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Students' Preferences in Selection of Computer Science and Informatics Studies – A Comprehensive Empirical Case Study

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Abstract. A selection of Computer Science, Informatics or similar study programs for academic studies evidently becomes an emerging choice of a vast number of students in recent years. To address some of the open questions, we performed an empirical study based on a survey, with a goal to find out the main motivating factors directing students to select computer science, informatics or similar programs for studying in a much greater extent. The survey was conducted on a sample of 1517 students from five well established, and most traditional faculties of computer science and informatics at three largest university cities in Serbia: Belgrade, Novi Sad, and Niš. The created sample is representative enough to illustrate the current situation and trends common for many similar societies. Our first analysis shows that the main motivating factor to select computer science or informatics study program at all faculties is the students' motivation to study just that topic, while at management faculty it is significantly less important. However, we also noticed that significant number of students wished to study something else but chose computer science and informatics due to possibility of finding jobs easier and of earning higher salaries in industry. The most important influential factors to choose a computer science or informatics major come from family members, and close relatives. The perceived brand and reputation of a faculty also plays a significant role. Students being examined prevalently tend to be satisfied with the faculty they have chosen. However, many of them see themselves leaving the country in a near or far future.

Keywords: students' preferences, computing education, Serbia.

1. Introduction

Nowadays, we are the witnesses of an evident social phenomenon of an extremely raised interest of pupils from secondary schools for studying disciplines such as Computer Science (CS), Informatics, Information Technologies (IT), Information Communication Technologies (ICT), Information Systems, Software Engineering, or Computer Engineering [7]. To avoid repetitions in the text, in this paper, we denote all those disciplines with the CSISE acronym, for short. Despite the fact that these disciplines are young and rapidly developing comparing to majority of other disciplines, they have proven to be extremely popular. Many research questions arise about the main motives of newcomer students' behavior and its short and long term influences on the educational process, quality of acquired knowledge and skills, and various social impacts. We notice a similar trend in many countries all over the world with some possible positive and negative social impacts of such a trend.

What we can notice in recent years is a constant increase of figures about the number of applicants for CSISE programs in the calls for first year of B.Sc. studies. In our environment, we often notice even four or more candidates applied for one available position in CSISE study programs where candidates also apply at the same time at multiple study programs. On the other hand, there are many study programs at non CSISE areas that remain without students. Due to these circumstances, many research questions arise about the main motives and factors that influence students' selection of CSISE study programs. To identify and address the most important ones, we have performed a comprehensive empirical study at particular faculties and cities in Serbia.

The goals of our research and the performed empirical study are to: a) reveal what are the main reasons why students choose a CSISE study program; b) to what extent they are satisfied about the selected study program; and c) which sources of information they have used to make their decisions. An important question is also to find out whether the competing faculties are actually competitive, i.e. whether students from different study programs within the same university have the same attitudes towards their study programs and quality of educational process, as well as acquired knowledge and skills. This reveals how much CSISE study programs are overlapping within the same university, and consequently attract the students of the same or similar profile. This would indicate some recommendations for better profiling study programs and mitigate the similarity and competitiveness between CSISE study programs. Results of our study are additionally useful for planning effective faculties' marketing activities and admission procedures to recruit CSISE students. Despite that we completed our empirical study on a sample of Serbian students, we designed it in a way to be representative as much as possible to illustrate a current situation and trends common for many societies. As Serbia is one of South-East European and ex-communist countries with similar or almost identical higher education systems, we believe that the results presented in this paper may be even more useful in a wider area with similar higher education systems, showing practically the same problems, but not only for Serbian universities and faculties with CSISE programs.

In such a context, in the paper, we discuss on the example of Serbia some common open questions that are to be addressed in a more systematic way.

Q1: What is a real impact of the increased number of CSISE students to the local software industry?

Q2: Can academic institutions keep to the satisfactory level of quality with drastically increased number of CSISE students?
Q3: How academic institutions can preserve a sustainable education process of CSISE students?
Q4: How academic institutions can prevent a significant drop-off of education staff, and retain the majority of students at master level studies?
Q5: How to overcome or even temper significant differences in a position of academic institutions in the main city centers, compared to the academic institutions from other, usually less developed regions of the same country?
Q6: How to raise the level of motivation of CSISE students, keeping in mind that not all of them selected such study programs as their primary wish, but as a consequence of strong economical reasons?

