

INTERNATIONAL CONFERENCE ON NEW HORIZONS IN EDUCATION
INTE2012

The Importance of ICT Sector and ICT University Education for the Economic Development

Milos Maryska^a, Petr Doucek^a, Renata Kunstova^a

^aUniversity of Economics, Prague, Faculty of Informatics and Statistics, W. Churchill sq. 4, 130 67 Prague, Czech Republic

Abstract

ICT (Information and Communication Technology) industry is an important contributor to growth almost every economy. Its contribution to the growth represents 5% of GDP and ICT also drive 20% of overall productivity growth in European Union (European Commission, 2010). In order to hold such portion of ICT sector on total GDP in the future, continuous supply of relevant qualified ICT professionals into this industry is required. These new jobs will have to be saturated by adequately qualified ICT specialists but this is not supported by the number of live births. This paper identified the most important factors that influence economic growth through ICT sectors in EU and especially in the Czech Republic.

© 2012 Published by Elsevier Ltd. Selection and/or peer-review under responsibility of The Association of Science, Education and Technology. Open access under [CC BY-NC-ND license](https://creativecommons.org/licenses/by-nc-nd/4.0/).

Keywords: tertiary education; ICT related study programs; ICT specialists; economic

1. Introduction

ICT is one of the most important factors for development and economic growth in the globalized economy. Currently is our community solving following questions: How much are we depended upon ICT? What will happen after losing ICT support for our processes?

In the context of the previous questions we have to mention that ICT (Information and Communication Technologies) industry seems to be also an important contributor to growth of European economy. Its contribution to the growth represents approximately 5 % of GDP (€ 592.6 billion in 2007) and ICT also drives 20 % of overall productivity growth (European Commission, 2010). The ICT industry includes ICT services and ICT manufacturing from general point of view. ICT manufacturing contributes by approximately 1 % to GDP (€ 130.6 billion in 2007) and ICT service sector is responsible for a little less than 4 % of GDP (€ 462 billion in 2007). These contributions seem to be quite effective, but in

comparison to other big players in world economy it is not enough. For the USA is the contribution of ICT manufacturing 1.33 % of GDP and ICT services represent 5 % of GDP. For Japan is the value of this indicator 2.9 % for ICT manufacturing and 3.95 % for ICT services (European Commission, 2010). Other Asian countries as Korea or China etc. show growing specialization in ICT manufacturing. Using ICT is important step for competitiveness of each economy. ICT are key drivers for innovation putting into work. Improvement of ICT and related innovation activities are permanent processes that combine business processes, organizational structures, competencies and responsibilities, human resources, personal skills, knowledge, hardware, software and other components of organization (European Commission, 2010). These components represent only elements of system, new quality and innovation potential takes with it rethinking of the whole system applying appropriate ICT principles.

One of the main problems of ICT adoption in global society and in corporations is caused by lack of ICT professionals (European Commission, 2010) with appropriate knowledge (Maryska, Novotny & Doucek, 2010) in networked economies (Kelly, 1998). Low number of ICT experts in economies of European countries cause lower innovation activities in this region in the comparison to USA, Japan and Canada. Low number of ICT experts in economies of European countries cause lower innovation activities in this region in comparison to USA, Japan and Canada. One way, how to limit this disadvantage of European countries is to increase investments into ICT education. (European Commission, 2010), (Doucek, Maryska & et al., 2012)

Knowledge of ICT specialists are in the current situation of the existing information technology world characterizes the increasing demand for different roles of Information and Communication Technology (ICT) specialists in different countries and regions. “Fundamental” ICT skills (e.g. programming, development and testing) are more required in countries with emerging economies as opposed to stable and developed countries where the demand is not so massive. In some regions, for example in Australia the rate of unemployment in these professions is permanently increasing according to some sources (Vorisek & Feuerlicht, 2006). In contradiction is (Hagan, 2004). On the contrary, there is an increasing demand for “new” ICT skills (e.g. sourcing, business analysis, multimedia working out, presenting information on social network) (Helfert & Doucek, 2010). We cannot forecast mechanically the demand for ICT specialists – each country and region has its own features and specific character.

