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Northern E-Dimension Action Plan: E-Skills Study in the Baltic Countries and Northwest Russia

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Abstract. The study is the first attempt to systematically gather information about what is happening in research and education in the ICT field in the Baltic countries and Northwest Russia, so it is mostly a general investigation and fact-finding project, leading to possible future research and activities in the field.

The study will estimate how well the supply of eSkills, that is, educated ICT graduates, meets the requirements of the ICT industry and the needs of the market in Northwest Russia, Kaliningrad, Estonia, Latvia and Lithuania. The main objective of this study can be divided into three tasks:

- Surveying educational organisations providing ICT education and training in the region. The main technical universities, high schools and other public and private institutions, as well as research centres, will be examined with the goal of charting what specialists are being produced and what research is being carried out in the universities and research institutions of the region.
- Identifying the market needs for ICT competence with the focus on the ICT industry and SMEs.
- Highlighting discrepancies between the supply of ICT educated graduates and the demand of the digital economy.

Key words: information and communication technology, eSkills, ICT competence, research and education, digital economy.

1. Introduction

1.1. *Purpose of the Study*

The purpose of the study is to investigate the opportunities for future co-operation in the Northern region in the field of ICT research and education. One of the central aims of the study is to identify preconditions for this co-operation and ascertain what collaboration would at first be reasonable.

The focus of the eSkills part is on ICT higher education and the demand for ICT specialists in the knowledge-based economy. It comprises only one rather narrow part of a wider area of eSkills, which consists of many different levels of skills and groups of

people, that is, from the general level of computer literacy of citizens to the specific skills of ICT professionals.

1.2. *To whom the Study is Addressed*

The feasibility study will serve as a guide for policy makers in the framework of NeDAP, as well as for local governments and other key actors in the Northern region. The study highlights the opportunities and potential for future co-operation in education and research in the ICT field.

Another audience, which may find this study useful, is universities and research institutions working in the ICT field. On the basis of the study's results, some concrete contacts can be made between the universities and research organisations with the aim of co-operation and mutual benefit.

Educational institutions may create contacts in order to intensify their co-operation and organize educational programmes for ICT specialists with participants from different countries in the region.

Scientists working in the ICT field may find some interesting new research directions in this study, which might be taken further in collaboration between scientists from different countries, and new international scientific groups can be created.

2. ICT Specialists after Graduation

2.1. *Estonia*

According to the Statistical Office of Estonia, the unemployment rate of ICT professionals is 0%.

After graduation about half go to work in the ICT sector, about 40% will work outside the sector but as an ICT specialist and 10% will change the specialisation. Those continuing studies at the next level are excluded. However, this ratio is very hard to estimate and may be quite wrong (e.g., in the USA, 2/3 of ICT specialists work outside the ICT sector).

Estonia has a small ICT sector, the biggest IT departments are in banks.

Most students already work while studying at university. TTU estimates that 90% of final year students in ICT are working. One of the main reasons for leaving university before graduation is to work.

Most students, who are obliged to do practical work, do so at their own work place. Most students will work after their studies at the same work place, where they worked while studying.

73% of the subcontracting activity in the Estonian ICT sector originates from abroad. Typically, subcontracting involves the assembly of various communication equipment and software outsourcing. As a result, subcontracting revenues constitute 60–100% of the Estonian turnover of telecommunications equipment production, industrial automation, consumer electronics and components, and about 15% of the computers and office machinery sub-sector in 2000.

2.2. *Latvia*

The development of information systems and software may well become Latvia's leading export over the next 10 to 20 years, bringing Latvia's IT export volumes closer to the level of those in the West – as much as Ls 4 billion per year.

The cornerstone for producing software and offering IT services is the educated and skilled specialist. Today, the problem is an inadequate number of educated and motivated employees, and this is keeping Latvia from increasing its export volumes to any really significant degree. Less than half the university students in these fields in Latvia graduate on time, because many students must work in order to finance their studies. The deficit of IT specialists, moreover, often leads to less than qualified people getting very good jobs.

The number of people working in the industry will have to increase to 40,000 if significant gains are to be made in exports. This means that the number of university graduates in the IT field must be increased three to six fold.

Latvia's leading software companies – the DATI Group and SWH Tehnologija – ran a study in which they found that additional investments of Ls 2 million a year in the educational system would ensure the training of 40,000 software design specialists in the course of 20 years. Without additional investments, the number of specialists in 20 years will be just a bit more than 1,000 – far less than enough to ensure that the software design industry can become an important export force.

In a survey organised under the auspices of the "Vocational Education and Training 2000" project from the EU Phare programme, 157 ICT companies in Latvia were sur-

Table 1

Forecast growth in the number of employees in the sector

Sectors in the ICT branch	Employees in 2002, compared to existing numbers, %	Employees in 2005, compared to existing numbers, %
Manufacturing		
Of computers and equipment	129	172
Telecoms network operators	88	88
Software development	161	194
Services		
Telecommunications services	126	154
Internet, e-commerce services	257	363
Information systems maintenance	130	153
Consulting	151	201
Hardware services	123	148
Sales		
Of equipment	141	177
Of software	141	173

veyed. The results show that the most rapid growth in employee numbers is expected in the field of Internet and e-commerce services, as well as in the provision of consultations and the production of software.

