0,11% coming from private sources (by 1,2% EU25). The SWOT analysis made in [28] highlights as main weaknesses in Bulgaria:

- weak links between science and businesses
- not sufficient measures to develop innovation infrastructure, support services, technological brokerage, intermediary services, etc.
- not involvement of university students in scientific and technological activities
- low innovative culture and weak innovative culture of businesses
- low level of investment in new products and processes
- slow implementation of measures and not systematic and transparent evaluation, etc.

Regarding the knowledge creation, it takes an average position among 145 countries – being more advanced in physics (on 39 place), mathematics and chemistry (45) and computer sciences and engineering (47). It is interesting to note that compared to the EU15 level, the publications and their respective citations in the field of Computer science are decreasing from 1995 to 2003, whereas the trend in mathematics, chemistry and engineering is of growing publications and their citation by other researchers. However, there is a long way ahead in order to turn knowledge into new products and processes by the industry. The commercialization of research results is reported to be very low as far as the patents obtained are taken into account [2].

The industry-academia collaboration in Bulgaria is reported to be at a very low level – only 6% of the innovative enterprises collaborate with universities, and 3.9% - with public research organizations [2]. Recent surveys on intersectoral mobility [22] and the academia-industry collaboration [38] pointed out that only 22% of the enterprises' respondents consider the relations with the academia as very good ones. The results from the surveys show that the forms of cooperation, connected with joint projects (11.7%) and the introduction of intellectual products (6.7%) are not well developed. In addition, only 1.1% of the respondents create intellectual products together with the academic institutions, and 7.5% - together with other organizations from the practice.

The lack of analysis of the needs of local and national enterprises is one of the main obstacles to the more market orientation of research outputs, and of university courses and programs. Subsequently, Bulgarian companies are seldom contracting research with universities. As the data for SU show, in 2005 less than 10% of its financial incomes were from Bulgarian sources. It is not surprising that industrial funding for research is very limited and far below the EU average, and many enterprises are importing technology from abroad without looking into the existing in Bulgaria research activities and capabilities for contract research. Research organisations do not market their research results, but also do not make enough efforts for commercializing them, and the process for setting-up of spin-offs is underdeveloped in Bulgaria. It is not surprising, therefore, that human resources problems exist in research. This is particularly severe in physics, where a number of research positions are vacant, and students are not interested in physics career [25].

Finally, building an entrepreneurial culture and communication skills of researchers, as well as innovation and knowledge management abilities of the entrepreneurs seems to be another important problem to be resolved. Having entrepreneurial skills is essential for capitalizing on innovative ideas. Technology entrepreneurship, commercialization, and fund-rising provide unique opportunities and motivation for researchers to better implement the research results into innovative products and services. Although SU is introducing such subjects in the university curricula, there are also needs to focus on existing labour force and enhance their knowledge and interdisciplinary competences and general vision [25].

D. FMI internal environment

The survey carried out at FMI in May 2008 [1] highlighted a number of strengths and weaknesses of the research and teaching staff. One of its main goals was to analyze not only the quantitative data provided by the researchers, but to try to summarize and define the personal attitudes of the staff and their approach to research activities. It focused on:

- *FMI staff experience*, skills, and research interests and needs,
- the *research priorities* according to the staff –on European, on national, and on personal short-term and long-term level
- the personal assessment of the *internal organization and work environment* of FMI
- the evaluation of the *overall national environment* and attitudes toward researchers and research career in Bulgaria.

The majority of the respondents declare strong (between 6-10 years) and very strong experience (more than 10 years) in

research activities, lecturing and teaching. The main experience of FMI researchers on research projects concerns the following topics: ICT in education and e-learning aspects, e-business applications, e-government, digitalization of cultural heritage, signals, biometrics, bioinformatics, soft computing, intelligent systems and others. The results further show that FMI staff has a great number of publications: made mainly on conferences and international magazines. As weak areas for FMI staff were identified: "cooperation with end-users and partners", "administration experience", "innovations and R&D". The FMI staff definitively lacks experience in the field of Patenting and IPR, which can be defined as one of the weaknesses for further knowledge transfer activities and links with the industry.