To create a basis for addressing some of the aforementioned questions, our empirical study is based on a survey, with a goal to address the main motivating factors directing the students in Serbia to select CSISE programs for studying in a much greater extent, than many other academic disciplines. The survey was conducted on a sample of 1517 CSISE students from five well established and recognized faculties of the three largest, public universities in Serbia. By this, we selected: School of Electrical Engineering (SEE-BG) and Faculty of Organizational Sciences (FOS-BG) from University of Belgrade; Faculty of Technical Sciences (FTS-NS) and Faculty of Sciences (FS-NS) from University of Novi Sad; and Faculty of Electronic Engineering (FEE-NI) from University of Niš. 46.28% of respondents come from the University of Belgrade, where Belgrade is the largest city and capital of Serbia. 34.34% of respondents are from the University of Novi Sad, where Novi Sad is the second largest city located in northern Serbia, i.e. Autonomous Province of Vojvodina, while the rest 19.38% of them come from the University of Niš, as the third largest city, located in southern Serbia.

To the best of our knowledge, there are still no systematic and quantitatively based analyses that examined this phenomenon, and its possible impacts, not only in Serbia but also in other countries. To address some of the open questions at various levels of the society, typically just speculative, descriptive formulations are used to justify a positive impact of such trend for the overall industry development of the country, notifying how promising and influential a development of our software industry for the whole society is.

As our empirical study is performed over a sample of Serbian students, here we give some basic facts about Serbia and its higher education system. There are almost 7 million citizens by population estimates of Statistical Office of the Republic of Serbia for 2019. Serbia is a country with a system of high academic freedom at the level of universities, faculties or departments, and study programs. This means in practice that similar study programs can be found on different faculties, as faculties even within the same university develop independently similar study programs. In Serbia, we have fully profiled study programs in CSISE that typically exist in all major Serbian universities. As it is typical for many other countries, they are implemented at faculties profiled as engineering, management, or science. In some cases, programs in CSISE are even not independent ones in terms of accreditation but blended with some other disciplines. E.g., at School of Electrical Engineering from University of Belgrade, the main study program is profiled in Electrical and Computer Engineering, where CSISE is a module profiled from the second year of B.Sc. studies.

Serbia is a South-East European country, as well as post-communist, and Ex-Yugoslav country with an emerging economy, dramatic past and a challenging and long-lasting road towards joining the European Union. The government of the Republic of Serbia perceives information technologies and software industry as a strategic goal towards achieving economic sustainability and stopping brain drain that prevents Serbia to develop more rapidly. Serbia has a great potential in its universities, as there are several universities among the top 1000 ranked in the world. According to UNIVERSITAS21 [1], it was even No. 1 country in the world in 2017 in terms of their ranking when adjusted for economic development. Although CSISE study programs are well established throughout Serbian faculties, currently we could not find a systematic and reliable study analyzing why students choose a specific CSISE study program at particular faculty, and how they see their future jobs and perspectives afterwards. We have identified several difficulties preventing an easy planning and performing such analyses in a wider scope. Some of them are the following. In practice, different CSISE study programs are independently developed at almost all Serbian universities and their faculties. Even, apart from independent CSISE study programs, we can find just CSISE modules blended with some other study programs, not primarily related to CSISE, and by this it is not easy to differentiate exact data about CSISE students. The faculties develop their own staff, where resources among faculties are mostly not shared, even at the level of the same university. More importantly, these CSISE study programs at one university are actually always competitors trying to attract the best students for themselves. Students normally apply in the same call for several study programs at several institutions, and there is no any unified register of the candidate applications in the enrollment process. Each faculty organizes its own entrance exam, which is mandatory. As a rule, such entrance exams are not of the same level of content, requirements, and rigor, across different institutions. One of predominant factors for students in a selection of a study program to enroll is if a student will be granted a budget-financed place that eliminates a scholarship fee for a student. We believe that it can cover up other significant motivation factors for a selection of study program.

By addressing the aforementioned research questions, we intend to contribute to mitigating some hot problems in CSISE education process in many world-wide countries, such as how to provide satisfactory amount of well educated CSISE professionals, as there is a significant deficit of human resources in software industry, all over the world. Also, one of such problems is how to improve a selection process at universities keeping to the students' affinities and their main motivation factors, so as to attract enough high quality students for CSISE programs. Finally we intend to transfer a message that academic education of CSISE students requires a clear and sustainable strategy, rather than to be seen as a purely 'spontaneous' process, if it is recognized as one of the main pillars of digital society transformation and rapid economic development of the society.