The ICT sector is based on high-level specialists in the exact sciences and on highly qualified workers. The main demand is that the content of the subjects and courses that are taught be up-to-date in terms of global technologies. This allows employers to avoid the trouble of organizing additional training, or at least to keep it at a minimum. The current educational system basically satisfies this requirement, because Latvia's ICT sector is following the spread of the latest technologies. The problem is that the technologies available at the educational institutions themselves are not being modernised sufficiently because of a lack of money.

2.3. *Lithuania*

Students

During the last five years (1996–2001), the overall number of students has grown in Lithuania from 58,300 to 177,000. In the academic year 2001–2002 there were 259 students to 10,000 inhabitants. Similar tendencies are observed in the education of IT specialists. *700 IT specialists are annually prepared in Lithuania in the state universities and colleges, with the total number of IT students being about 5,000.* Over 1,200 students study in colleges.

The number of IT specialists being prepared in the universities and colleges is obviously too few in comparison with other countries and does not completely satisfy the market needs in Lithuania. In 2001, the intake of students in IT curricula was increased by 60%, while some universities and colleges have even increased their intake by 100%.

One of the most serious problems in Lithuania is the brain drain of IT specialists. Currently, 20% of student respondents do not see a future in Lithuania and would like to find work abroad. Of those going to stay in Lithuania, 41% want to be employees, and only 4% want to create businesses.

One more tendency is the absolute unwillingness of graduates to work in the universities and colleges to conduct scientific activity and to teach (only 5% of the respondents). Subsequently, it will be reflected in ageing of teachers and science officers. To keep young people in the universities and colleges, first of all it is necessary to create favourable conditions for work and scientific activity. The decision of students to stay in the universities and colleges and to continue scientific work can be influenced by the opportunity of target training abroad and co-operation of the universities and colleges with the most advanced IT firms in Lithuania and abroad, participation in prestigious IT actions and events, an opportunity to create, apply and use new IT technologies in their work.

The greatest demand in Lithuania is for specialists in computer science and engineers in computer science, and it is growing with the wider application of IT. The need for specialists in mathematics and computer science grows in areas where IT now quickly takes root. The need for these specialists will also be influenced further by such strategic matters as the development of communications services, wide use of computer engineering and creation of computer networks.

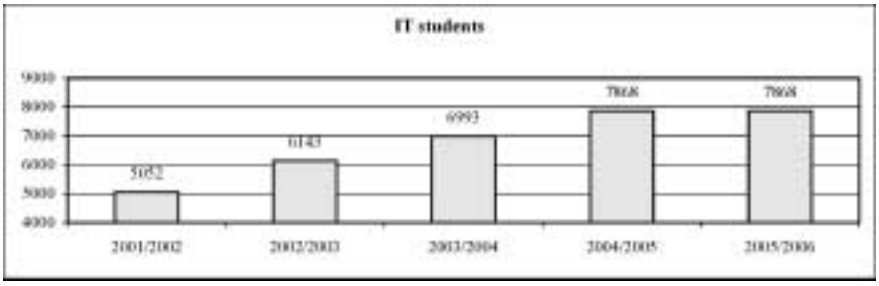

Fig. 1. The forecast of the growth in the number of IT students.

Education of specialists in computer science and the maintenance of their professional qualifications are directly connected to the progress of various information systems, which are part of the infrastructure, creating favourable conditions for development of business and industry. It is expedient that the intake of students in IT programmes not be reduced in comparison with 2001 and increased a little according to the material base of the universities and colleges, number of teachers and needs of the labour market.

Teachers

Currently, in universities there are 288 teachers who occupy 249 established posts. It is estimated that one teacher is needed for each 19 students. Therefore, the forecast for the future need of ICT teachers is as follows:

- in academic year 2001/2002 – 266 (249 established posts);
- in academic year 2002/2003 – 323;
- in academic year 2003/2004 – 368;
- in academic year 2004/2005 – 414.

For this growing need for teachers, it is necessary to encourage training in doctoral studies; see the forecast of the growth in number of students of doctoral studies in Fig. 2. This forecast is based on the data of 1995–2001. It is predicted that by 2005 about 70 students of doctoral studies will write theses for a doctoral degree. But it will not compensate for the lack of teachers since some teachers will leave universities for higher paid work, and also most new doctors will leave universities and be employed in various firms. It is a very acute problem, because a lot of time is needed to educate a qualified expert in computer science.

It is necessary to develop a special programme encourage doctoral studies. There are no longer places for more doctoral studies of computer science and computer science engineering because teachers are overloaded. Some training in doctoral studies is available at the Institute of Mathematics and Informatics. Currently, scientists of the Institute have offered students of doctoral studies about 30 new topics. However, financial restraints do not permit the Institute to accept so many new students of doctoral studies.

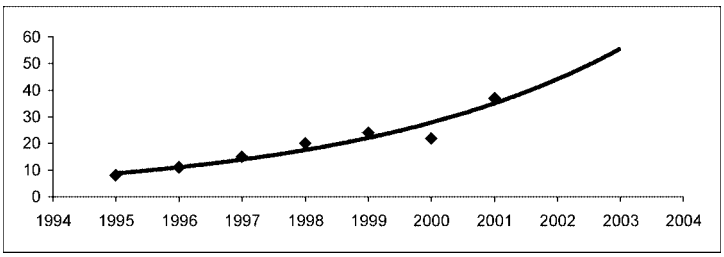

Fig. 2. The forecast of the growth in the number of students of doctoral studies in 2002 and 2003.