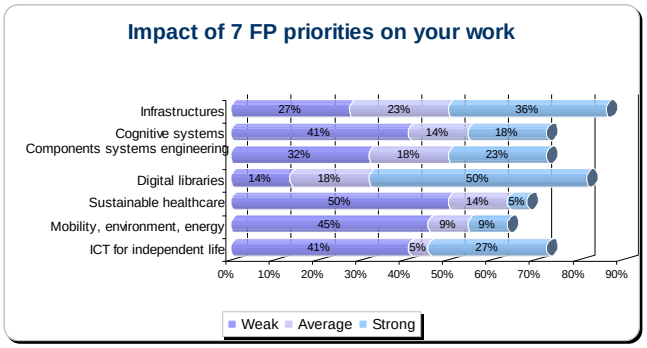


Fig. 6 Impact of 7 FP priorities on FMI research

According to the survey [1], FMI researchers are well informed about the priority areas in ICT set by the FP7 program of the European Commission. Most of them identify their research interests, experience and competences mainly in the areas of Digital libraries, Infrastructure and ICT for independent life. There is small interest in areas like mobility, environment and energy, sustainable healthcare and cognitive systems. The impact of ICT priorities of FP7 on FMI research are shown on Fig. 6 [1]. Researchers recognize that the Bulgarian society and business will be influenced mainly by the Digital libraries program, Infrastructures and healthcare, components, systems and engineering and mobility, environment and energy.

The main specific challenges for FMI related to research in Computer Science and ICT may be summarized as follows:

- FMI has to overcome the lack of experience and aspiration to *interdisciplinary research and education*. Moreover, the Faculty should play a leading role at Sofia University in the establishment of proper flexible rules and corresponding documentation supporting interdisciplinary academic activities.
- FMI should initiate a debate aimed at considerable improvement of the existing heavy *administrative procedures and financial rules* at Sofia University in order to increase the motivation of FMI staff for research and project activities.
- The *organization of the educational process* at FMI should be rearranged and optimized in order to ensure more time for research and innovation in the ICT area for the teaching staff of the Faculty.

The main areas for further (continuous) skills improvement, identified by FMI staff, are Project management, New Programming skills, Technology transfer, organizational skills and others. The identified needs for additional training are related to the FMI researchers' intentions to improve themselves in management of international research projects and technology transfer, improving industry-academia partnerships and cooperation (Fig. 7) [1].

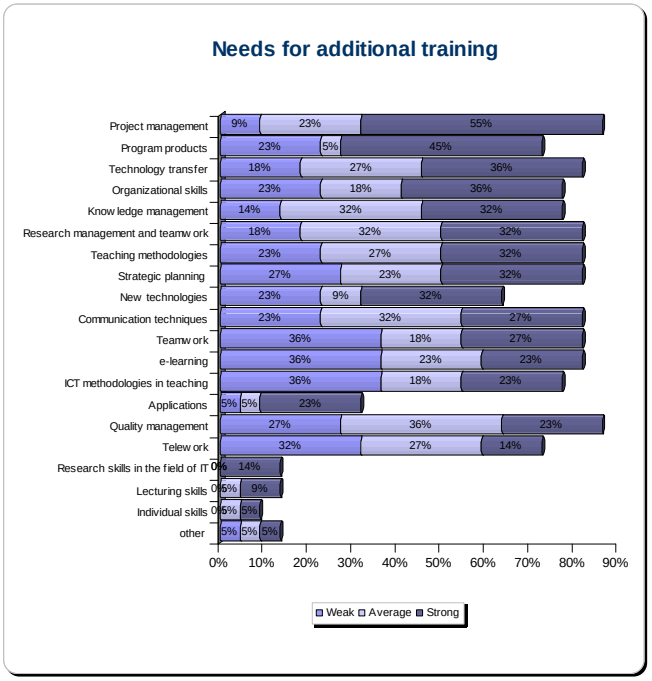


Fig. 7 Needs for additional training

For personal development and career of researchers is essential the working environment, both the employer and the national landscape. The general attitude of the respondents is that there are weak processes for planning strategic research and innovation activities at FMI (64%). In addition, they claim that FMI lacks clear mission, vision, values and priorities set in the research (68%). Strategy issues in FMI are in generally considered as weak and at low level (Fig. 8) [1]. Furthermore, majority of the respondents (41%) are aware of the lack of standards and measurements of success and consider that FMI has not sufficient capacity to evaluate the progress and effectiveness of its internal processes.

