IT Study Program as a Crucial Factor for Development of IT Ecosystem: Case Study of Moravica District, Serbia

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Abstract— **The research presents the role of the Information Technology study program, offered at the Faculty of Technical Sciences Čačak, in the development of the IT ecosystem in the Moravica District in Serbia. The data were collected on the companies and their employees, as well as on the percentage of the students and graduates of the mentioned study program in these companies. The correlation between the growth of the number of companies and the development of the study program was measured and the Pearson's coefficient (0.755) was calculated, which points to the existence of a strong relationship between the number of students enrolled in the IT study program and the number of IT companies in the Moravica District. Future work relates to further monitoring of the IT ecosystem and improvement of the study program following the market needs.**

Keywords-curriculum; courses; study program; IT

I. INTRODUCTION

University of Kragujevac (UNIKG) is one of nine state Universities in Serbia – Universities whose founder is the Republic of Serbia. UNIKG consists of twelve Faculties whereby half of them are located in the city of Kragujevac and the other half in Kraljevo, Jagodina, Užice, Vrnjačka Banja and Čačak. The city of Čačak has two faculties – Faculty of Agronomy and Faculty of Technical Sciences (FTS).

Faculty of Technical Sciences in Čačak offers study programs on all three levels (bachelor, master and doctoral studies). Besides academic studies, there is a large variety of study programs of professional studies. With more than 110 teachers and associates, and more than 2100 active students, FTS Čačak represents the largest faculty on UNIKG.

The city of Čačak is the administrative center of the Moravica District which is located in the western part of Central Serbia (Fig. 1). Besides the city of Čačak, Moravica District includes three municipalities: Lučani, Ivanjica and Gornji Milanovac. IT companies in the District currently employ around 500 people and there is a pressing need for at least another 100 employees from various IT fields. However, the real demand for IT experts is twice or even triple as high.

Figure 1. Location of the Moravica District, Serbia

The study program of bachelor academic studies in Information Technologies (IT) at the Faculty of Technical Sciences Čačak, was first accredited in 2009 with an enrollment quota of 40 students. The second accreditation process was in 2014 when the number of students to be enrolled was increased to 80. In 2017, the curriculum was further innovated since the Faculty was included in the Action Plan for IT Development of the Government of the Republic of Serbia, implemented by the Council of Ministers for IT.

A new curriculum for 130 students with state-of-the-art courses which were in line with industry needs was developed. In addition to increasing the enrollment quota, both the infrastructural and staff capacities have been strengthened following the guidelines of the Strategy for the Development of the Information Technology Industry for the period from 2017 to 2020 [1] and Information Society and Information Security Development Strategy of the Republic of Serbia for the period 2021-2026 [2]. Acting according to the Action Plan, the experts from IT sector were hired as

auxiliary external lecturers ie lecturer outside the employment relationship on Faculty. This measure brought considerable improvement of the quality of teaching process. Moreover, the Faculty successfully appeals for the Ministry funds every year and consequently constantly updates and improves individual courses within the new IT study program (through projects of Higher Education Development Ministry of Education, Science and Technological Development). Furthermore, since 2017 the Faculty of Technical Sciences Čačak has been offering the second and the third level of IT studies (master's and PhD studies).

The study program has clearly defined goals which are in accordance with the: (1) recommendations and guidelines of ACM/IEEE curriculum for the field of information technologies (IT), (2) education Strategy in Serbia, as well as (3) the information technology industry development strategy until 2020. The goals of the study program are aimed at acquiring academic knowledge, skills and specific experiences ie competencies in accordance with current world practice. The study program aims to provide graduated students with the necessary skills and knowledge for successfully performing IT jobs, advancement towards leadership positions or further research and scientific work. The Faculty of Technical Sciences in Čačak defined basic tasks and goals within the Quality assurance strategy, with which the goals of the study program are fully harmonized.

In recent years the interest for the mentioned study program has been very high. New generations of students come with better scores from high schools than before. Besides the better input quality aspect, the number of interested students exceeds the enrolment quota every year.

As the number of IT experts is the major limiting factor in the overall development of the IT industry and since the enrolment quota cannot be broadened at the moment, the Faculty organizes non-formal education short cycle courses, thus trying to contribute to bridging the existing gap on the labor market.

The goal of the proposed research is to determine the correlation and role of the IT study program in the IT ecosystem development in the Moravica District. The development of the IT study program implies continuous work on improving the curriculum and subject content, as well as increasing the enrolment quota. On the other hand, the development of the IT ecosystem in the Moravica district implies an increase in the number of IT companies and the number of open positions for IT experts.