2.4. *Northwest Russia*

All the universities follow state standards for teaching programmes and give broad fundamental education in ICT. Although there are many peculiarities in curricula offered by the universities, the graduates from all of them go to work in a very wide variety of enterprises.

The following tables present figures illustrating how graduates from four leading universities providing ICT education are situated in enterprises after graduation.

From interviews and the official reports of the universities to the Committee for Higher Education, it is noted that approximately 90% of graduates have found a job according to their speciality when they graduated.

Table 2

Number of graduates working in ICT enterprises after graduation

University	No of enterprises offering workplaces for graduates (for the last 2 years)
St Petersburg State University of Telecommunications	240
St Petersburg State University of Fine Mechanics and Optics	140
St Petersburg State Electrotechnical University	190
St Petersburg State Aerospace Instrumentation University	160

Table 3

ICT graduates go to work in the following sectors of the economy (distribution of graduates among groups of enterprises (averaged))

Communications	17%
Scientific research institute	13%
Factories	10%
Shipbuilding	11%
Transport	10%
Medical institutions	15%
Food-processing industry	18%
Others	6%

3. The Market Needs for ICT Competence

3.1. *Estonia*

56% of the Estonian ICT companies are in immediate need of specialists in specific products or technologies, 39% need project managers and sales staff. Only 10% currently need research and development personnel, and 20% expect a need for additional R&D staff only in the longer term.

The categories of ICT specialists most in demand, and who can be expected to be hired immediately, are: programming 29%, support 22%, analysis 19%, electronics 12%, management 8%.

52% of the Estonian ICT companies state that there is no one with the required skills on the labour market. However, if an employee has ability, the company will provide additional education. This approach assumes that the person has a general theoretical (university) background. 22% of the Estonian ICT companies complain that available ICT personnel demand too high a salary. This concerns the higher echelon of the specialists.

Several small enterprises are quite dependent on their top specialists. On the other hand, top specialists are quite loyal to their employers.

There definitely exists a need for informatics teachers in secondary schools.

Besides the specialist's competences, the market badly needs competent ICT users. This concerns lowering the digital divide in the community, as well as teaching ICT in universities outside ICT specialisations, e.g., digital signing infrastructure using public key ciphering and data security issues. The users' lack of competence may hinder the adoption of the best services.

3.2. *Latvia*

The ICT sector is based on high-level specialists in the exact sciences and on highly qualified workers. The main demand is that the content of subjects and courses that are taught be up-to-date in terms of global technologies. This allows employers to avoid the trouble of organizing additional training, or at least to keep it at minimum.

The current educational system basically satisfies this requirement, because Latvia's ICT sector is following the spread of the latest technologies. The problem is that the technologies, which are available at the educational institutions themselves, are not being modernized sufficiently because of a lack of money.

Even more important will be the demand for specialists and ICT solution providers who have *the very highest qualifications.* There will be a need for a larger number of specialists who can introduce new products, adapt software to user requirements, etc. Educational institutions must focus more closely on co-operation with the world's leading IT products manufacturers, so that specialists who can be certified by companies such as Microsoft, Cisco, 3COM etc., can be prepared during the educational process.

The number of university graduates in the ICT field must be expanded as much as possible, at least three-fold or even better six-fold. The larger companies which work in

the IT sector understand the meaning of education very well, helping the process along in various ways, such as scholarships for the best students, permission for employees to teach classes at universities, organisation of student conferences and competitions for scientific projects, support for the participation of Latvian students in local and international Olympiads etc. It cannot be hoped, however, that Latvia's companies will be able to bear the entire financial burden of educating the employees which they need, because enterprises have to invest all of their available resources in expanding their own operations and creating new jobs.

According to the study of Latvia's ICT companies, it is clear that in sectors where the most rapid growth is expected and where new jobs will, therefore, be created (software manufacturing, Internet and e-commerce services and consultations), specialists with the fourth level of qualifications are in greatest demand (Table 4).

The Latvian educational system has five levels of professional qualifications:

- Level 1 means preparedness which allows the person to engage in simple tasks in a specific area of practical activities; simple work supervised by someone else;
- Level 2 is a person who can engage in qualified work without supervision;

Table 4

Distribution of the qualifications levels of employees in the sectors of the industry

The ICT sector	**Proportion of employees at each level of qualifications in the sector, %**					**Forecast employee numbers, compared to current numbers, %**	
	1^{st} *level*	2^{nd} *level*	3^{rd} *level*	4^{th} *level*	5^{th} *level*	*2002*	*2005*
Manufacturing							
Of computers and equipment	6	9	24	37	24	129	172
Telecoms network operators	4	13	26	32	24	88	88
Software development	2	10	24	36	28	161	194
Services							
Telecommunications services	3	13	26	34	26	126	154
Internet, e-commerce service	7	12	20	40	21	257	363
Information systems maintenance	3	9	30	38	21	130	153
Consulting	6	7	22	33	32	151	201
Hardware services	2	21	32	29	17	123	148
Sales							
Of equipment	2	8	25	41	25	141	177
Of software	1	6	28	43	22	141	173