The rest of the paper is organized as follows. Related work is presented in the subsequent section. The main method and ways of collecting data, description of sample and distribution of respondents per faculties are explained in Section 3. In Section 4 we present obtained results, their analysis and comprehensive discussion. Concluding remarks and lessons learned are given in Section 5.

2. Related Work

Understanding how pupils from secondary schools select college/faculty study programs is a well-studied area all over the world. Especially in the last two decades a lot of papers have been published analyzing gender differences and motivational factors in studying Science, Technology, Engineering, and Mathematics (STEM) disciplines [2,4,5,13]. The study of factors that influence computer science studies is a hot topic in science. It has been analyzed from many aspects, like dropout [10], career counselling [16] among others.

Also, different research studies present analysis of a wide range of factors and aspects that influence students' intentions to study CSISE programs and even aspirations to particular SC and ICT courses, e.g. [6]. On the other hand, some studies try to discover general students' satisfaction with selected study programs and faculties/collages/universities.

Choosing faculty study programs has been considered from different perspectives in a lot of countries and schools, and some of these results are presented in this section.

Soria and Stebleton [18] analyzed several aspects of students' satisfaction about selected study programs in different disciplines. First of all, they tried to discover the relationship between students' motivations for selecting faculty study programs, satisfaction with educational experience, and also their satisfaction of belonging on campus. They conducted a multi-institutional survey with students from several big public universities in US. Obtained results showed that "external extrinsic motivations for selecting a study program tend to be negatively associated with students' satisfaction and sense of belonging. Intrinsic motivations and internal extrinsic motivations tend to be positively related to students' satisfaction and sense of belonging".

Phelps et al. [15] studied the role of high-school course selection on choosing college STEM study programs. They showed that students who earned three credits in high school engineering and engineering technology courses were 1.60 times more likely to enroll in STEM study programs in four-year institutions than students who did not earn high school credits in those courses.

Yu et al. [21] used self-determination theory to study the choice of college study programs. They used SEM - Structural equation modeling, and showed that self-determined motivation, parenting styles and individual differences, motivation to study all have specific influences on choosing a major. This conclusion holds both for Eastern and Western populations.

Wang [19] identified several factors why students choose STEM study programs. Factors such as achievement in mathematics, motivation to study STEM study program, financial support in the beginning of the studies, exposure to science courses show a big impact on choosing STEM study programs.

Wegemer and Eccles [20] analyzed how gender and altruism influence the STEM career choice. They showed that altruism mediates the relationship between femininity and STEM career choice.

Malgwi et al. [12] reported several influencing factors on students choosing a faculty study program. Interest in the subject was the most important factor for both genders. For female students, aptitude in the subject is the next most important factor, where for male students the potential for career advancement, job opportunities and the salaries level were more significant.

Putnik et al. [17] presented the interesting students' opinions and correlations on satisfaction and views about computer science studies and their ambitions and expectations for future careers and jobs. Authors statistically processed data collected from extensive survey, where questionnaire contained more than 120 questions and options, conducted on a considerable sample of students from several Balkan countries.

Leppel et al. [11] studied the impact of parental occupation and socioeconomic status on choice of faculty study program. Having a father in a professional or executive occupation has a larger effect on female students than does having a mother in a similar occupation. The opposite holds for males. On the other hand, females from families with high socioeconomic status are less likely to study program in business; the opposite holds for males. Students who believe that being very well off financially is very important are more likely to choose study program in business than other students.

Montmarquette et al. [14] developed a model that showed that the expected earning mostly influences the choice of a study program. This general conclusion varies by race and gender.

Giannakos [6] shifted a little bit focus of his research to explore students' intentions to study computer science and additionally to find out the differences between programming and ICT courses. He combined several theories, including Social Cognitive Theory, Unified Theory of Acceptance, and Use of Technology, as motivating factors in students' attitude towards CS courses in a Greek university. His expectations were similar as ours: that such research can open new ways of understanding students' intentions to pursue computing and IT related careers and motivations to enroll CSISE studies.

Kori et al. [9] conducted a research rather similar to ours. They studied the reasons why students choose to study informatics. Their main intention was to analyze data and find useful guidelines on how to improve future students' recruitment and retention in informatics studies at three universities in Estonia. Main conclusions of the research were: "the most frequent reasons for studying informatics were general interest in ICT, previous experience in the field, need for personal professional development, and importance of the field in the future". Additionally, "analysis showed that candidates were accepted with higher probability if they found informatics to be suitable for them, or expressed good opportunities in the labor market."