II. IT ECOSYSTEM IN MORAVICA DISTRICT

Collaboration between the community and faculties is very important, especially for the faculties in the field of engineering. Professors and students should be closely connected with the community, and partnerships between the faculty members and the community are established in various ways [3].

The authors in [4] proposed collaboration between the faculty and the community through various students' projects to solve specific needs of the community. IT education and education in general can be viewed as a way of preparing the students (future workforce) to engage in the selection of their future careers from an ethical standpoint in order to become "good citizens" beneficial for the society [5]. According to [6], "engineering students must be prepared to function as professionals in increasingly diverse societies".

When it comes to cooperation between science and economy in the Moravica district, but also in Šumadija and Western Serbia if we look at the broader picture, Faculty of technical sciences in Čačak has a large support and excellent partnership in Science Technology Park (STP). STP Čačak is one of only four Science technology parks in Serbia. His founders are besides the Government of the Republic of Serbia and the City of Čačak, both faculties in Čačak, the Fruit Research Institute, but also business associations (Gradac 97 and Unija Čačak 2000). As part of the local economic development of the district in support of business ideas, STP Čačak provides [7]:

- Connecting to institutions and organizations, access to financial resources;

- Support for the development of startup ideas/teams through Startup Center;

- Support for economic entities through equipped infrastructure capacities and high-technological equipment (STP Lab);

- Support within the mentoring program for economic entities, technological companies, young startups (lectures, trainings, courses) and mentoring for startup teams and frilensers (consulting and educational content);

- Virtual incubation (promotion and set of services in the field of management and marketing particularly intended for newly established and startup companies);

- Infrastructural support to different groups of users (public sectors, science, researchers, economy, innovators, startup teams).

Although modern paradigm of cooperation between technical faculties and community is such that the largest emphasis is placed on cooperation with the economy, directly or through various projects, professors must not forget about their first and most important role – teaching. Under this role, not only the teaching of students is considered, but also engaging in providing aid for teachers in primary and secondary education. In this regard, professors should follow the changes in the education system and react to them through creating various forms of training for primary and secondary education teachers since innovated materials in the field of IT are continuously incorporated in learning programs. Čačak has a Center for professional development of teachers (CPD) which belongs to the network of twelve state centers of such

kind. CPD Čačak is the place where FTS professors are involved in trainings and other forms of informal lifelong learning.

The FTS in Čačak has a long tradition of both informal and formal teacher education and training. Graduates on integrated academic studies in technics and informatics may teach in primary and secondary schools (courses: informatics and computing, technics and technology, computing and informatics, etc.).
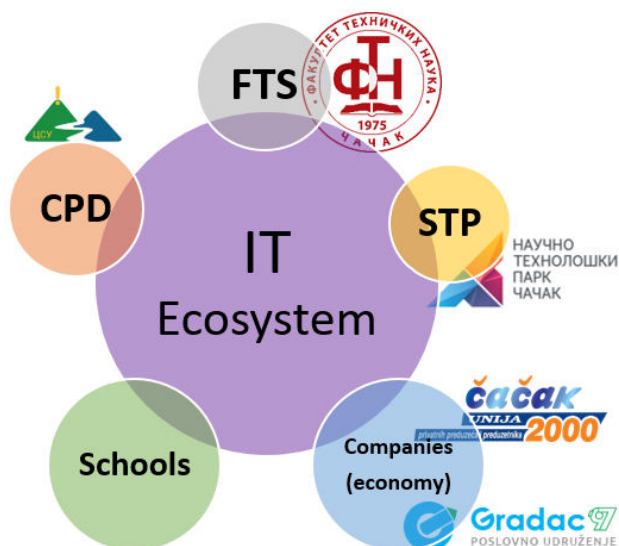

Figure 2. IT ecosystem in Moravica district

The teaching materials in the field of programming in primary schools in Serbia, started like electoral modules within the election subject but soon became the teaching topic within the compulsory subject that takes half of the annual classes. The present topic is more complex for students than other topics in the subject Informatics and computing but it is incomparably more significant from the point of view of future employment in the IT sector, which is constantly developing and in which employee standard is generally higher than other areas [8].

Changes in the status of the subject of informatics and computing in primary schools occurred from the school year 2017/2018, while the application of the new Rulebook on the program of teaching and learning for the fifth grade started from the school year 2018/2019 [9]. The same regulations envisages a change in teaching and learning programs for the sixth grade, with it to take effect from the school year 2019/2020. Successively, regulations for the seventh and eighth grade were published [10, 11] and been applied in school years 2020/2021 and 2021/2022, respectively. These regulations envisaged that the subject of informatics and computing is performed in the scope of 36 classes in the fifth, sixth and seventh grade, and 34 hours in the eighth grade. Contents and outcomes of teaching and learning programs from the eight grade are studied in the second year of high school, where teachers have more than a double number of classes for the realization of materials (74) in comparison to

primary schools [12]. Rulebook related to the eighth grade informatics and computing was already in mid-2021 (one year after the adoption of the basic version), supplemented with contets related to artificial inteligence and inovated with some contents in the field of programing [11: Educational Gazette 5/21].

Based on the above, it can be realized how the field of IT is dynamic and subject to changes or improvements and how important the role of the faculties is to help teachers in primary and secondary schools, and consequently provide oneself better input in terms of better trained students to enroll in the near future.

III. METHODOLOGY

Based on the subject of the paper, the following hypothesis was defined:

H: *There is a statistically significant correlation between the development of the Information Technology study program and the development of the IT ecosystem in the Moravica district.*

In order to prove or reject the hypothesis, research methodology, consisting of four phases, was defined, as shown in Figure 3.

General data on individual IT companies in the Moravica District were collected through official business portals [13, 14]. Then, specific data on the employees, company activities, etc. were collected through direct contact with the representatives of the given companies.

In the second phase, the data were transformed into the appropriate format and prepared for further analysis. Namely, the data were recorded in different periods, in different formats, and the analysis required all data to be recorded uniformly.

Figure 3. Structure of the research

IV. RESULTS AND DISCUSSION

After collection and preprocessing, the data were analyzed and the most important results are the following:

- 75% of the employees in the IT companies in the Moravica district are former (or current) students of the Faculty of Technical Sciences Čačak

- Over 90% of the companies declared that they want to achieve business and technical cooperation with the Faculty

- Over 90% of the companies plan to expand their capacities in terms of human resources

Figure 4 presents the share of different IT business areas that the companies from the IT community in the Moravica district are engaged into.
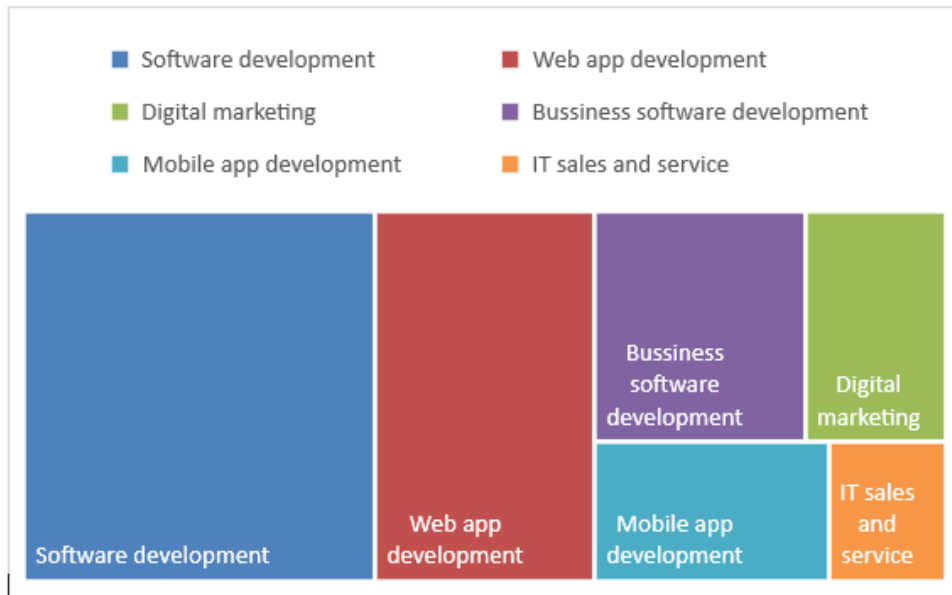
Figure 4. IT business areas of the IT companies in the Moravica district

The most dominant areas are *software development* and *web app development*, but the areas of *business software development* and *mobile app development* are also prominently displayed in the figure above. The areas that are not directly related to development, such as *digital marketing* and *IT sales and services*, are represented to a lesser extent. If we were to analyze the curriculum of the IT study program, we would come to the conclusion that knowledge and skills necessary for work in all areas shown in the figure are obtained through the compulsory and optional subjects to a significant extent.

Table I shows the correlation values between the quantitative indicators in both categories – the number of students on the one hand and the number of IT companies on the other.

TABLE I.   THE CORRELATION BETWEEN THE NUMBER OS STUDENTS AND THE NUMBER OF IT COMPANIES

		Number of students	*Number of IT companies*
Number of students	Pearson correlation	1	0,755
	Sig.		0,019
Number of IT companies	Pearson correlation	0,755	1
	Sig.	0,19	

The size of the correlation coefficient indicates the strength of the connection between the enrollment quota (number of students) and the number of IT companies in the Moravica district. Given that the obtained Pearson coefficient value is positive, it is a positive correlation - large values on one scale are followed by large values on the other scale. The value of 0.755 indicates a high correlation [15, p. 79-81]. Therefore, it can be claimed that the research hypothesis has been confirmed.

V. CONCLUSION

The main contribution of the research is a quantitative analysis of the data related to the IT study program which is being realized at the Faculty of Technical Sciences Čačak and its influence on the IT ecosystem in the Moravica District.

The results point to a crucial role of IT studies in the development of IT sector in the district. The obtained results could help stakeholders from both sides to plan their further activities for successful collaboration.

Future work relates to the dissemination of the obtained results and informing the policy makers both on local and republic level, in order to keep in mind the current situation and plan additional enrolment quota expansions, as was the case in 2017. An additional professional contribution of this research is that a database of IT companies has been formed, which will be constantly updated in the future. Further plans are to create a direct connection between the Faculty and IT companies from the aforementioned database through a portal implemented on the official website of the Faculty, whereby job or internship ads would be visible on the portal in real time. Only Faculty students will be able to access the portal, so the employers would have direct insight into the portfolio of registered candidates.

REFERENCES

[1]   Information Technology Industry Development Strategy for the Period from 2017 to 2020, "Official Gazette of RS", No. 95/2016, available at:

https://www.neobilten.com/strategija-razvoja-industrije-informacionih-tehnologija-za-period-od-2017-do-2020-godine/

[2]   Strategy for the Development of the Information Society and Information Security in the Republic of Serbia for the period from 2021 to 2026, "Official Gazette of RS", No. 86 of September 3, 2021, available at:
http://www.pravno-informacioni-sistem.rs/SlGlasnikPortal/eli/rep/sgrs/vlada/strategija/2021/86/1/reg

[3]   B. G. Tucker, D. Kazmer, A. Bielefeldt, K. Paterson, O. Pierrakos, A. Soisson and C. Swan, "Principles of Sustaining Partnerships between Higher Education and their Larger Communities: Perspectives from Engineering Faculty Engaged in Learning through Service", International Journal for Service Learning in Engineering – Humanitarian Engineering and Social Entrepreneurship, Special Edition, pp. 48-63, 2013

[4]   M. Jordaan, "Community-based Project Module: A service-learning module for the Faculty of Engineering, Built Environment and Information Technology at the University of Pretoria", International Journal for Service Learning in Engineering – Humanitarian Engineering and Social Entrepreneurship, Special Edition, 2014, pp. 269-282.

[5]   J. L. Hess, A. Lin, G. A. Fore, T. Hahn and B. Sorge, "Testing the Civic-Minded Graduate Scale in Science and Engineering", International Journal of Engineering Education, vol. 37, No 1, 2021, pp. 44–64.

[6]   W. C. Lee, B. D. Lutz, H. M. Matusovich and S. Bhaduri, "Student Perceptions of Learning about Diversity and its Place in Engineering Classrooms in the United States", International Journal of Engineering Education, vol. 37, No. 1, 2021, pp. 147-162.

[7]   Science technology park Čačak, official website, available at:
https://www.ntpcacak.rs/sr/o-nama/

[8]   Papić, M., Čukljević, D. and Luković, Z. "Teaching of programming in the cloud: a paradigm for the new era", 9th International Scientific Conference Technics and Informatics in Education, Faculty of Technical Sciences, Čačak, Serbia, 16-18th of September 2022, pp 483-487, ISBN 978-86-7776-262-9, DOI: 10.46793/TIE22.483P

[9]   Rulebook on the plan for teaching and learning for the fifth and sixth grade of primary education and teaching and learning program for the fifth and sixth grade of primary education (Official Gazette of the Republic of Serbia – Educational Gazette, No. 15/18, 18/18, 3/19, 3/20, 6/20 and 17/21)

[10]   Rulebook on the program of teaching and learning for the seventh grade of primary education and upbringing (Official Gazette of the Republic of Serbia – Educational Gazette, No. 5/19, 1/20, 6/20, 8/20, 5/21 i 17/21)

[11]   Rulebook on the program of teaching and learning for the eighth grade of primary education and upbringing (Official Gazette of the Republic of Serbia – Educational Gazette, Numbers 11/19, 2/20, 6/20, 5/21 i 17/21)

[12]   Rulebook on the plan and program of teaching and learning for high school (Official Gazette of the Republic of Serbia – Educational Gazette, No. 4/20)

[13]   Economic Directory of Serbia, available at:
https://privredni-imenik.com/

[14]   Business Register Agency, available at:
https://www.apr.gov.rs/претрає.1843.html

[15]   J.W. Cohen, Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.