Table 5

Forecast for professional demands

Profession	**Forecast employee numbers compared to present numbers, %**		**Forecast proportions of employees in these professions in the sector, %**	
	2002	*2005*	*2002*	*2005*
Programmer	173	215	10.2	11.0
Software project manager	133	160	3.2	3.5
Systems analyst	133	160	3.2	3.3
Tester	214	239	2.6	2.5
ICT consultant	149	195	2.0	2.3
Computer network / system administrator	103	119	1.7	1.7
Database administrator	145	174	1.5	1.6
Database designer	215	258	1.2	1.3
Internet page designer	232	314	0.9	1.1
Specialist in electronic communications	471	707	0.7	0.9
System architect	282	339	0.9	0.9
Quality manager	192	238	0.8	0.9
Expert on clients in the sale of software and equipment	153	188	0.8	0.9
Software training specialist	171	181	0.9	0.8
Marketing specialist	200	294	0.4	0.5

- Level 3 means preparedness and professional skills which allow the person to carry out specific tasks which involve planning and organization; independent work with supervisory elements;
- Level 4 allows the person to engage in complicated work and organize and lead the work of other specialists;
- Level 5 is the highest level, allowing the person to plan and engage in scientific research work in the relevant sector.

The results of the survey of Latvian ICT companies show (Table 5) that the professions which are most in demand, and in which the largest increases in staff numbers can be expected in the ICT sector, are software designers, software project managers, system analysts, software product testers, ICT consultants, computer network and system administrators, and other professions that are related to the development and servicing of software and Internet applications.

3.3. *Lithuania*

The roots of the Lithuanian labour market are in the electronics industry. Before the restoration of independence, Lithuania had a strong enough electronics industry in which

over 200,000 specialists worked. Conditions were good for the creation of IT enterprises since there was no lack of IT specialists, and the greatest growth in IT enterprises was during the first period of independence. Today in Lithuania there are about 200 active IT enterprises. The basic directions of the Lithuanian IT enterprises are:

- creation and introduction of IT systems;
- creation and introduction of the software;
- telecommunications and services of data transmission;
- preparation of projects, consultation and training of adults;
- manufacture of IT equipment;
- distribution of IT equipment.

The greatest share of the market is equipment at 67% (see Fig. 3). In the markets of the developed countries, software and services is the largest sector, and equipment is about 40%.

The structure of workplaces in economy changes constantly. Many experts recognise that now the Lithuanian economy experiences a structural lack in the labour force. In a modern economy, the trend in the development of the IT industry is obvious. In European workplaces, ICT specialists make up 3.9% of all workplaces (i.e., about 6.5 million workplaces). It is predicted that within the next four years this number will increase by 20% to about 7.8 million.

The other area where specialists in computer science work is in training. The latest studies claim that there are about 1,400 teachers and trainers of computer science in Lithuania.

According to various calculations about 8,000–9,000 specialists in computer science work in the IT industry of Lithuania, and taking into account not only the IT industry, but also the enterprises of "IT consumers", and scientific and educational establishments, this number may reach 15,000–16,000, or about 1% of all the workforce in Lithuania. Therefore, it can be stated that Lithuania lags behind the average European level by fourfold.

Besides, the need for specialists in computer science already determines not only the needs of the domestic market of the country, but also the phenomenon of integration and

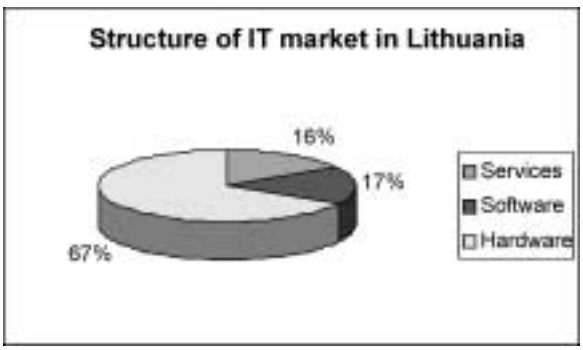

Fig. 3. Structure of the IT market in Lithuania.

globalisation, that is, the labour market becomes global and integrated. This is seen by the following examples:

- Penetration in the markets of neighbouring countries of the enterprises registered in Lithuania (for example, about 40 specialists of ALNA work on from foreign firms, SONEX has created divisions in the neighbouring states).
- Departure of specialists in computer science to work in foreign countries, as confirmed by the official policy the advanced countries (for example, Germany declares it will hire about 30,000 foreign specialists in computer science).

On the other hand, specialists in computer science from other countries come to work in Lithuania, and it is probable that their number will grow. What kind of specialists come to Lithuania? First of all, they are:

- specialists looking for new markets;
- specialists who have arrived through projects of international co-operation;
- specialists who have arrived through programmes of partnership with local enterprises;
- specialists brought by investors.

In Lithuania in 2002, it is predicted that 26,200 new workplaces will be created (about 1.5% of the total labour force) and 17,800 workplaces eliminated (about all 1% of the workforce). The greatest changes are planned in industry and services. These figures show that there is a process of re-structuring in the labour market in which traditional skills give way to new skills, and it is probable that a relatively large percentage of the eliminated workplaces will be replaced by workplaces for specialists in computer science.

A nation-wide IT industry has not been created in Lithuania over the past ten years, neither has there been a programme to develop the IT industry until now, as was the case with the development of the radio electronics industry. Moreover nobody was engaged in studying the market needs, and there is currently no means of regulating the market for training specialists in Lithuania.