All aforementioned research works show a plethora of different motives and factors influencing a selection of some CSISE study program. Some of the motives are highly dependent of local conditions of a particular university, country, a wider region, or a profile of target population. In Serbia, as an emerging economy, post-communist country, CSISE study programs are spread across many schools/faculties which have often very similar study programs that are allocated in different scientific fields, e.g. mathematics, engineering, or even social sciences. In such circumstances it is not always clear what are the main reasons and motives that students choose specific study programs. Additionally, for several competing influential faculties that offer different study programs in CSISE in Serbia, it is extremely important and challenging to discover these reasons and motivational factors. Comprehensive analysis and obtained results can play an essential role in attracting new generations of students to particular faculty and study program. Presented results can be also used by different universities and governmental educational policy stakeholders to carefully consider position of educational staff, properly plan marketing campaigns to

attract more CSISE students, and adequately support improvement of study programs to adjust them to emerging needs of labor market and local numerous ICT companies.

3. Data Collection about CSISE Studies in Serbia

3.1. Methods

Before we preset methodology and design of questionnaire to investigate students' opinions we will briefly present school system in Serbia. It can help readers to better understand obtained results. In Serbia compulsory primary education lasts eight years. After that, pupils enter secondary education level, which consists of: 1) general grammar schools, 2) specialized grammar schools, intended for education of highly talented students, and 3) vocational schools, oriented to one of 15 different areas. All grammar schools have four-year programs, and their students can enroll at almost any faculty. On the other hand, some vocational schools last for three years only, so their students need additional year of study in order to proceed to higher education system in their specialization field. Candidates are admitted to the faculty based on secondary school grades (40% weight in total score) and the entrance exam results (60% weight in total score). Entrance exam is organized by each faculty, but it is expected to be replaced by centralized State Matura exam in 2020.

In order to investigate students' opinions about faculties and study programs in CSISE, we designed a questionnaire shown in Table 1 based on our domain expertise in the field of CSISE education. Besides common demographic questions, the questionnaire contains questions addressing:

- Primary motivating factors to study CSISE and factors for choosing a concrete CSISE faculty;
- Students' expectations and satisfaction with chosen study programs and faculties;
- How students informed themselves about CSISE faculties and study programs before enrollment and questions asking whether someone recommended the chosen faculty; and
- Students' future short-term and long-term plans and career opportunities.

Table 1: The questionnaire used to obtain students' opinions about CSISE faculties in Serbia.

Item	Question	Comments
1	Please specify (a) University, faculty and study program/module/direction (b) Study year (c) Have you renewed the current study year and how many times? (d) Gender (Male/Female) (e) City and country where you finished elementary school (f) City and country where you finished secondary school (g) Which type of secondary school have you attended? (h) Secondary school average grade (5 – excellent, 4 – very good, 3 – good, 2 – satisfactory)	Demographic questions

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Table 1 – *Continued from previous page*

Item	Question	Comments
2	After finishing your studies you plan to (a) continue with master studies at the same faculty (b) continue with master studies at some other faculty in Serbia (c) continue with master studies abroad (d) find an IT job in Serbia (e) find an IT job abroad (f) something else (please specify)	Multiple-choice question addressing future short-term plans
3	Have you considered enrolling informatics studies abroad before enrolling the faculty in Serbia? If yes please specify country and university.	Yes-no question. Additional comments are possible for the "Yes" answer.
4	Why have you chosen to study informatics and computer science? Please rate the relevance of the following factors. 1) Informatics has always attracted me and I feel it as my life's calling 2) I wanted to study something else, but I did not see any perspective of that profession in Serbia 3) I have chosen to study informatics since the IT industry is expanding globally and everyone talks about IT	Five-points Likert scale questions (from 1 – strongly disagree to 5 – strongly agree) addressing primary motivating factors for studying informatics
5	Did someone recommend you to enroll the chosen faculty? Please indicate whether the following persons recommended you to enroll the chosen faculty and whether their recommendation strongly influenced your faculty choice. 1) Secondary school teachers 2) Secondary school friends 3) Parents and close family 4) Current students of your faculty 5) Current students of some other faculty 6) Someone who finished your faculty 7) Someone who finished some other faculty 8) Persons working in IT sector 9) Persons working at my faculty Please indicate whether there are some other persons who recommended you to enroll your faculty. Also please indicate whether there are persons who recommended you not to enroll the chosen faculty and what were their key arguments.	Students answer by selecting one of three given answers: 1. No 2. Yes, but the recommendation did not have a major impact on my choice 3. Yes, the recommendation had a big impact on my choice

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Table 1 – *Continued from previous page*

Item	Question	Comments
6	Why have you chosen your current faculty to study informatics and computer science? Please rate the relevance of the following factors. 1) The study programs offered by your faculty better suit your interests and processional aspirations compared to study programs at other faculties in Serbia 2) Informatics studies at other faculties in Serbia are much more demanding and harder compared to informatics studies at your faculty 3) You heard that students of your faculty easily get well paid IT jobs 4) You thought that it would be easier to obtain state financing at your faculty than at some other faculty in Serbia 5) You were informed about possibilities to get an internship practice in IT companies during studies at your faculty 6) You heard that students of your faculty easily get jobs in foreign IT companies or go abroad for master studies 7) You heard that teachers of your faculty are competent and that the teaching content follows modern trends 8) The faculty you enrolled is considered more respectable compared to other faculties in Serbia offering informatics studies 9) Persons you consider competent nicely spoke about the faculty you enrolled 10) You heard that courses at your faculty are of better quality than courses at other informatics faculties in Serbia 11) You thought that you will be in a better position at the labor market after finishing studies at your faculty Please specify if there are additional reasons for choosing the faculty you currently study.	Five-points Likert scale (from 1 – strongly disagree to 5 – strongly agree) questions addressing factors for choosing a concrete faculty
7	Have you considered enrolling some other faculty offering informatics and computer science study programs beside the faculty you currently study? If yes please specify which faculty and why did you choose the faculty you currently study.	Yes-No question. Additional comments are possible for the "Yes" answer.
8	How and how often did you inform and get information about your faculty and study program before enrollment? Please indicate the relevance of the following information sources. 1) Secondary school friends 2) Secondary school teachers 3) Current students of my faculty 4) Former students of my faculty 5) Social media (Facebook, Twitter, etc.) 6) Faculty web site 7) Official faculty profiles on social media 8) Classic media (TV, newspapers, etc.) 9) Faculty promotional and advertising campaigns 10) Science popularization lectures 11) Preparatory lectures for student competitions 12) Seminars, courses and other extracurricular activities 13) Educational fairs	Students answer by selecting one of three given answers: 1) Never 2) Rarely 3) Frequently

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Table 1 – *Continued from previous page*

Item	Question	Comments
9	What are your expectations from the chosen faculty and study program? 1) To obtain knowledge enabling easier adaptations to labor market needs 2) To obtain a broad education in the study field necessary for further academic advancement (master and doctoral studies) 3) To master practical techniques and tools used in IT companies 4) To learn how to solve problems from real IT practice 5) To learn knowledge that can help me to start my own IT business 6) To obtain advice from my professors regarding my further professional development 7) To obtain also knowledge from other scientific fields that is applicable in real IT practice 8) To obtain theoretical knowledge necessary for understating and solving problems from real IT practice If you have some other expectations please specify them.	Five-points Likert scale questions (from 1 – strongly disagree to 5 – strongly agree) addressing expectations from the chosen faculty and study program
10	Has your opinion about your faculty and study program changed during your studies?	Students answer by selecting one of three given answers: 1. Yes, to better 2. No 3. Yes, to worse
11	According to your experience, how satisfied are you with the chosen faculty and study program?	Five-point Likert scale question (from 1 – completely dissatisfied to 5 – completely satisfied)
12	If you could go to the past, would you enroll the same faculty? If no please explain which faculty would you enroll.	Yes-No question. Additional comments are possible for the "No" answer.
13	Please indicate key advantages and key disadvantages of your faculty compared to other faculties offering informatics and computer science program.	Open-ended question
14	How do you see yourself in the IT sector for a long-term? 1) Freelancer 2) An IT expert working in a non-IT company 3) Employee in a Serbian IT company that makes software/hardware products for the Serbian market 4) Employee in a Serbian IT company outsourcing software/hardware products for foreign IT companies 5) Employee in a Serbian IT company designing and developing its owns software/hardware product for the global market 6) Employee in a large multinational company having a development center in Serbia 7) Employee in a small/medium foreign IT company 8) Employee in a large foreign IT company 9) IT entrepreneur home 10) IT entrepreneur abroad	Multiple-choice question addressing future long-term plans

The questionnaire was disseminated using Google Forms among students conducting CSISE study programs. The Google Forms platform allows pollsters to send a link to a questionnaire to potential respondents. The link to the questionnaire was disseminated to our students using institutional learning management systems and mailing lists, and they filled-in questionnaire voluntarily and anonymously. The questions were formulated in

Serbian. The questionnaire was live for approximately 3 months (from January to March 2018).

The reliability of collected data was assessed using the Cronbach's alpha coefficient. Then, collected students' responses were analyzed by using descriptive statistics, Pearson's correlation coefficients and non-parametric statistical tests. Non-parametric statistical tests were utilized to compare responses to a questionnaire item considering two or more independent subsamples. Subsamples were formed by various criteria: enrolled faculty, study year, gender and primary motivating factors to study informatics. The Mann-Whitney U (MWU) test and the Kolmogorov-Smirnov (KS) test were instrumented to compare two independent subsamples. MWU is a test of stochastic superiority and it examines the null hypothesis that responses in one sample do not tend to be neither higher nor lower than responses in another sample. This test is suitable for questionnaire items to which respondents provide answers on the Likert scale (e.g. question 11 and question groups 4, 6 and 9 in Table 1). To quantify the degree of a difference between two subsamples S_1 and S_2 considering responses to a Likert-scale questionnaire item Q, we examine two probabilities of superiority: the probability that a randomly selected response from S_1 is strictly higher than a randomly selected response from S_2 and the inverse probability, i.e. the probability that a randomly selected response from S_2 is strictly higher than a randomly selected response from S_1. The KS test was utilized to examine the null hypothesis that the distributions of responses of two independent samples to a questionnaire item are not significantly different. To compare more than two independent subsamples we employed the Kruskal-Wallis (KW) ANOVA test with a post-hoc pairwise comparison based on the MWU test with the Bonferroni adjustment for the p-value.

3.2. Sample

The questionnaire aimed at collecting students' opinions about Serbian faculties offering CSISE study programs was disseminated at five faculties listed in Table 2. The table also shows the number of respondents from each institution. A total of 1517 respondents is distributed as follows: 46.28% from the University of Belgrade as the largest state university in Serbia, 34.34% from the University of Novi Sad, the second largest state university in Serbia, and 19.38% from the University of Niš, the third largest state university in Serbia.

Table 2. Serbian faculties which participated in the survey.

Faculty	University	Abbrv.	#respondents
School of Electrical Engineering	University of Belgrade	SEE-Bg	434
Faculty of Organizational Sciences	University of Belgrade	FOS-Bg	268
Faculty of Electronic Engineering	University of Niš	FEE-Ni	294
Faculty of Technical Sciences	University of Novi Sad	FTS-NS	302
Faculty of Sciences	University of Novi Sad	FS-NS	219

The basic demographic characteristics of the respondents are summarized in Table 3 that shows the distribution of respondents by study year and gender. It can be seen that

the distribution of respondents by study year, excluding final year students, is fairly balanced. Final year students constitute the smallest fraction of the sample, less than 5%. The distribution of respondents by gender is also relatively balanced: approximately 60% of respondents are male students and 40% of respondents are female students. Having in mind that in Serbia and several other Balkan countries, number of female students in CSISE disciplines is bigger than in other West European countries, number of female respondents in this research is more than satisfactory [17,8].

Table 3. The distribution of respondents by study year and gender.

	Study year					Gender	
	1st [%]	2nd [%]	3rd [%]	4th [%]	5th [%]	Male [%]	Female [%]
FEE-Ni	23.81	31.63	21.43	20.07	3.06	69.05	30.95
SEE-Bg	10.37	30.88	30.88	26.04	1.84	68.43	31.57
FOS-Bg	33.96	22.01	21.64	19.78	2.61	36.57	63.43
FTS-NS	29.8	27.48	14.24	20.86	7.62	60.6	39.4
FS-NS	28.31	24.2	17.81	20.09	9.59	55.71	44.29
Total [%]	23.6	27.82	22.21	21.89	4.48	59.53	40.47

A large majority of the respondents (93.21%) finished secondary school in Serbia. Our sample also contains students that finished secondary school in several other Balkan countries: Bosnia and Herzegovina (5.34%), Montenegro (1.05%), and Croatia (0.4%).

The top 10 most frequent Serbian cities our respondents come from are: Belgrade, Novi Sad, Niš, Leskovac, Šabac, Vranje, Pirot, