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IT Education as an Opportunity for Uprising of Serbian Economy

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The analysis of IT market in Serbia indicates an increase in exports of IT services. Consequently, the need for experts with competitive skills in modern information and communication technologies rises. International priorities related to the application of IT in business and science until the year 2020 include: e-education, cloud computing, mobile technologies, internet of things, ubiquitous and pervasive computing, social media, virtual reality, and big data. Designing environment for providing IT services in these fields can be an opportunity for the development of Serbian economy, because it does not require high infrastructural investments, only investments in education. This paper gives a proposal for leveraging higher education and lifelong learning in Serbia, with respect to the demands of the IT market.

Keywords: information technologies, education, IT market, trends in development of IT

1. Introduction

Development of information technologies (IT) has influenced the overall growth of all the economic sectors. Nowadays, the IT sector makes around 5% of the European economy, while the European Union plans an increase in investments in this sector. The Horizon 2020 programme for funding research and innovation projects has a 25% higher budget for IT in comparison with the previous funding programmes . Priorities are oriented towards new generations of computer systems, the future Internet, technologies for content creation and distribution, robotics, micro and nano technologies . Most resources are invested in projects that have direct market value and impact on the economy.

The global trends in information technologies influence the development of the Serbian economy. Despite the economical crisis, the export in IT services has significantly increased in the past few years. Information technologies and software development require highly qualified experts, and the need for IT specialists in Serbia rises .

Study programmes in Serbia are slow in reacting on the market demand. The harmonization can be achieved by improving the existing study programmes and designing new ones for both high and lifelong learning. The goal of this paper is to propose a set of actions to foster university education in the field of information technologies in Serbia, with respect to market demand. The proposal is based on designing an educational environment for creating highly qualified IT experts, without large investments into infrastructure. New master programmes with shorter study cycles are proposed, as well as permanent education programmes.

2. Analysis of IT market in Serbia

IT is a significant element of the economy development in Serbia, together with agriculture, energy, infrastructure, tourism, and automotive industry. Telecommunications and information technologies participate with 5.5% in the Serbian GDP . The value and the structure of the IT market in Serbia for the period 2011-2015 is shown in Table 1. All the presented data are taken from the research conducted by Mineco . Column v1 represents the value of IT market, while the v2 column represents the estimated potential of the IT market. A significant difference between the existing and potential values can be noticed.

Table 1. Serbian IT Market Value and Structure, 2011 and Potentials 2011-2015.

	IT market (million €)			Share (%)			Annual growth rate (%)	
IT market segment	2011	2015 (v1)	2015 (v2)	2011	2015 (v1)	2015 (v2)	2015 (v1)	2015 (v2)
IT Services	108.9	211.8	325.5	25.7	29.5	32.1	18	31
System Software	24.3	42.0	60.5	5.7	5.9	6.0	15	26
Applications	29.2	49.4	71.1	6.9	6.9	7.0	14	25
Server systems and storage	29.7	41.8	53.9	7.0	5.8	5.3	9	16
Personal computers	160.1	226.3	282.5	37.8	31.5	27.8	9	15
Peripherals	43.7	86.8	132.4	10.3	12.1	13.1	19	32
Networking equipment	27.3	59.8	88.7	6.4	8.3	8.7	22	34
Total	**423.0**	**717.9**	**1.014.5**	**100**	**100**	**100**	**14**	**24**

Although many Serbian companies develop software for their own needs, most of them are focused on outsourcing. Software designed in Serbia is mostly produced for western markets, where most of purchasers and customers are located. The most important products include software for automatic remote meter reading, solutions for online betting and lottery, applications for communication, network equipment software, and services in the field of advanced web development.

There were 554 enterprises and 6000 employees in the IT sector in Serbia in 2011 and the revenue was 200 million euro. The rapid growth of the IT sector is confirmed by the data given by the National bank of Serbia, stating that the export of IT services in 2007 was € 62 million, while in 2012 it was € 185 million. The 2013 export is estimated to be € 200 million (Figure 1) .

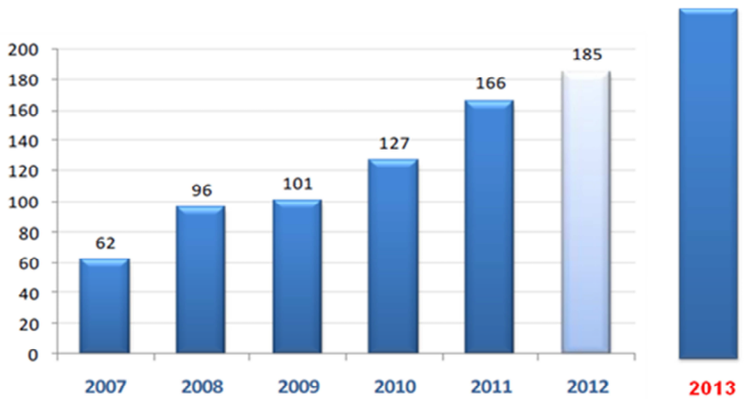

Figure 1: Export of computer and information services from Serbia (million of €).
Source: National Bank of Serbia

3. Analysis of education and employment in IT sector

According to the IDC study, employment in the IT sector in the world is expected to rise in the next 4 years by 5.8 million of jobs, and 51% of all IT employees will be oriented toward software development.

Employment of IT experts in software development in Serbia rises by about 1000 positions annually, with the recorded lack of experts in the fields of designing information systems in the Internet environment, and IT management .

Study programmes in information technologies are organized in 18 towns in Serbia, at 16 state faculties, 6 private faculties, and 13 vocational schools. In 2011, in the field of IT :

- 1773 students completed their undergraduate studies,
- 1827 students completed their master studies,
- 37 students defended their PhD theses.

In 2012, more than 10% (around 5500) freshmen enrolled study programmes in the area of informatics.

Study programmes in the field of informatics in Serbia are mainly created with respect to IEEE and ACM curricula . The main deficiency of these curricula is that they are made for a longer time period (5-8 years or longer) where the connection with IT trends and market demands is lost.