Many specialists with higher education (71%) work in small and average IT enterprises in Lithuania. The number of IT specialists, who have finished universities or college, in such enterprises is about 44% of all employees. The number of IT specialists in such enterprises, who have completed training programmes in computer science in the universities and colleges, is about 32% of all employees. 55% of interrogated enterprises are satisfied with the quality of the training of specialists in computer science. The interrogated enterprises are satisfied most of all with the qualifications of specialists in computer science from Vilnius University (VU) and Kaunas University of Technology (KTU) (one of the reasons that these universities educate the most IT experts). 61.5% of enterprises recognises that there are positive shifts over the last five years in the education of specialists in computer science with the degrees of the universities and colleges.

3.4. *Nortwest Russia*

Two major trends influence the needs of enterprises in the ICT sphere:

1. General improvement in the economic situation in the country and the rise of the economic activity in industry.
2. Diversity of enterprises' sizes and fields of application.

The general improvement in the economic situation leads to a growth of investments in IT spheres as a whole, and in IT education, in particular. According to IT Academy studies, the prognosis for the change in the rate of investments in IT education in the Russian Federation gives 10–15% increase a year:

IT and IT education market prognosis (mln dollars)

Market estimate	2001	2002	2003	2004	2005	2006
IT market	2.786	3.145	3.475	3.822	4.166	4.500
IT educations market	25	31	38	45	48	54

Gartner Group studies predict 13% a year growth in the world IT education market and 15% in the Russian Federation market.

So, the first trend is steady growth in ICT education needs and stable investments in it. The second trend is that, in fact, the market is not uniform and the requirements of different groups vary depending on their peculiarities.

From this point of view, the following groups can be distinguished:

- ICT industry enterprises – large and SMEs;
- other industries' large enterprises;
- SMEs;
- outsourcing jobs.

The ICT industry large enterprises are usually the leading and very dynamically developing enterprises. They need to employ specialists of various qualifications in a range of specialisations. Only these enterprises have an opportunity to offer employment to the high-skilled specialists and provide a high salary (2,000–3,000 USD). There exists a shortage of such specialists in the labour market.

SMEs in ICT are usually companies selling communication items and/or computers. They often use to employ new graduates and even students from four- or five-year courses, which is certainly more profitable. There is no problem finding such workers. Such enterprises were the first to introduce e-commerce.

Large enterprises in different branches of industry have clearly understood that good and efficient IT support is a cornerstone of competitiveness and profitability in their future. Most of them began to introduce complex information systems including local and intranet networks, databases, management programmes like ERP, that is, those providing IT support to all business processes at the enterprise. For these purposes, they organize their own IT divisions and hire specialised firms for implementation and further consulting and support. A good example is the "Severnaya Verf" shipbuilding company. Such companies need a wide range of specialists in ICT, including very highly qualified specialists possessing at least 4–5 years' experience in particular programming products.

These teams also need programming developers to precisely adapt the tasks to concrete business processes.

SMEs of other industries

Despite differences in the working domains, the needs of SMEs are to a great extent similar. In the first place, they introduce the next set of programmes and in the following order:

- office technologies, local networks;
- book-keeping, salary;
- warehouse, marketing and sale, Internet using;
- HR management;
- logistics and other business processes.

Usually SMEs have one or more ICT specialists of medium expertise and they readily employ postgraduates and students. Often they use only the service support of the companies that installed the software. Trading enterprises are the ones that mostly think about and begin to carry out e-commerce.

Outsourcing jobs

Many foreign companies and their affiliated branches have started to use outsourcing for solving their tasks. They use small specialised firms, teams of specialists and individuals specifically for the development of software and similar problems. The requirements of such specialists are very high and firm. Still this kind of business is developing very quickly which means the availability of specialists meets the demands.

4. Does the Supply of ICT Specialists and their Education Correspond to the Demand of the Market and Needs of Industry?

4.1. *Estonia*

Estimates of specialists needed at present in ICT vary from 500–6,000 (according to different newspaper articles). Estimates of the annual need for new ICT specialists with higher education also varies greatly from 400–1,000.

Some talented Estonian ICT specialists go to work abroad. It may be possible that this tendency will grow if Estonia enters the EU.

It is very uncertain to forecast the need for specialists in future, because most of the Estonian ICT companies have no development strategies. In part, this is due to the ICT sector collapse in 2000 and the general economic uncertainty. This is also because several Estonian ICT companies are mostly subcontractors of foreign companies.

Nevertheless, employers expect that there will also be a great lack of ICT specialists in two years time.

The Estonian National Development Plan states: “There exists a great lack of highly qualified engineers in technical fields connected with the development of new products and services, including the IT field.” IT is the only specific field mentioned.

However, some authors express their concern over producing too many ICT specialists in future, drawing attention to the fact that ICT personnel are predominantly young and, thus, no one will retire in the near future. According to Indrek Reimand, who is an expert in the field of Estonian ICT education, Estonia is now far from producing too many ICT specialists.

Several foreign investments have not been made, and several projects in Estonia were not realised, because there were not enough ICT personnel.

As the ICT sector has high salaries, the policy-makers of Estonia expect that the need for ICT personnel can be solved by fee-based education. However, business education is so expensive, and the academic requirements for suitable students are so high, that fee-based teaching does not supply sufficient specialists. The solution is to open more state-financed student places in universities.

Conclusions: some tasks to solve

- Based on regular financing, public universities are unable to invest in ICT as much as necessary while ICT equipment and software is expensive and is quickly out-of-date.
- ICT teaching staff are underpaid and recruited to work at companies.
- A balance must be found so that industry does not impoverish engineering education and research by attracting young talented researchers exclusively to industry. It is vital for the development of Estonian society that industry is backed by strong publicly financed research and education. This can only be accomplished by having a proportion of young scientists devote their talent to research and education. An absolute necessary component in the future policy in order to reach this goal is to offer salaries to young scientists, which are competitive with salaries offered by industry.
- The companies expect students to have practical skills in the new technologies. However, education in ICT has to be of a universal nature to make it easier for students to educate themselves throughout their work life.
- The academy – companies linkage is quite weak in Estonia. In fact, almost no R&D activities are performed in companies, and universities do not perform R&D for companies. But several initiatives have been started in Estonia, including technology centres at TTU and TU, *spin-off'* programmes and strengthening science parks.
- Generally, Estonian IT is tilted towards PC and Microsoft for historical reasons (there was no IBM mainframe, Sun, Alpha etc. traditions before independence, so Estonian computerisation started from small units, that is, PCs). This is reflected in the ICT higher education as well. First, the market demands PC-oriented knowledge, which is dominant here; second, universities are burdened by PC traditions, and while there is a permanent lack of resources, they are unable to obtain other platforms. Universities acknowledge the need to strengthen other platforms.

- The Estonian electronics and software industry is bound to develop rapidly and educational initiatives must closely match this development. There is a definite high demand for software (study field: Informatics) specialists, while the electronics, telecommunication and computer design labour market is probably not yet strongly developed.
- An annual increase of students of Informatics by 20 percent in the next few years would probably correspond to the future demand for ICT specialists in Estonia.

4.2. *Latvia*

Ernst & Young and the Latvian Development Agency recently published a research project called "The Information Technology Services Sector Study", which said that there is a lack of conformity between university training programmes and the demands of industry. The authors noted that universities usually train good theorists in computer sciences, but there is insufficient training in practical work in the area of major software design projects.

Statistics about the number of employees in some ICT sectors can be seen in Table 6.

Conclusions: some tasks to solve

- There should be increased investments and support for ICT education and training at all levels.
- No less than 5% of government investments should be aimed at the training of highly qualified IT specialists.
- Requirements for a doctorate in the ICT field should be normalised and harmonised with European practice.
- The involvement of Latvian scientific institutions and companies in the European Union R&D programmes should be enhanced, ensuring sufficient information, enabling participation in international events and supporting the preparation of project applications.
- Research work at universities should be supported, and the commercialisation of research results by Latvian companies should be fostered through the involvement of risk capital.

Table 6

Number of employees in some ICT sectors (Central Statistics Bureau)

	1999	2000	2001
Number of employees in electronics industry	5.508	5.547	5.269
Number of employees in telecom industry	70177	6.774	6.678

- Lifelong education should be fostered; the government should support efforts to update skills and knowledge, as well as programmes aimed at retraining at higher education institutions.
- There should be more highly developed dialogue between employers and educators when it comes to the extent to which educational programmes are in line with the needs of the sector.
- The support of enterprises for education should be enhanced by repealing taxes on investments in the setting up and maintenance of internship facilities, and on gifts that are presented to nationally accredited universities.

4.3. *Lithuania*

Most employers consider that it is necessary to educate more specialists at the university level – 43.5%, compared with 14% at a non-university level. In the opinion of employers, university education should concentrate on the formation of knowledge and the skills necessary to make decisions concerning strategic problems and the management of these problems, and that a university education is necessary for deciding about practical tasks. Moreover, university education is broader and more in-depth than non-university education. Employers are optimistic when speaking of the need for specialists in the future, confirming the number of new workplaces predicted.

The employers believe that in 2003 the increase in the need for specialists in computer science is planned to be 2.45 times, compared with 2002, in 2004, 2.76 times, in 2005, 3.47 times and in 2010, 5.21 times. This is rather optimistic. A more realistic estimate is 20–30% annual growth in the need for specialists. This script corresponds to trends in Western Europe. Lithuania is estimated to be four times less than Western Europe, and a growth in the need for specialists of 20% every 4 years is predicted.

The need for specialists is predicted as follows:

1) 93% of the graduates of the universities and colleges in 2001 were employed according to their speciality, and it has completely satisfied the domestic needs;
2) the need for specialists in the future will grow annually from 20% (minimum growth) to 30% (maximum growth). Experts predict such growth in IT enterprises will take place in the near future.

Summarising the needs and experience of IT enterprises, it is necessary to note that specialists in computer science generally do not have any real experience in the field. It means that in curricula in universities and colleges it is also important to pay attention to training. According to the study, students are not trained enough:

– to work in a team,
– to communicate,
– to think systematically,
– to work independently,
– to update knowledge,
– to estimate factors of profitability and time.

The lack of theoretical knowledge is also mentioned in the following tasks:

– management of IT projects,
– planning of information systems and architecture of the websites,
– preparation of specifications of technical projects,
– planning of research activity,
– quality management.

In the opinion of employers, university and college curricula should:

– pay most attention to market needs and business;
– make the training process flexible and energetic;
– teachers should be more in tune with the needs of industry;
– emphasise practical experience more vigorously;
– students should be acquainted with the latest IT products;
– ensure that degrees from the majority of the Lithuanian universities would be accepted abroad.