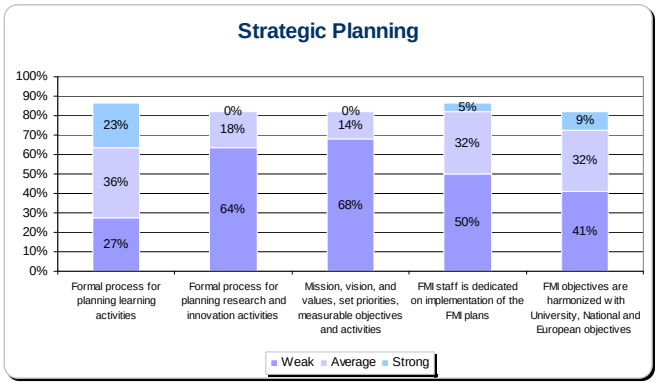


Fig. 8 Strategic planning in FMI

The question concerning evaluation of existing infrastructure and resources reveal the material problems in FMI. Among the main problems are identified the lack of access to recognized literature sources and magazines, learning materials, lack of enough researchers, lecturers and technical support staff and lack of modern research labs. The best resolved problem at FMI is the availability of modern ICT for lecturers (Fig. 9) [1].

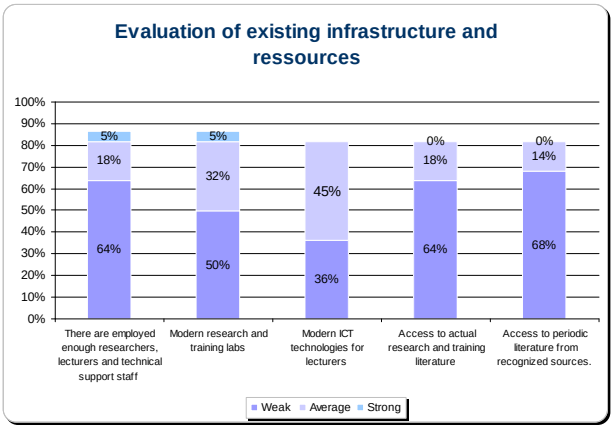


Fig. 9 Evaluation of existing infrastructure and resources

E. FMI external relations

Another weakness of FMI is related to its role and relations with students, industry and society. Only 14% of the respondents are confident that FMI has adopted systematized processes for identification of students' needs and satisfaction. The majority do not agree that FMI regularly collects and uses external feedback and information from students, society and industry in order to improve its internal processes and activities. In general, FMI is not considered as participative and communicative organization – it rarely issues messages to the society (Fig. 10) [1]. The weak communication of the success and results to the society in general results in lack of documents and evidences for the successes of FMI, especially in electronic and printed media.

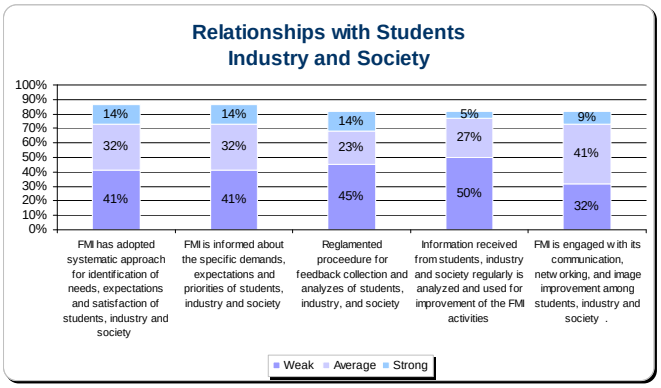


Fig. 10 FMI relations with students, industry and society

The survey among users of FMI services further pointed out that the collaboration in research and innovation is not at sufficient level (Fig. 11) [36]. The relationships are mainly in the area of training of employees and further professional development.

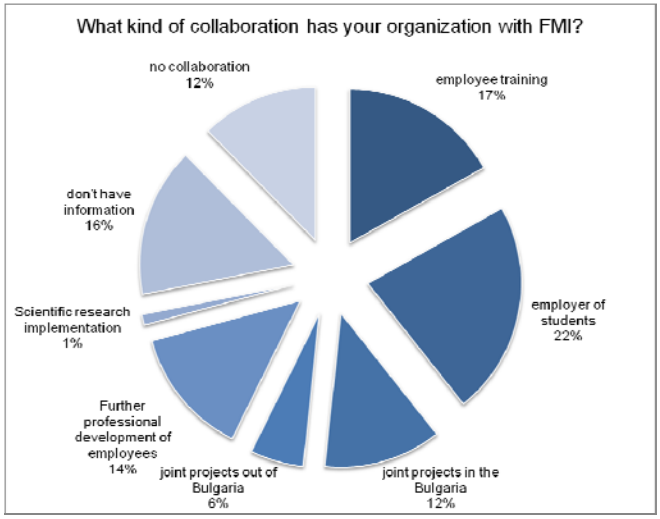


Fig. 11 Collaboration between business and FMI

The main goal of the users' survey was to analyze and determine the current situation about student's education, the needs of employers, the level and capacity of students educated at FMI. A special attention was paid on PhD and postdoctoral training, and the ways of beneficial collaboration with the industry.

It should be noted that the users' survey [36] showed that the employees are considered with very good level of skills in the field of business intelligence. At second place are pointed out the employees' skills in artificial intelligence. At excellent level are educated bachelor and master students in programming, whereas the PhD students have high competences in analysis and design, requirement analysis and project management. In addition, FMI students have excellent skills in product testing, and a good level in ideas generation and product innovation. The worst results are in the area of product commercialization and business process reengineering, as well as in pilot implementation.

During the FMI surveys were prepared SWOT analysis for capacity, technology, innovation and education. A summary of the analysis of FMI survey is given in Table II [36].

Table II: SWOT analysis of FMI

	STRENGTHS	**WEAKNESSES**
INTERNAL FOCUS	• Bachelor technology education degree is very high ranking in the abstract part. • Strong technology education at all. • High level of development of joint technology projects local, as well as international	• Lack of management information systems education • Many unsatisfactory answers of education quality in some areas. • Low level of business collaboration practices. • Part of the staff is hesitant to accept any changes in working life.
	OPPORTUNITIES	**THREATS**
EXTERNAL FOCUS	• Faculty has autonomy in its own management. • Capacity to increase computers and networks. • Ability to deliver information services on time. • To involve hardware and software suppliers.	• Persistent education just in the strong technology fields excluding interdisciplinary competences required from the business. • Not keeping abreast of the advance of ICT R&D

Besides, the challenges for FMI are closely linked to the advancement of the knowledge economy and society [26]:

- FMI should link its activities to *facilitate the usage of electronic content and services*, the provision of e-learning opportunities, as well as to support SMEs together with the IT cluster organizations to make maximum use of ICT and grasp their benefits for higher competitiveness and growth.
- For FMI researchers, there is a need to *focus on the real end-users demands* and to change curricula on the bases of technology trends, companies' and societal interests.
- *More structured contacts* should be established for joint research projects with industry, exchange of staff, internships and joint supervision of PhD students, knowledge brokerage events, etc. A regular communication with industry and business organizations will further support the establishment of strong intersectoral collaboration and linkages.
- *Higher transparency of FMI research results* might be a first step towards better collaboration with industry in research. A successful innovation platform, exploring various faces and approaches for knowledge transfer will allow better exploitation of knowledge resources within organization and in the environment, motivating and fostering new value-adding activities.

IV. FMI RTDI STRATEGY

A. General requirements

The general background of ICT development in Europe and in Bulgaria faces FMI with a number of challenges for adoption of a comprehensive strategy and action plan in line with the general and national trends.

FMI staff takes into account contemporary global educational trends and the main challenges ahead universities in the knowledge economy. First, universities should be aware of the labor market trends, and the skills and competences required by employers. Second, they need to provide up-to-date curricula and courses. Both call for a strong and multilevel collaboration with industry, and building in most cases an effective industry-academia partnership.

The competition among universities requires also that the strategy for attracting, educating and maintaining students and preparing them for future jobs must be coherent with the Faculty and University strategy. Therefore, a number of general issues need to be resolved [26]:

1. The first important issue is to create an *organizational framework* providing clear objectives for the long- and medium-term development of FMI, supporting collaboration and knowledge transfer within FMI, as well as facilitating all ICT-related activities.
2. Given the fact that financial resources are limited, *R&D and innovation investments* should be targeted towards strategic areas that will potentially function as economic multipliers. A clear strategy should be in place outlining priorities for research and education, and relating them to economic and societal needs and possible financial sources.
3. As in the contemporary society no organization could survive on its own, an emphasis should be placed on *developing strategic partnerships*, networking and twinning with other universities and learning providers, public bodies, industry and business organizations. There should be a clear focus on knowledge transfer and innovation, as well as meeting demands for skills and competences of the future employees.
4. Faced with the brain-drain and ageing of researchers, there is a need for targeted actions to establish a *favourable environment for young researchers*, including advanced technologies, access to knowledge, as well as career development prospects.

B. Goals and objectives

Formal strategic planning is a relatively new phenomenon at Sofia University. At present, no approved university and Faculty strategic plans exist. Therefore, the FMI team follows the best practice and benchmarking of the university leaders. In particular, the strategy plan [35] is defined following BSC methodology [16]:

- *FMI Vision:* Creating a Faculty community that becomes locally and internationally recognized in research, teaching and service, and recognized nationally for student excellence. This will establish

a reputation of being more valuable to all stakeholders.

- *FMI Mission:* Provision of a flexible, multi-disciplinary environment for high quality informatics research and education using latest technologies and world expertise, and achieving excellence in research and teaching within the university, country and international IT/IS communities.
- *FMI Strategic Objectives:* The Faculty mission and vision require more stakeholders-oriented decisions. The FMI strategic plan focuses on specific goal and objectives to advance the mission and to attain the vision.

The FMI education and research system, consisting of departments and institutions governed by the Faculty board, delivers public undergraduate, graduate and postgraduate education, information and research services in Bulgaria and, on a limited basis, to other countries. These departments collaborate in order to provide to the society high quality, accessible, relevant and efficient educational programs and services.

The FMI strategy sets the following goals [26]:

1) Undertake continuous efforts to increase the quality of FMI education, training, research and information services to gain program competitiveness, ensure high levels of achievement and knowledge.
2) Ensure that education and research services are relevant to the needs of Bulgarian citizens, laborforce, industry, local and state government.
3) Provide individuals of all ages access to education, training and information services in order to develop their competences and to become globally competitive workers, responsible citizens, capable for lifelong learning.
4) Ensure efficient operation and management of the education and research system, and investments in ICT focused on student learning, in order to reach greatest benefit from education and research resources.

C. FMI key priorities

The priorities of the FMI RTDI strategy in ICT [26] could be presented in four different views on the bases of Balanced Scorecard methodology - Financial, Stakeholders, Internal processes, and Learning and Growth.

The Financial priorities are the same for all areas – Education, R&D and Innovation, and they comprise:

- Revenue growth for all activities
- Improve cost structure at FMI
- Increase foreign financing (EU / non EU)
- Enhance industry support (Grant, Commercial)

The Internal processes priorities are common for all areas:

- Facilitate operations
- Support collaborative activities at FMI
- Improve collaboration

The Learning and Growth priorities are common for all areas and include:

- Champion leadership at FMI
- Faculty members competences development
- Development of lifelong learning culture
- Equal access to technology and Innovation

The Priority Areas for ICT Research in FMI were identified having in mind the results of the analysis of EU policy in ICT, the SWOT analysis and the survey of Bulgarian stakeholders. The brainstorming at the Expert panel meetings also supported to determine the following priority areas for ICT research:

- Fundamentals of Computer Science
- Intelligent systems (incl. Intelligent Content and Semantics)
- Information systems
- Information security
- IT services
- Software intensive systems
- Bioinformatics
- Computer graphics
- e-Learning.

The Priority Areas for ICT Innovations in FMI came out of the analysis of the innovation policy trends and challenges for Bulgaria, as well as of the surveys carried out. The project team identified the following priority areas for FMI innovation [26]:

- Promoting innovations in education and R&D with a special focus on commercialization of results
- Expanding the cooperation with stakeholders for educational practice and fellowships
- Promotion of a flexible and open innovative solutions in all areas
- Creation of efficient technology transfer mechanism
- Increasing the collaboration with Bulgarian and European stakeholders
- Building flexible failure culture by better usage of lessons learned
- Expanding technology entrepreneurship education at undergraduate, graduate and postgraduate levels.