As a reaction to the relatively low flexibility of the institutional education system in the ICT skills area, the research team on Faculty of Informatics and Statistics decided five years ago to initiate research activities in order to map:

- ICT education offered in the Czech Republic,
- Demand for ICT skills in the Czech Republic,
- Influence of ICT graduates and ICT sector on GDP.

University education (tertiary education) forms an important component of the education system in each country in the world and this level should be one of the most effective and required in the area of ICT. Other aim of these research activities was to motivate universities and formulate recommendations for further development of the Czech university education in the area of ICT. To set up and formally pass the accreditation process of a new study program takes in minimum one year (only under conditions that relevant school or university has enough experts in required knowledge areas).

The last goal was to carry out a survey of the ICT graduates skills requirements in the Czech business. This survey was performed for three times (2006, 2009 and 2011). Further facts are presented as result of the last survey in year 2011.

2. Problem formulation

Several new questions without answers appeared in our research team during our survey work. How

many ICT professionals will be needed in the Czech economy in oncoming years? At what degree are the domestic universities able to cover this need? Does the lack of ICT professionals endanger Czech economy in the period of recovery after economic crisis? Is the knowledge of graduates in ICT study program appropriate for companies? The aim of this article is to present possible scenarios in requirements on ICT specialist up to 2015 in the Europe with methodology that is presented on the example of the Czech Republic and to evaluate impact of this fact on the Czech ICT job market.

Based on these facts, our team started to formulate the model of possible requirements on numbers of the ICT professionals (Doucek et al, 2007), (Maryska, Novotny & et al. 2012). Relations in this model are based on actual economic trends in ICT sector, partially taken from literature and partially based on our survey's results of Czech reality. The first part of this model is presented in this contribution.

3. Methodology

The first activities for this model formulation focused on number of required ICT professionals in the Czech economy in the future. We had three main sources. The first one - results of our surveys. For this model we used results from 2011 surveys, although actual data from 2011 were not completely evaluated by statistical (cluster analysis) methods yet (some other facts will be presented on conference event in September of this year). Methodology: There were identified main ICT business roles, their key competences, in business informatics in the first phase of the project. After this role definition phase were defined knowledge domains and metrics for measurement level of knowledge in each knowledge domain. The level of knowledge was graduated in relation to ECTS credits on HEIs and in relation to number of necessary training days for appropriate position by business organizations – details in (Doucek et al, 2007), (Maryska, Novotny & Doucek, 2010), (Doucek., Maryska & Novotny, 2012).

The second main source is the future economic development scenarios prognosis (McCormack, 2010) and data concerning ICT industry in the Czech Republic, collected by European Commission in Digital Competitiveness Report 2010 (European Commission, 2010). Data from UIV (Institute for Information on Education) are the last source of information in this contribution. These data deal with number of students and graduates in ICT - related study programs in the Czech Republic's HEIs (Higher Education Institution). Prognostic model was formulated based on demographic projection applied on data from surveys - ICT related study programs enrolled students and required numbers of ICT specialist for ICT business roles now and in the future. Results of this model are combined with conclusions of McCormack's (McCormack, 2010) prognosis in this contribution.

The third main sources are data provided by the Czech Statistical Office (CSU, 2010), Eurostat (Eurostat, 2010) and UIV (UIV, 2010) that are connected with number of tertiary education students, trends in population etc.

4. Results

During our research we find out three factors that are mutually interconnected and strongly influence economic development of each country through evolution in the ICT sector. These factors are:

- Investment into ICT,
- Knowledge of ICT specialists,
- Number of ICT specialists,

Investments into any sector of economy represent essential instrument for its further expansion. Some aspects of ICT investments are presented in (Delina & Vajda, 2005).

Another, more detail, synthetic indicator of the ICT sector contribution to the economic growth is share of added value of the ICT sector on the whole GDP. Evolution of the added value of the ICT sector

to the European countries and to Czech economy is presented in (Doucek, Nedomova & Novotny, 2011). „Productivity“ of Czech ICT sector and its portion on GDP is shown in comparison to other selected countries on Fig. 1. Other general aspects of productivity of Czech Economy are presented for example in (Vltavska & Fischer, 2010).

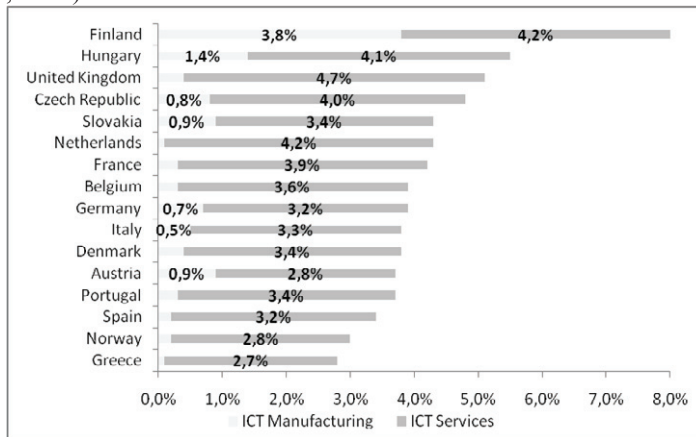


Fig. 1. Comparison of ICT Sector Added Value in Per cents of GDP for Selected European Countries, source: (CSU, 2010)

The largest contribution of ICT sector to GDP in EU is in Finland – 8 %, where is also large ICT manufacturing industry. The largest ICT service industry is in the United Kingdom – 4.7 % of UK's GDP. From the Figure 5 is visible that there are only few countries, where the share of ICT services on GDP is more than 4 %. Behind the UK are with 4.2 % Finland and Netherlands, followed by Hungary 4.1 % and Czech Republic 4.0 %. For other countries is the share lower than four per cents. Detailed analysis of ICT sector's influence on economic development and how can be measured costs on ICT are in (Novotny & Doucek, 2010), (Novotny & Doucek, 2007), (Maryska, 2008, 2009) and (Sudzina & Kmec, 2006).

These figures prove our statement, that investments into the ICT in the economy are really important because portion of ICT sector on GDP is high and still increasing. If we want to hold this portion and make stronger increase of GDP through ICT we need enough ICT specialists with appropriate knowledge and education.

The second one factor is total number of ICT specialists and trends in their numbers. Majority of developed countries (China don't show up) can be characterised by decreasing population rate in the EU 27 countries. The same situation is in the Czech Republic (see Fig. 2.). Graph presented in the Fig. 2 is number of live births in the Czech Republic (dotted line on right axis) in time series from year 1980 to year 2009. These numbers are important for future situation in the tertiary education system. We see that future years will be difficult for universities and also for quality of tertiary education system as a whole because numbers of potential students (based on number of live birth) was decreasing until year 2001. When we take into account average entering age to the tertiary education system, the difficult times will be for tertiary education system till year 2020. Trends in this indicator are the same as in the Czech Republic also in the EU 27 countries. Really interesting is similarity both curves in the Fig. 2.

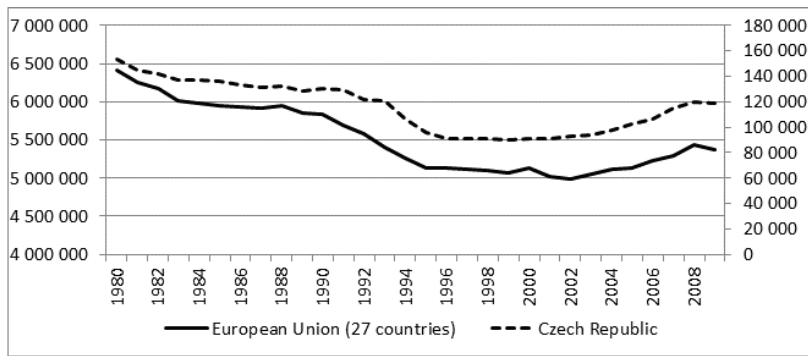


Fig. 2. Time Series of Live Births in the EU 27 countries and in the Czech Republic source: authors, (Eurostat, 2010)

This findings don't give us to good prospect in tertiary education in general and also in education of new ICT specialists. In the situation the population rate and number of live births is decreasing we cannot increase number of student at universities.

These findings provide important data for another analysis that is based on McCormack book (McCormack, 2010). In this book are also noted that countries have one of the last opportunities to make arrangements to prevent the lack of ICT specialists. In the case that they find out no solutions, they can expect difficulties in providing ICT services in the future that also influence GDP and other indicators describing analysed country.

We have said that the information society requires sufficient number of ICT specialists with adequate knowledge and education. A fulfilment of this requirement is based combination of these three factors (Doucek, Kunstova & Maryska, 2011):

- People – to make an ICT related study programs more attractive for students,
- Knowledge – to better up and raise up knowledge of people working in ICT and also people working in other sectors. This is closely connected with the third factor - education,
- Education – this is the most important opportunity to change current trend and the fill the gaps that were shown in (Doucek, Maryska & Kunstova, 2011). Education can be provided in various forms:
 - Lifelong learning.
 - University education at public and private universities.

The second and the third point influence the third factor. Detailed analyses of these factors are devoted for example (Doucek et al, 2007) and (Maryska, Novotny & Doucek, 2010). In this place we can mentioned that the situation in the Czech Republic is not good because knowledge expected by companies aren't fulfilled by university graduates in ICT related study programs. On the defence of the tertiary education system we have to accent that business sector usually doesn't define requirements on knowledge future graduates. One of examples for this is dynamical changes in internet technologies and mobile application (Apple, Google).

Our analysis of the situation in the Czech Republic in the context the Digital Competitiveness Report 2010 (DCR) (European Commission, 2010) takes into account above mentioned facts. In DCR is mentioned that the share of Czech work force in ICT sector on the whole European ICT sector work force is approximately 2.8 %. Because the number of ICT professionals in the Czech Republic is, from this "European" point of view, constant, we propose the same share for oncoming years also. Applying this approach on data presented in (McCormack, 2010), (CSU, 2010), (Eurostat, 2010), the following prognosis of the gap between supply and demand in ICT professionals till the year 2015 in our country could be expected. McCormack (McCormack, 2010) distinguishes five scenarios in the evolution of

economy. These scenarios are presented in the Table 2 that compares demand and supply of ICT specialists.

The Czech education system is very strong limited in ICT area. The first limit is real number of HEIs realizing ICT study programs. From other point of view this fact represents a lack of ICT teachers in ICT tertiary education. The number of students involved in the ICT study programs in 2004 – 2009 is presented. These data are adequate to our contribution, as we are not so much interested in students, but in the graduates and the students of 2009 will graduate on bachelor level in 2012. If they start their master studies, they will graduate as masters in ICT in 2014.

In UIV database the number of graduates of ICT-related study programs since 2001 was identified. In Table 1, the numbers of graduates since 2007 – 2009 are presented.

Table 1. Number of Graduates of ICT Related Study Programs, Source: (UIV, 2010), authors

Study program/Year	2007	2008	2009
Bachelors	3,636	4,137	4,194
Masters 5 years	1,165	894	510
Masters 2 years	982	1,672	2,123
Total	5,783	6,703	6,827
Reduced number of graduates	3,359	3,945	4,031

Numbers presented in Table 1 show that Czech education system offer approximately 7,000 ICT professionals in Czech economy in year 2005. In the book (Doucek et al, 2007) is mentioned that required number of graduates covering reproduction is 4,200 annually. There are identified two main problems in the table. The first problem is all the more important, as not all the bachelor graduates do enter the labour market. Approximately 2/3 of them enter master study level in ICT - related study programs (see row “Reduced number of graduates” in Table 1) (conclusion from survey 2011). Also, the **bachelor-level qualification of graduates is not commonly accepted by all corporations looking for ICT professionals. Especially in ICT corporations, the master level of graduation for higher managerial positions is strongly required.** Approximately one third of graduates in all ICT-related master study programs are not sufficiently qualified for business informatics, but reports finished tertiary education formally.

“For what scenarios do our politicians prepare Czech economy?” The Czech Republic’s education system delivers approximately 4,000 ICT graduates annually according to the information from UIV (Table 1). Our demand for reproduction of existing level of ICT services and manufacturing is approximately 4,200 ICT professionals. Comparison of these two numbers gives us a warning that the actual gap between supply and demand on ICT professionals is approximately 200 persons annually. Future scenarios in ICT professional’s requirement development represent another aspect: increasing gap between supply and demand. Missing numbers of ICT professionals on the Czech labour market up to 2015 are presented in Table 2.

Table 2. Missing Number of ICT Professionals in Czech Economy for Different Scenarios, Source: authors

Year	Turbo Economy	Investing in the Future	Back to Normal	Traditional Wins	Stagnation
2010	1,180	200	-1,060	-1,200	-1,480
2011	2,440	1,600	200	200	-1,480
2012	4,400	3,000	1,600	760	200
2013	5,800	5,240	3,000	1,600	1,040
2014	12,240	10,700	7,200	2,720	1,740
2015	19,240	16,720	11,120	3,840	2,860

Numbers presented in the Table 1 informs us (positive numbers in the table take with them negative information) that the Czech Republic is not prepared neither for real evolution of information society in our country (number of ICT professionals reproduction is 4,200 annually) nor for any of the above presented scenarios. Numbers in Table 2 represent real gap between demand and supply in ICT professionals on our labor market (negative bold number represents overhang of qualified ICT professionals entering Czech economy in certain year). We have enough ICT professionals up to the 2011 in case of the “Stagnation” scenario in our economy. There is no efficient number of qualified ICT professionals for other scenarios at all. These numbers of well qualified ICT professionals will be missing on Czech market annually and no matter what scenario will come true.

5. Conclusions

All of developed countries are depending on ICT. This dependency is represent by increasing investment into the ICT, and also increasing required number of ICT specialist. Still increasing are also requirements on knowledge of non-ICT employee.

The Czech Republic would like to be developed information society supporting dynamical trend in increasing of GDP. Current situation in the tertiary ICT education doesn't support this aims because the gap of ICT specialists is increasing and potential number of tertiary ICT related students is on the contrary decreasing. General trend in Czech education system is stagnant number of ICT students. These facts have following consequences.

Lack of ICT educated professionals will have an impact on decreasing competitiveness of the whole economy, decreasing global innovation potential and this could start degeneration of our population.

Without adequate number of ICT specialists cannot be achieved required increase in GDP not only produced by ICT sector but all sectors in the Czech economy.

The Czech Republic has opportunity to change education system with accent on tertiary education in order to prepare the ICT professionals in ICT business and for the roles of key users in public administration and in business corporations as well. These changes are connected with financial abilities of the Ministry of Education, Youth and Sports that is responsible for education in the Czech Republic and that is providing financial support to the universities for providing education.

Acknowledgements

Paper was elaborated with support of Grant Agency of the Czech Republic – project No.P403/10/0092

„Advanced Principles and Models of Managing Business Informatics“.

References

- CSU. (2010). Czech Statistical Office Demografická ročenka 2009. Retrieved 4.1.2011, from <http://www.czso.cz/csu/2010edicniplan.nsf/p/4019-10>.
- Delina, R. & Vajda, V. (2005). Problems connected with financial effectiveness of ICT investment evaluation In: *Financie, bankovníctvo, investovanie: 1. medzinárodná vedecká konferencia mladých vedcov*, Herľany, 20.-21.10.2005. Košice: TU, 2005, s. 1-12. ISBN 80-8073-355-4.
- Doucek, P. (2010). Human Resources in ICT – ICT Effects on GDP. Jindřichův Hradec 08.09.2010 – 10.09.2010. In: *IDIMT-2010 Information Technology – Human Values, Innovation and Economy*. Linz : Trauner, 2010, pp. 97–105. ISBN 978-3-85499-760-3.
- Doucek, P., Kunstova, R. & Maryska, M. (2011). Do We Have Enough ICT Specialists in the Period of eDependency? Bled 12.06.2011 – 15.06.2011. In: *Creating Solutions for the Individual, Organisations and Society* [CD-ROM]. Maribor : University of Maribor, 2011, s. 1–17. ISBN 978-961-232-247-2.
- Doucek, P., Maryska, M. et al. (2012). *Konkurenceschopnost ICT sektoru* 1. vyd. Praha. Professional Publishing.
- Doucek, P., Maryska, M., Novotny, O. (2012). Requirements on the competence of ICT managers and their coverage by the educational system – experience in the Czech Republic. *Journal of Business Economics and Management*. ISSN: 1611-1699. DOI: 10.3846/16111699.2012.658436,
- Doucek, P., Nedomova, L., Novotny, O. (2011). *How ICT Affect the Czech Economy?* ECON, 2011, roč. 19, č. 1, s. 106–116. ISSN 1803-3865.
- Doucek, P., Novotny, O., Pecakova, I., Vorisek, J. (2007). *Lidské zdroje v ICT*. Praha : Professional Publishing, 2007, pp. 179 202. ISBN 978-80-86946-51-1.
- European Commission. (2010). *Europe's Digital Competitiveness Report*. ISBN 978-92-79-15829-2
- Eurostat. (2010). *Eurostat, statistics*. Retrieved 18.1.2010, from <http://epp.eurostat.ec.europa.eu/portal/page/portal/education/data/database>.
- Hagan, D. (2004). *Employer Satisfaction with ICT Graduates, Proceedings of the sixth conference on Australian computing education 2004*, www.acm.org.
- Helfert, M. & Doucek, P. (2007). *European Projects*. Budweis 12.09.2007 – 14.09.2007. In: *IDIMT-2007*. Linz : Universitaet Linz, Trauner Verlag.
- Kelly, K. (1998). *New Rules for the New Economy, Ten Radical Strategies for the Connected World*. Penguin Group, New York USA, 1998. ISBN 067088111-2.
- Maryska, M. (2009). Model for Measuring and Analysing Costs in Business Informatics. Wuhan 30.05.2009 – 31.05.2009. In: *The Eighth Wuhan International Conference on E-Business* [CD-ROM]. Sigillum : Alfred University Press, 2009, s. 1–5. ISBN 978-0-9800510-2-5.
- Maryska, M. (2008). Business Informatics in a Light of Costs. Profits and Gains. Jindřichův Hradec 10.09.2008 – 12.09.2008. In: *IDIMT-2008 Managing the Unmanageable*. Linz : Verlag Osterreich. s. 23–40. ISBN: 978-3-85499-448-0.
- Maryska, M., Novotny, O. & Doucek, P. (2010). ICT Knowledge Analysis of University Graduates. Jindřichův Hradec 08.09.2010 – 10.09.2010. In: *IDIMT-2010 Information Technology – Human Values, Innovation and Economy*. Linz : Trauner, 2010, pp. 125–135. ISBN 978-3-85499-760-3.
- Maryska, M., Novotny, O. et al. (2012). *Lidské zdroje v ICT – nabídka a poptávka v České republice*. 1. vyd. Praha. Professional Publishing. ISBN 978-80-7431-082-9.
- McCormack, A. (2010). *The e-Skills Manifesto, The Call to Arms*. European Schoolnet. Belgium. ISBN 9789490477301 – EAN: 9789490477301.
- Novotny, O. & Doucek, P. (2007). Competitiveness of the Czech ICT Graduates. Portorož 28.03.2007 – 30.03.2007. In: *Ustvarjalna organizacija – Creative Organization* [CD-ROM]. Maribor : Univerzita v

Mariboru, 2007, s. 1380–1386. ISBN 978-961-232-200-7.

Novotny, O. & Doucek, P. (2010). Impact of the ICT Sector on Economic Growth. Portorož 24.03.2010 – 26.03.2010. In: *Človek in organizacija* [CD-ROM]. Maribor : Univerza v Mariboru, 2010, s. 999–1006. ISBN 978-961-232-238-0. Abstrakt ISBN 978-961-232-237-3.

Sudzina, F., Kmec, P. (2006). Technologický paradox a hodnotenie prínosov informatizácie [in Slovak]. Ekonomický časopis. Vol. 54. Ekonomický ústav SAV a Prognostický ústav SAV. ISSN: 0013-3035.

UIV. (2010). *Institute for information in education. databáze studentů*. Retrieved 7.1.2011 from <http://www.uiv.cz>.

Vltavska, K. & Fischer, J. (2010). Labour Productivity and Total Factor productivity in the Czech ICT. Jindřichův Hradec 08.09.2010 – 10.09.2010. In: *IDIMT-2010 Information Technology – Human Values, Innovation and Economy*. Linz : Trauner, 2010, s. 251–257. ISBN 978-3-85499-760-3.

Vorisek, J. & Feuerlicht, G. (2006). Vliv globálních ICT trendů na změny požadavků trhu na ICT specialisty. Prague 11. 06. 2006 – 13. 06. 2006. In: *Pour, J., Voříšek, J. (ed.). Systems Integration 2006*. Prague : VŠE FIS, 2006, s. 337–350. ISBN 80-245-1050-2.