Summarising the needs of enterprises and their operational experience with the students who have just finished their studies, the skills of specialists in computer science should correspond to the list of specialities most lacking in the market (in opinion of employers):

– heads of IT projects;
– heads of software projects;
– software architects;
– managers of databases;
– specialists in safety of IT systems;
– quality control managers, specialists in testing;
– auditors of IT systems;
– integrated IT projects specialists;
– computer network specialists;
– specialists in designing consumer interfaces;
– specialists in designing automated equipment;
– Internet and multimedia designers;
– managers of specific operation systems and platforms (LINUX, UNIX etc);
– specialists in the management of knowledge and programming.

All this shows that the knowledge of ICT specialists, the ability to use that knowledge, as well as personal qualities are important for employers.

Conclusions: some tasks to solve

- From the point of view of some companies employing ICT graduates, the education of students is too theoretical, not in touch with practical problems and tasks, or too narrow. Universities and colleges should reconsider their curricula and also update and correct the contents.
- So that young specialists can be included in business in Lithuania, it is necessary to create 3–5 incubators or business and technical integrated parks of IT business

and science, creating an opportunity for them to use all the necessary infrastructure and services on favourable terms.

Employers consider that the following factors prevent the successful activity of the universities and colleges:

- in the education of specialists insufficient attention is paid to the requirements of the market and business;
- in universities, insufficient attention is given to the ability to put knowledge into practice, unsolved problems of students in IT enterprises, weak connections with IT enterprises;
- educational process is not flexible;
- teachers participate too little in business, do not participate in the large projects and have insufficient practical experience, therefore, the students seriously lack these skills;
- there are almost no young qualified teachers;
- the quality of teaching suffers as teachers are given too many material incentives;
- insufficient investments in knowledge and the qualification of teachers;
- classes are too big;
- practical work by students very formal and short;
- students are given too little information on new IT products;
- weak material and technical base of the universities and colleges.

4.4. *Nortwest Russia*

Most the investigating companies and analysts note in general that:

- rate of ICT industry development is very high;
- need for ICT specialists in Russia and in its Northwest region is also very high;
- education of ICT specialists at universities basically corresponds to the concrete needs of the enterprises.

All graduates who wish to work in their speciality find work. The basic education allows them to be able to quickly adapt to the concrete needs of the ICT at their workplaces and to become full members of the team. Some of them hold key positions in ICT matters in the enterprises.

At the same time, an analysis of enterprises' inquiries for ICT specialists shows not only similar industry expectations but also sheds light on significant discrepancies. 106 inquiries were analysed concerning demands for ICT specialists. The following specialisations are in great demand:

1. Web engineer;
2. e-commerce;
3. Web designer;
4. IT chief manager;
5. Multimedia specialist;
6. Internet and data transmission;

7. ICT analyst;
8. Computer security.

Still there are some significant disparities between education and the needs of industry. The most valuable are as follows:

- The IT specialist must permanently follow technical progress, in which the rate of change is extremely high. The workers in the field must be able to adapt to changes to the business processes and the introduction of new products and services. New technical opportunities and platforms will require upgrades to existing systems and the contribution of new ones. This is a never-ending game. The challenge to the IT professional is to balance and anticipate all these requirements and provide a technical infrastructure and applications that are both flexible and cost-effective. Universities do not have appropriate opportunities, either in hardware or in most up-to-date software.
- The broad education of students in fundamental disciplines makes them able to adapt to various applications of their knowledge, which is a positive thing. At the same time, it is a drawback as the lack of practical skills leads to the need to study at the workplace, and this is often unsuitable for enterprises.
- The latest trend in ICT is that, to a great extent, computers and communication means become an instrument for solving problems in various domains. Professionals in ICT cannot get to the matter of the subject area and such misunderstanding may be rather long. So, the need for interdisciplinary specialists is clear: informatics and economics, informatics and law, informatics and commerce etc.
- It has become clear that there exists a discrepancy between the nomenclature of specialities corresponding to the standard classification according to which the university curricula are formed, and the range of requirements for the specialists put forward by enterprises. They interweave each other. There are no analysts, system administrators, integrated tasks specialists etc.
- There is a discrepancy between the dynamic rate of the market structure development and dynamic changes in education processes, e.g., increase in the demand for specialists in distributed and parallel computing, GRID, content streaming development, in programming logic structures, such as SOC (systems-on-a-chip), CAD/CAM/CAE, robotics etc. There is no systematic prognostication of the marketplace enablement. Systematic informing of professionals in SMEs about the news and perspectives of the field is absent.
- Existing institutions created for vocational training to certified brand products are insufficient for growing demands of SMEs. There is no consulting and software support for SMEs on problems of advanced technologies, e-commerce and distance learning.
- There is no institutional system for training the university lecturers in the new trends in the ICT industry.

Conclusions: some tasks to solve

- The link between public and private sectors is not strong enough.
- It is important to develop new university curricula which will meet the requirements of enterprises to a much greater extent.
- Additionally, the organisation of the Center of ICT Competence equipped with the most up-to-date hardware would aim at solving the following tasks:
    - *Educational:* increasing the educational opportunities for specialists in the Northwest region in most advanced directions of ICT development – GRID, parallel high-performance computing, eCommerce, content streaming etc., thus, decreasing the shortage in skilled ICT professionals.
    - *Promotion of SME development*: rendering vocational services, informing services, consulting services, hosting services.
        - Vocational services (training the personnel in ICT, training by SME ordered programmes and on demand, vocational training by DE means *in situ*).
        - Informing services (design of a special information portal, informing on best practice cases, warning of negative experiences, web publication of the latest relevant news for SMEs etc.).
        - Consulting services (methodical support for SMEs, consulting in the definition of the strategy of eBusiness implementation, help in the choice of such ICT structures that in future will not be in contradiction to eBusiness solutions, help in small individual SMEs' ICT projects, planning of companies e-transformations, e.g., reengineering, refactoring, logistics, etc.).
        - Hosting services (providing Internet possibilities for SMEs, design of web-sites for companies and providing their publication on the Internet, implementation of virtual kiosks, shops, stores by orders, carrying out companies eCommerce transactions, etc.).

5. Conclusions: Regional Overview

The Baltic Sea region represents an interesting area in the field of ICT education and research. The Baltic countries and Russia have inherited from the former Soviet Union a strong educational and research system, which has not suffered the same scale of degradation as the economic system during the first years after the break up of the Soviet Union. However, even in the education system very fundamental changes have been going on. Russia and the Baltic states have had to develop their ICT education and research in new conditions, with diminishing budget funds for research and education and with a growing demand from the emerging private sector. The traditional problem of the Soviet type of educational system with narrow specialisations and a dubious relationship with actual working life also seems to be characteristic during the transition period.

The current study is one of the first attempts to estimate the perspectives for international research cooperation in the Baltic Sea region in the ICT field. There is no other

broad research of this kind estimating how reasonable it is to start coordinated collaboration in the region with the participation of the Baltic countries and Northwest Russia on the one hand, and the Nordic countries on the other. The study by its very nature is a basic investigation – a feasibility study, the findings of which will serve as a general guideline for further investigations and practical steps.

As a general conclusion, it could be argued that on the basis of this study both Russia and the Baltic States have been able to keep up with the development of the ICT sector, especially as far as the theoretical academic level of research is concerned. However, there seems to be many problems with the infrastructure. The development is also very uneven. Although on the basis of this report, some strong institutions and fields of study can be indicated, a detailed international evaluation of the scientific level of the basic research units and universities would be the next inevitable step.

When it comes to meeting the demand and supply, it is worth noticing that even within each country there seems to be a growing domestic labour market in the ICT sector. What the actual needs of foreign companies are, and how they can be matched with the economic needs and educational systems of Russia and the Baltic countries, is also one of the key issues for further analysis. Expanding prospects for international co-operation would give a good basis for such an evaluation. Projects funded by the European Union should, as a first step, identify such interests in a precise and analytical way. So far neither the countries themselves nor the EU donors seem to have any detailed strategy for identifying the strategic starting points for each institutional player. These players comprise universities, academic research institutes, domestic private companies or international firms, and last but not least, EU programmes and domestic public sector policies such as eRussia for the Russian Federation.

In spite of the geographical proximity, the Baltic countries and Northwest Russia hardly collaborate with each other at all in the field of education and research. The break up of the Soviet Union created a situation in which the countries lost their close connection and started to develop in their own ways. Even the Baltic countries, which at first glance look homogeneous and close to each other, do not have many common activities in ICT research or education. The working co-operation links are missing to an even greater extent between them and Russia.

Estonia, Latvia, Lithuania and Russia participate nowadays in international education and research projects separately. There is no coordinated scheme for collaboration in international research or education. However, the region represents a huge potential for such collaboration, especially taking into account the proximity of the Nordic countries with their experience of beneficial scientific co-operation.

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Šiaurės e-dimensijos veiksmų planas: e-gebėjimų tyrimas Baltijos šalyse ir šiaurės vakarų Rusijoje

Eugenijus KURILOVAS

Šis tyrimas yra pirmasis bandymas sistemingai surinkti informaciją apie tai, kas vyksta Baltijos šalyse ir šiaurės vakarų Rusijoje IKT srities tyrimuose bei švietime.

Iš esmės tai yra bendrojo tyrimo ir faktų analizės projektas, kurio tikslas sudaryti palankias sąlygas tolimesniems tyrimams bei projektams IKT srityje.

Tyrimas nustato, ar e-gebėjimai, t.y., IKT specialistų parengimo lygis, atitinka IKT pramonės reikalavimus ir rinkos poreikius šiaurės vakarų Rusijoje, Kaliningrado srityje, Estijoje, Latvijoje bei Lietuvoje.

Pagrindinį šio tyrimo tikslą galima padalinti į tris uždavinius:

- Švietimo organizacijų, teikiančių IKT specialistų rengimo paslaugas regione, apžvalga. Tam kad nustatyti, kokie specialistai yra rengiami bei kokie tyrimai yra atliekami regiono universitetuose ir mokslinių tyrimų institutuose, yra tiriami pagrindiniai technologijų universitetai, aukštosios mokyklos ir kitos viešosios bei privačios mokymo įstaigos ir tyrimų centrai.
- Kompetencijos IKT srityje rinkos poreikių identifikavimas, nukreiptas į IKT industriją bei smulkiąsias ir vidutines įmones.
- Nesutapimų tarp IKT specialistų parengimo lygio ir skaitmeninės ekonomikos reikalavimų, nustatymas.