The analysis of the research and development of potentials in Serbia indicated that, despite the economic crisis and low investments in science, there are several IT centres of excellence that can be competitive on the world market .

Still, cooperation between educational institutions, research centres, and companies in Serbia is insufficient, and so are investments in science. Teh results of research are not adequately transferred to the economy and are not used to improve study programmes.

An indicator of development, success, and compliance of the IT market and education can be shown using a „knowledge triangle" whose elements are: education, research, and innovation. The analysis of information flows in the knowledge triangle leads to conclusion that the role of the IT market is to materialize qualitative and quantitative information provided by the users. On the other hand, the market should provide new, measurable, high quality information in the form of new requirements, needs, and trends, where a dynamic feedback among the stakeholders is created . Information from the IT market needs to be analyzed as important factors when designing study programmes in IT, on all the levels of study.

4. Priorities in development of ICT until 2020 and potentials for Serbia

The newest trends in the IT market are a basis for developing education in the area of information technologies. Programmes for funding scientific and research projects in the EU, the USA and other developed countries, such as Horizon2020 and the OECD emphasize trends in the IT market that should be studied and discussed : cloud computing, Internet of things, big data, mobile and pervasive computing, robotics, micro and nano technologies. According to Gartners' forecasts the market priorities are: Internet of things, hybrid and personal cloud, software-defined anything (SDx), 3D printing.

New advanced technologies such as robots, 3D printing, and quantum computing are becoming reality . Educational aims from the area of robotics are reflected in studying the elements that robots consist of and empowering students' abilities to use applications for robots and existing mechanical constructions. The 3D printing is a technology used for designing complex 3D structures that can be used as a basis for a particular shape. Micro and nano electronics are directed toward establishing new types of universal memory that shouldn't require electronic power for storing information . Quantum computing uses increased computer power based on principles of quantum mechanics in order to support common problems, such as database search, optimization issues, and solving bugs in source code. The main problems related to education and research of advanced information technologies are reflected in the necessity for huge financial investments in equipment and laboratories for conducting experiments and labs.

In Serbia, not all the above-mentioned advanced technologies could be developed due to the lack of funds for investment in scientific research and development infrastructure. Given the current state and development constraints, education in Serbia can be most improved by investing in technologies that do not require large infrastructure investments, but represent a trend in the IT market :

- E-learning,
- Cloud computing,
- Mobile computing,
- Internet of things,

- Ubiquitous and pervasive computing,
- Context aware computing,
- Social media,
- Virtual reality,
- Big data.

4.1 Distance education

The European Commission has defined four goals of education until the year 2020: achieving education during life and mobility, improving quality and efficiency of education and training, promoting fairness and social cohesion, and improving creativity, innovation and entrepreneurship .

Instead of just passively responding to changes in the environment, education should be the creator of change. Today, the trend of democratization of formal and permanent education processes can be noticed. Open online courses are new concepts that enable education and training via the Internet in various fields. The courses are based on some of the existing academic courses that are recognized and respected in the academic environment .

Numerous world leading universities such as Stanford and MIT offer free online courses for all interested participants, who do not necessarily have to be the university students. Coursera (https://www.coursera.org/) is one of the most popular aggregators of free online courses from various universities worldwide.

4.2 Cloud Computing

Cloud computing represents a new paradigm for delivering computing services. Cloud computing can be defined as an abstract, scalable and controlled computing infrastructure that enables end-users to access various computer applications . Services and data are stored in shared and scalable sets of resources.

There are three cloud computing service models (figure 2): Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) . Software as a Service enables customers to use software hosted on providers' infrastructure. Platform as a Service is a model in which customers can use applications they bought or developed themselves at the platform provided by a provider. Infrastructure as service is a model in which clients are provided with hardware, processor power, memory, storage, operation system, or similar. With respect to types of cloud infrastructure management, there are private, community, public, and hybrid clouds .

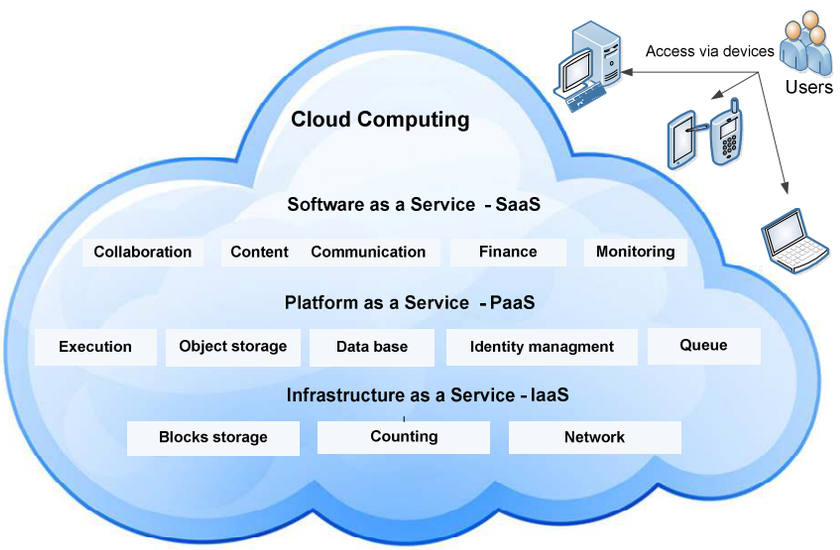

Figure 2: Cloud computing service models

Leading universities in the world use private cloud infrastructure, and different combinations of service models of cloud computing, in order to reduce significant financial investments in new computing infrastructure. New services that allow students to use educational infrastructure and learning resources easily and efficiently are being introduced .

4.3 Mobile computing

Mobile computing implies interaction between humans and computers that can be used on the move using mobile communication, mobile devices and applications. Today, predominant is the usage of the so-called "smart devices", which is growing in comparison with the use of PCs . According to studies from 2013, the most widely used mobile operating system is Android .