D. Key performance indicators

Once the strategic objectives are identified, FMI managers can measure performance in terms of how well is executed the strategy. Key performance indicators allow fast and complete overview of the efficiency of processes in organizations. Therefore, within the identified strategy, KPI help to define and measure progress towards university goals [19], [35].

For successful implementation, measures should [37]:

- focus on important faculty issues
- link strategy and tactics
- help assess performance against a baseline
- provide feedback that guides changes.

In the FMI draft strategy are defined some practical, meaningful measures which will assess the effectiveness of FMI management and its support to mission accomplishment. Following the Balanced Scorecard methodology, the measures are split into 4 perspectives:

- *Financial measures*: including different financial sources of FMI

- *Stakeholder measures:* including University image rating, stakeholders' satisfaction rating
- *Internal Processes measures:* focused on measuring the improvement of Operations and Management processes, and the Regulatory and Social processes
- *Learning & Growth measures:* measuring Human Capital, Organizational Capital and Informational Capital.

The learning and growth measures are of special importance in the knowledge economy. Some of the measures identified are related to the human resources growth, the motivation of young people/PhD students for a research career, reward and remuneration initiatives, teambuilding, internal knowledge transfer, adoption of best academic culture practices, etc.

The stress is on development of performance measures for leading drivers. Learning and growth perspective of the strategy map is obligatory strategic consideration in present competitive academic environment [4], [33]. This perspective identifies the intangible assets that are most important for the strategy: which jobs (the human capital), which systems (the information capital), and what kind of climate (the organization capital) are required to support the value-creating internal processes. These assets must be bundled together and aligned to the critical internal processes.

The FMI team stresses the strategic performance of the faculty, rather than its contribution to separate academic function. It tries to give the faculty executives timely and strategically relevant measures of intellectual capital performance and the leading indicators about it. The complete process for building and implementing a strategic management system [19] is present on Fig. 12 [31].

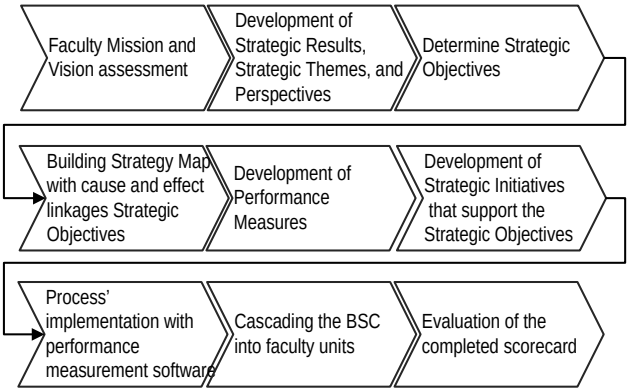


Fig. 12 Building and Implementing a Strategic Management System

V. Conclusions

Faced with the rapid technology changes, educational institutions need to broaden curricula and implement new teaching methodologies. At the same time, there is a need for a broad partnership approach and more active involvement of industry in the educational process and research activities.

Despite that FMI has strong linkages with the IT cluster and several IT companies in Bulgaria, e.g. IBM, Microsoft, CISCO, etc., the links with industry need a lot of changes in order to meet the needs of the knowledge economy. There should be established more structured contacts for joint projects, exchange of staff, internships and joint supervision of PhD students, knowledge brokerage events, etc. Higher transparency of FMI education and research results might be a first step towards better collaboration with industry. What skills are needed for FMI researchers in order to enhance the dialogue and collaboration with industry and to turn their ideas into innovative products and processes should be also considered. A regular communication with industry and business organizations will further support the establishment of strong intersectoral collaboration and linkages.

Thinking more globally, the model of open innovations provide deeper opportunities to work with the smartest experts both inside and outside the organization, to benefit from external R&D, to build better business models for exploitation of innovations, to make best use of external and internal ideas and knowledge. A successful innovation platform, exploring various faces and approaches for knowledge transfer will allow better exploitation of knowledge resources within organization and in the environment, motivating and fostering new value-adding activities.

Finally, FMI should widely explore the opportunities for integration into the European Higher education area and the European Research Area and undertake actions for strengthening research collaboration, building attractive universities, and creating a favourable environment for study, work and life. The development of joint courses and degrees with EU universities could draw Bulgarian universities into the mainstream teaching activities of the EU, and strengthen their integration in the European Higher Education Area.

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