One of the key preconditions for the development of mobile computing is the existence of mobile infrastructure. The Long Term Evolution (4G - LTE) brought an increase in bandwidth and decrease in the data delay, which contributed to an increase in the number of mobile services users . At the same time, 4G technology is developed with the aim to save energy and to extend mobile devices' battery life . One of the biggest challenges of the next generation of mobile networks is a significant increase in the number of connected devices, that implies the need to increase bandwidth . In order to answer this challenge, the IEEE and industrial consortia have developed new versions of standards for all types of mobile networks (WAN, MAN, LAN, PAN). For instance, IEEE 802.11ac and IEEE 802.11ad (Wireless Gigabit - WiGig) technologies should enable data delivery at the speed of 7Gbps.

Mobile networks are used not only for communications among humans, but for M2M (Machine to Machine) communication as well. Accordingly, mobile computing is part of a wider field of ubiquitous computing. Figure 3 shows the relations between mobile computing and other technologies.

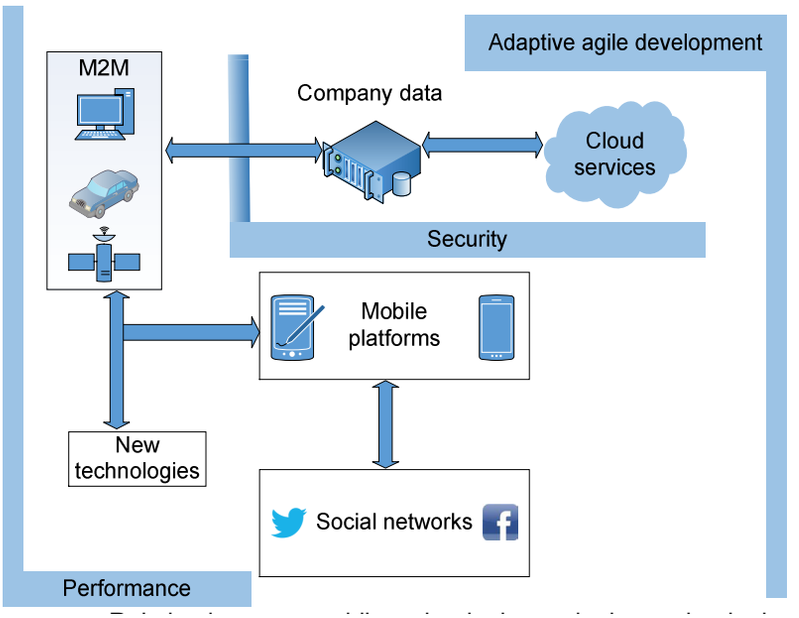

Figure 3: Relation between mobile technologies and other technologies

Near-field communication (NFC) is one of the newest mobile technologies that enables interaction among users and the environment .

Interaction between users and the environment is performed by bringing mobile devices close to objects used in commerce, traffic, tourism, identification and security. This technology has huge potentials for application at universities .

4.4 Internet of things

Internet of things (IoT) is a world in which physical objects are integrated into the information network and they become active participants in business processes . In the last few years, the rise of the Internet usage and the number of devices connected to internet is to be noticed. It is estimated that by the year 2015, the number of connected devices will be three times greater than the world's population and it will reach a number of 50 billion .

Thanks to lower prices, various types of electronic devices, such as sensors and actuators, become available to millions of users. These devices are able to connect to the global network and overcome the distinction between the physical and the IT worlds . Wireless sensor networks are distributed systems that consist of groups of different types of sensors interconnected by wireless communication network. The sensors are distributed in space and autonomous. They are used to monitor different physical and ecological values such as temperature, sound, vibration, pressure, motion, air pollution, etc. The sensors within the network collect raw data that are to be processed later. Figure 4 shows the possibility of using the sensors for the development of smart environments in the field of the Internet of things.

The development of the Internet of things is a prerequisite for the introduction of smart environments . Smart environments can be considered as a digital ecosystem composed of two layers: 1) reality that involves communication between people and everyday activities, and 2) virtual environment in which people and objects interact via the Internet, their communication being achieved through different collaboration technologies. Smart environments are : smart cities, smart grids, smart houses and smart classrooms.

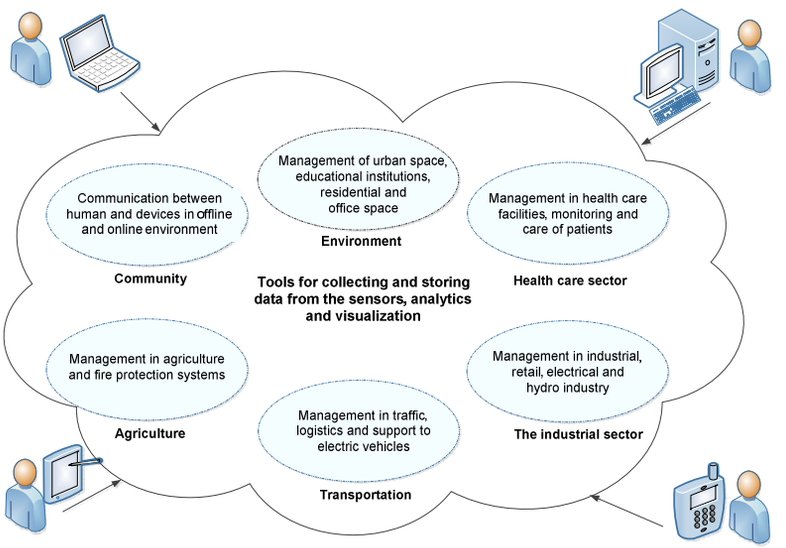

Figure 4: Application of sensors in the Internet of things

4.5 Ubiquitous or pervasive computing

In the author defines ubiquitous or pervasive computing as „improving the use of computers through the physical environment, so that computers become virtually invisible to end users". Ubiquitous computing combines two trends: integration of computers with other devices and portability of computers. It represents a new paradigm that enables collection and processing of data at any time and any place . Ubiquitous computing applications can operate in a dynamic environment, and need to be sensitive to the context (Context Aware).

Pervasive computing involves a number of small devices that have the ability to implement computer operations and communications, such as smart phones, smart cards, sensor networks, GPS, RFID (figure 5).

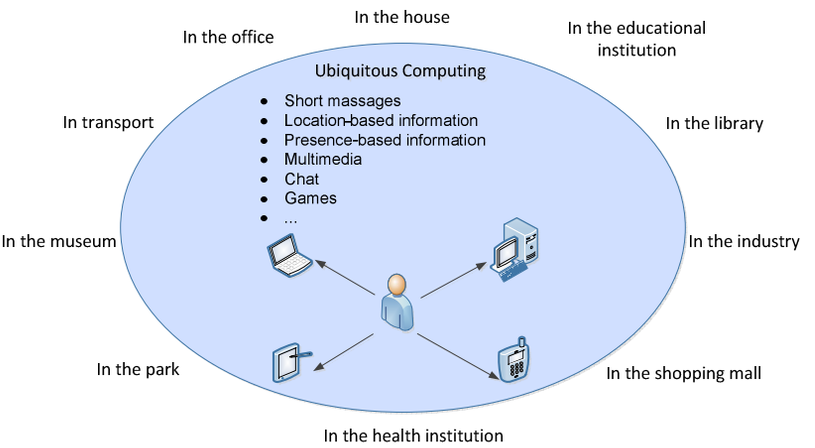

Figure 5: Ubiquitous Computing

Ubiquitous computing in education has influenced the emergence of the concept of ubiquitous learning, which enables students to acquire knowledge anytime and anywhere . The environment for ubiquitous learning integrates a mobile learning environment for e-learning using a computer in motion, smart phones, sensors, and other devices .

4.6 Context-aware computing

Context-aware computing involves systems that recognize the characteristics of the environment and adapt to the contexts in which the user is;. The context is determined by: location, potential users and available nearby devices and resources. Figure 6 shows an example of a context-aware system.

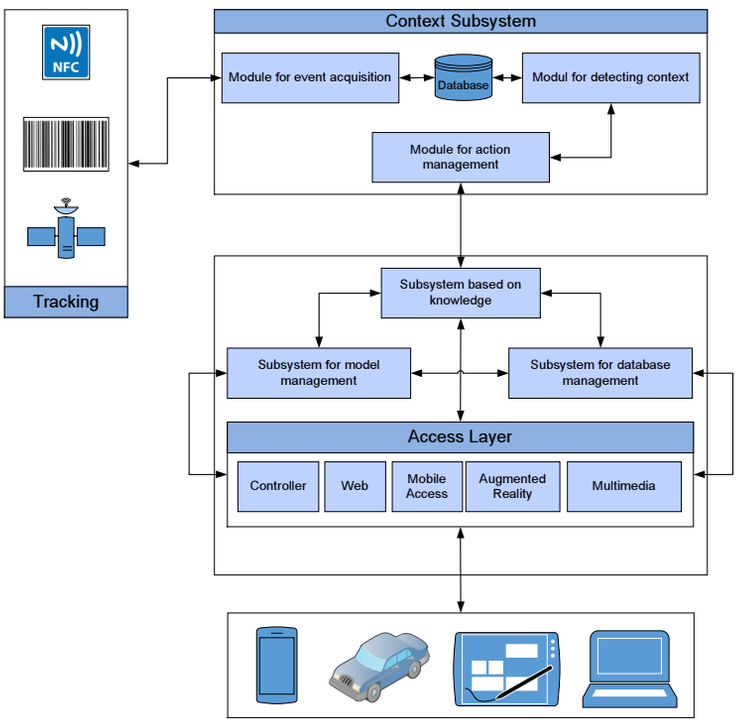

Figure 6: Context-Aware system

In the context of education, a great potential of context-aware computing in development of context-aware system and ubiquitous environment for learning and designing learning activities is also recognized.

4.7 Social media

Social media sites represent a class of web sites that allow social interaction between their users by using Web 2.0 technologies . They are used in business and education, most often for purposes of sharing content, opinions, experience, and trends. Social media allow a rapid exchange of information and interactivity, increase the impact of direct marketing, improve branding, focus customer attention on the products of a specific company, improve loyalty and trust programs, allow for the execution of market research and competition tracking, strengthen customer service, improve reputation, help with finding employment, and improve finding and communicating with personal and business contacts .

Aside from blogs, microblogs, and social web pages, social networks are the most commonly used social media tool. Social networks represent a convenient environment for crowdsourcing . In the business context, crowdsourcing allows a faster, easier discovery of solutions through brainstorming and gathering of relevant information from individuals that participate in business activities. In the educational context, participants in the learning processes can expand their knowledge by exchanging educational materials and experiences.

Higher education institutions have recognized the potential of social networks, and they are using them for sharing educational materials, displaying informational messages, keeping communication with students and among colleagues, and other purposes. Social networks are also used within the educational environment as a medium for student relationship management and can play a significant role in recommending high-quality professionals for jobs.

4.8 Virtual reality

Virtual reality represents a computer generated model of the real world presented in such a way that it should be accessible to human senses. The information model of a real or virtual world is an abstract, mental image conceived by its creator and stored on physical media. These media should allow storing and transfer of information through time and space. Information flows in virtual reality are shown in figure 7.

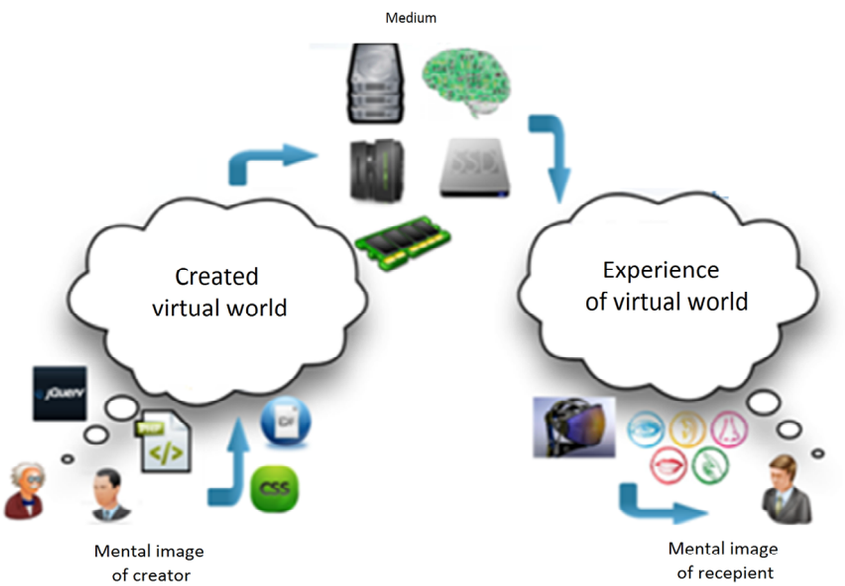

Figure 7: Abstractions and information flows in virtual reality

3D modelling allows for a quick and simple construction of irregular and complex objects adapted for virtual reality applications to be used for construction of models and structures in business and education. Currently, there are no fully-defined standards for integration of the 3D content into the web and its information infrastructure. Different proposals and methodologies for interface design exist, but there is still none that give a clear definition for an interface that integrates hypertext and interactive 3D graphics . By developing modern Internet technologies and standards like HTML5, CSS3, jQuery, WebGL, and 3D graphics, new possibilities for moving from standard, 2D web to 3D virtual reality-supported web appear.

Augmented reality is a form of virtual reality where a user can observe the real world in combination with virtual objects . Unlike a virtual reality, the augmented reality does not replace the real world environment, but uses it as a background .

Virtual reality is used in medicine, for visualizations in biochemistry, engineering, maintenance of complex systems, for military purposes, in art, industrial design, etc. 3D worlds based on simulation models can also play a significant role in the realization of educational processes . The application of visualization methods can allow students and professionals to collaborate and communicate, develop and implement ideas, and can increase theeffectiveness of the entire project .

4.9 Big Data

The “Big data” expression denotes the design and realization of reliable, distributed, and scalable infrastructures for controlling, analyzing, sharing, storing, and transferring large amounts of data . Dimensions relevant for Big Data include diversity, speed and volume. The data used for processing are not structured and are stored in different formats, such as text, audio, video, clickstream, log files, sensor data, etc. Data are often time sensitive and need to be delivered and processed quickly. Such data are usually large in volume (larger than 1 terabyte), accordingly, the size can cause constraints in analysis .

The key problems related to Big Data are gathering, transferring, searching, sharing and distributing, analysis, and visualization of data. Data are gathered using various sources - mobile devices, sensors and sensor networks, log files, cameras, microphones, RFID readers etc. The cloud computing infrastructure represents a suitable solution for storing, searching, and discovering knowledge in large amounts of data. The infrastructure for Big data can be realized by using open source software such as the Hadoop framework.

The Big data concept is applied in various sciences, such as biology, medicine, and physics , as well as in university environments. The Big data study programs should include scientific, computing, analytical, application, and security aspects. These programs can be modelled after the world most respected universities like Stanford and MIT.

5. Proposals for improving IT education in Serbia

5.1 Study programmes for higher education

The educational domain can be placed in line with needs of the IT market by developing modern instructional curricula in such a way that they follow current trends of the IT market. A rapid development of information technologies and frequent shifts in IT markets should be taken as the basis for creation of new undergraduate IT elective courses, new short-length study programs for master (1-2 years) and doctoral studies (3 years), with all courses oriented towards following the trends and needs of IT markets. Short-length, IT-oriented study programs in Serbia should encompass theory and practice in cloud computing, mobile computing, the Internet of things, ubiquitous computing, context aware computing, big data, social media, and virtual reality.

The suggested structure for a single study programme for one-year master studies is presented in figure 8. The study program encompasses two elective groups, one covering e-business technologies covering topics such as Internet technologies, Internet of things, and mobile technologies, and the other covering topics in the area of management in e-business.

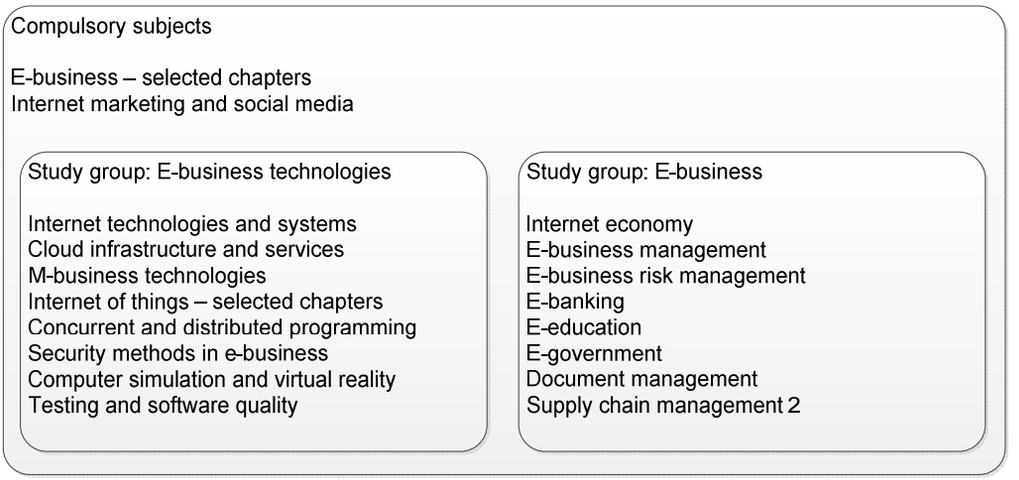

Figure 8: The structure of the curriculum for one year master studies in the field of e-business

According to the presented trends in IT, master studies curricula should concentrate on a time period up to year 2020. The curricula should be focused towards educating professionals for some of the most sought occupations like software engineers, computer system analysts, big data engineers, web programmers, and IT managers. The curricula of doctoral study programmes should be oriented towards performing scientific research in specified domains.

The IT domains that are suggested for introduction into higher education programmes are based on the infrastructure that does not require significant financial investments. The realization of the set goals can be accomplished by participating in Tempus projects and cooperating with leading European universities that have already launched the implementation of similar study programmes.

5.2 Permanent education

Considering the rapid advancement of science and technology, the basic required knowledge level of an IT engineer increases daily and so does the need for permanent, lifelong education. The ability to recognize the need for permanent education and the aspiration towards self-actualization represent two important requirements for building a successful career in engineering. The basis for lifelong learning is established through well organized study programmes and perpetuated through mentorship and cooperation programmes. The final result is an engineer capable of implementing a working environment that enables continuous education, improvement, and generation of new ideas .

In the report of the American national academy, “The engineer of 2020“, engineers are encouraged to perform continuous learning and the importance of permanent self-improvement to economical growth and keeping the leading position in domains of IT application is stressed . A continuous development of key competencies should be integrated as one of the most important goals in study programmes of higher education institutions . Permanent education should be the answer of higher education institutions to the dynamics and challenges coming from current socio-technological environment .

Until recently, permanent education of IT engineers in Serbia was mostly comprised of professional courses organized within Cisco and Microsoft academies. However, a downward trend in frequency of the said courses is apparent.

Numerous higher education institutions in Serbia have already defined programmes for the realization of permanent education, but the number of actually implemented courses is relatively small. The adoption and realization of permanent education university programmes in Serbia can have an impact on the democratization of educational processes in accordance with market trends. Activities that can be applied rapidly in order to improve permanent education are the following:

- Compulsory permanent education for IT engineers employed in their field;
- Activities for promotion and raising awareness about the necessity and advantages of applying permanent learning concepts;
- Compulsory realization of permanent education programmes within projects dealing with technological development and integral and interdisciplinary studies funded by the Ministry of education, science, and technological development, as well as within international projects;
- Creating an environment for the realization of open, free, online courses, as well as creating partnerships with existing open courseware providers;
- Applying ubiquitous technologies for realizing permanent learning;
- Participating in international programmes for lifelong learning.

By realizing the suggested activities, the permanent education of IT engineers will contribute to the improvement of their competencies, increase in productivity, and allow for a more efficient transfer of technology and knowledge from the educational system and science to industry.

5.3 Improving scientific research

Investing in IT projects within the funding programmes of the Ministry of Education, Science and Technological Development of the Republic of Serbia aims to develop human resources for science and research. Professional scientists and application of their research in educational environment is important for establishing a consistency between the IT market and the teaching curricula. However, a trend of investing in human resources should be also directed to their retention in Serbia and enabling them to have a professional or academic career according to their professions.

Excellence in science represents one of three priorities defined in the financing programme Horizon 2020 . The main aim defined in this priority is improving and extending excellence of scientific research. The key elements in providing scientific excellence are:

- establishing funds for supporting researchers in the most actual research areas;
- using modern technologies for supporting collaboration and communication between researchers and scientific organizations, supporting interdisciplinary research, solving technological challenges and supporting new ideas;
- developing infrastructure for scientific research until and after the year 2020 – providing key services via e-infrastructure, accessing and managing scientific data, global infrastructure, using high performance computing,
- fostering skills and developing careers of scientists, researchers and scholars.

The research area of information and communication technologies represents one of seven national priorities in domains of science and technology, defined within a strategic document “Strategy of scientific and technological development of the Republic of Serbia in the period from 2010 until 2015“. The key elements in deploying this strategy are: developing and preserving talents, evaluating projects according to priorities, a more flexible system of funding which supports priorities, establishing an inner collaboration network between research organizations, institutes and university schools, partnership with society, industry and diaspora, international community.

A special development opportunity can be the participation in international research projects. It is possible to acquire funding for improving research and educational infrastructure in Serbia from these projects. Research organizations should establish strategic partnerships with international institutions in order to provide exchange of knowledge, material and human resources. Furthermore, ICT companies should be stimulated to collaborate with research organizations. The Strategy of open-access is one approach which can be used by research organizations in Serbia. It is based on dissemination of research results by enabling open access to specific results of researches performed by the organization .

The recognition and reputation of Serbian IT scholars in the world can have a big impact on developing the IT market in Serbia. The credibility of Serbian scientists and professionals worldwide can bring new investments in Serbia and involve Serbian scientists and professionals in international research projects.

Conclusion

A proposal for improving graduate education according to trends in information technologies is given in this paper. Most important technologies that can represent a development opportunity for the Serbian industry are proposed. The following technologies are analyzed: cloud computing, mobile business, the Internet of things, context aware computing, ubiquitous computing, big data, social media and virtual reality. These technologies do not require huge infrastructural investments, but only investing in education. Developing new study programmes for these areas can be significant for the upraise of the Serbian industry and the Serbian society. Professional competences acquired by students can improve the level of industry competitiveness on local and global markets.

By matching the needs of the IT market, adapting the current curricula and creating new curricula with respect to the requests of modern IT industry, it is possible to increase the number of IT students and enforce relationships between education, science and industry. If these proposals are accepted, the volume of Serbian exports of computing services and software can reach a level of 5% of the Serbian GDP by the year 2020.

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REFERENCES

[1] (1)ACM/IEEE-CS Joint Task Force on Computing Curricula. (2013). Computer Science Curricula 2013. doi:10.1145/2534860
[2] (2)Atzori, L., Iera, A., & Morabito, G. (2010). The Internet of Things: A survey. Computer Networks, 54(15), 2787–2805. doi:10.1016/j.comnet.2010.05.010
[3] (3)Azuma, R. T. (1997). A survey of augmented reality. Presence-Teleoperators and Virtual Environments, 6(4), 355–385.
[4] (4)Beaty, D. L. (2013). Cloud Computing 101. Ashrae Journal, 55(10), 88–93.
[5] (5)Borrego-Jaraba, F., Luque Ruiz, I., & Gómez-Nieto, M. (2011). A NFC-based pervasive solution for city touristic surfing. Personal and Ubiquitous Computing, 15(7), 731–742. doi:10.1007/s00779-010-0364-y
[6] (6)Bouchlaghem, D., Shang, H., Whyte, J., & Ganah, A. (2005). Visualisation in architecture, engineering and construction (AEC). Automation in construction, 14(3), 287–295.
[7] (7)Caruso, J., Nicol, A., & Archambault, E. (2013). Open Access Strategies in the European Research Area.
[8] (8)Casey, D. (2005). u-Learning = e-Learning + m-Learning. In G. Richards (Ed.), Proceedings of World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2005 (pp. 2864–2871). E-Learn 2005--World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education: AACE.
[9] (9)Chandra, D. G., Kathing, M., & Kumar, D. P. (2013). A Comparative Study on IPv4 and IPv6. In Communication Systems and Network Technologies (CSNT), 2013 International Conference on (pp. 286–289). doi:10.1109/CSNT.2013.67
[10] (10)Chellappa, R. (1997). Intermediaries in cloud-computing: A new computing paradigm. In INFORMS Dallas. Dallas, Texas: Cluster: Electronic Commerce.
[11] (11)Chen, H., Chiang, R. H. L., & Storey, V. C. (2012). Business Intelligence and Analytics: From Big Data to Big Impact. MIS Quarterly, 36(4), 1165–1188.
[12] (12)Chittaro, L., & Ranon, R. (2007). Web3D technologies in learning, education and training: Motivations, issues, opportunities. Computers & Education, 49(1), 3–18.
[13] (13)Dabbagh, N., & Reo, R. (2011a). Back to the future: Tracing the roots and learning affordances of social software. In M. J. W. Lee & C. McLoughlin (Eds.), Web 2.0-based e-learning: Applying social informatics for tertiary teaching (pp. 1–20). Hershey, PA: IGI Global.
[14] (14)Dabbagh, N., & Reo, R. (2011b). Impact of Web 2.0 on higher education. In D. W. Surry, T. Stefurak, & R. Gray (Eds.), Technology integration in higher education: Social and organizational aspects (pp. 174–187). Hershey, PA: IGI Global.
[15] (15)De Assunção, M. D., Di Costanzo, A., & Buyya, R. (2009). Evaluating the cost-benefit of using cloud computing to extend the capacity of clusters. In Proceedings of the 18th ACM international symposium on High performance distributed computing (pp. 141–150).

[16] (16)Demestichas, P., Georgakopoulos, A., Karvounas, D., Tsagkaris, K., Stavroulaki, V., Lu, J., … Yao, J. (2013). 5G on the Horizon. IEEE Vehicular Technology Magazine, 8(3), 47–53. doi:10.1109/MVT.2013.2269187
[17] (17)Despotović-Zrakić, M., Simić, K., Labus, A., Milić, A., & Jovanić, B. (2013). Scaffolding Environment for e -Learning through Cloud Computing. Educational Technology & Society, 16(3), 301–314.
[18] (18)Dey, A. K. (2001). Understanding and Using Context. Personal Ubiquitous Comput., 5(1), 4–7. doi:10.1007/s007790170019
[19] (19)Ding, D., Cooper, R. A., Pasquina, P. F., & Fici-Pasquina, L. (2011). Sensor technology for smart homes. Maturitas, 69(2), 131–136.
[20] (20)European Commission. (n.d.). A guide to ICT-related activities in WP2014-15.
[21] (21)European Commission. (2013). Horizon 2020 Work Programme 2014-2015.
[22] (22)Gartner. (2013a). Gartner Identifies the Top 10 Strategic Technology Trends for 2014. Gartner, Orlando, Florida.
[23] (23)Gartner. (2013b). Gartner истраживање за 2013. годину. Barcelona, Spain.
[24] (24)Gligoric, N., Uzelac, A., & Krco, S. (2012). Smart Classroom: Real-time feedback on lecture quality. In IEEE International Conference on Pervasive Computing and Communications Workshops 2012 (PERCOM Workshops), (pp. 391–394). IEEE.
[25] (25)Gubbi, J., Buyya, R., Marusic, S., & Palaniswami, M. (2013). Internet of Things (IoT): A vision, architectural elements, and future directions. Future Generation Computer Systems, 29(7), 1645–1660. doi:http://dx.doi.org/10.1016/j.future.2013.01.010
[26] (26)Gutierrez, A., Dreslinski, R. G., Wenisch, T. F., Mudge, T., Saidi, A., Emmons, C., & Paver, N. (2011). Full-system analysis and characterization of interactive smartphone applications. In Workload Characterization (IISWC), 2011 IEEE International Symposium on (pp. 81–90). doi:10.1109/IISWC.2011.6114205
[27] (27)Henricksen, K., & Indulska, J. (2006). Developing context-aware pervasive computing applications: Models and approach. Pervasive and Mobile Computing, 2(1), 37–64. doi:http://dx.doi.org/10.1016/j.pmcj.2005.07.003
[28] (28)Huang, J., Qian, F., Guo, Y., Zhou, Y., Xu, Q., Mao, Z. M., … Spatscheck, O. (2013). An In-depth Study of LTE: Effect of Network Protocol and Application Behavior on Performance. ACM SIGCOMM Computer Communications Review, 43(4), 363–374. doi:10.1145/2534169.2486006
[29] (29)Huang, Y.-M., Huang, T.-C., & Hsieh, M.-Y. (2008). Using Annotation Services in a Ubiquitous Jigsaw Cooperative Learning Environment. Educational Technology & Society, 11(2), 3–15.
[30] (30)Hwang, G.-J., Yang, T.-C., Tsai, C.-C., & Yang, S. J. H. (2009). A context-aware ubiquitous learning environment for conducting complex science experiments. Computers & Education, 53(2), 402–413.
[31] (31)IEEE Spectrum. (2014). 2014 Top Tech to Watch.
[32] (32)Jankowski, J., & Decker, S. (2013). On the design of a Dual-Mode User Interface for accessing 3D content on the World Wide Web. International Journal of Human-Computer Studies, 71(7–8), 838–857. doi:http://dx.doi.org/10.1016/j.ijhcs.2013.04.006
[33] (33)Kirkpatrick, D., & McLaughlan, R. (2000). Flexible Lifelong Learning in Professional Education. Educational Technology & Society, 3(1), 24–31. doi:10.1.1.35.7320
[34] (34)Kolomvatsos, K. (2007). Ubiquitous Computing Applications in Education. Ubiquitous and Pervasive Knowledge and Learning Management: Semantics, Social Networking and New Media to Their Full Potential, 94–117.
[35] (35)Kwon, O. (2006). The potential roles of context-aware computing technology in optimization-based intelligent decision-making. Expert Systems with Applications, 31(3), 629–642.
[36] (36)Labus, A., Simić, K., Vulić, M., Despotović-Zrakić, M., & Bogdanović, Z. (2012). An Application of Social Media in eLearning 2.0. In Proceedings of the 25th Bled eConference eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future (pp. 557–572). Bled, Slovenia.
[37] (37)Lifelong Learning Policy. (n.d.). European Commission.
[38] (38)Lynch, C. (2008). Big data: How do your data grow? Nature, 455(7209), 28–29.
[39] (39)Makarov, A., Sverdlov, V., & Selberherr, S. (2012). Modeling Emerging Non-volatile Memories: Current Trends and Challenges. Physics Procedia, 25, 99–104. doi:http://dx.doi.org/10.1016/j.phpro.2012.03.056
[40] (40)Martinez-Mediano, C., & Lord, S. M. (2012). Lifelong Learning Program for engineering students. In Proceedings of the 2012 IEEE Global Engineering Education Conference (EDUCON) (pp. 1–6). IEEE. doi:10.1109/EDUCON.2012.6201072

[41] (41)Matijević, M., & Jevremović, S. (2013). Semantička interoperabilnost podataka u istraživanju IKT tržišta zasnovana na ontologijama. In Infotech 2013 (pp. 1–6).
[42] (42)Matijević, M., & Šolaja, M. (2013). ICT in Serbia: At a Glance. Novi Sad.
[43] (43)Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1995). Augmented reality: A class of displays on the reality-virtuality continuum. In Photonics for Industrial Applications (pp. 282–292). International Society for Optics and Photonics.
[44] (44)Milojičić, D. (2013). IEEE Computer Society 2022 Report. In Joint Seminar on Computer Science and Applied Mathematics, 30.12.2013. Belgrade.
[45] (45)Miraz, G. M., Ruiz, I. L., & Gómez-Nieto, M. Á. (2009). University of things: applications of near field communication technology in university environments. The Journal of E-working, 3(1), 52–64.
[46] (46)Naimpally, A. V., Ramachandran, H., & Smith, C. (2012). Lifelong Learning for Engineers and Scientists in the Information Age. Elsevier.
[47] (47)National Academy of Engineering. (2004). The engineer of 2020: Vision of enginnering in the New Century. The National Academies Press.
[48] (48)NBS. (2012). Bilans usluga, januar - decembar 2011-2012/1. Beograd.
[49] (49)Pascall, S. C. (2010). Serbia - ICT RTD Technological Audit. European Commission, Information Society and Media. Retrieved from http://books.google.rs/books?id=k_aTMwEACAAJ
[50] (50)Petroulakis, N. E., Tragos, E. Z., Fragkiadakis, A. G., & Spanoudakis, G. (2012). A lightweight framework for secure life-logging in smart environments. Information Security Technical Report, 17(3), 58–70.
[51] (51)Piro, G., Cianci, I., Grieco, L. A., Boggia, G., & Camarda, P. (2014). Information centric services in Smart Cities. Journal of Systems and Software, 88, 169–188. doi:http://dx.doi.org/10.1016/j.jss.2013.10.029
[52] (52)Samad, T., & Kiliccote, S. (2012). Smart grid technologies and applications for the industrial sector. Computers & Chemical Engineering.
[53] (53)Satzger, B., Psaier, H., Schall, D., & Dustdar, S. (2013). Auction-based crowdsourcing supporting skill management. Information Systems, 38(4), 547–560.
[54] (54)Spector, J. M. (2014). Emerging educational technologies: Tensions and synergy. Journal of King Saud University-Computer and Information Sciences, 26(1), 5–10.
[55] (55)Stefanović, M. (2013). Informaciono-komunikacione tehnologije: Peti element razvoja Srbije. Novi Korak - Časopis Privredne komore Srbije, (79), 12–13.
[56] (56)Trelles, O., Prins, P., Snir, M., & Jansen, R. C. (2011). Big data, but are we ready? Nature Reviews Genetic, 12(3). doi:10.1038/nrg2857-c1
[57] (57)Wang, W., Xu, Y., & Khanna, M. (2011). A survey on the communication architectures in smart grid. Computer Networks, 55(15), 3604–3629.
[58] (58)Weiser, M. (1991). The computer for the 21st century. Scientific american, 265(3), 94–104.
[59] (59)Wu, X., Zhu, X., Wu, G.-Q., & Ding, W. (2014). Data Mining with Big Data. IEEE Transactions on Knowledge and Data Engineering, 26(1), 97–107. doi:10.1109/TKDE.2013.109
[60] (60)Zhioua, G. E. M., Labiod, H., Tabbane, N., & Tabbane, S. (2013). LTE Advanced Relaying Standard: A Survey. Wireless Personal Communications, 72(4), 2445–2463. doi:10.1007/s11277-013-1157-1

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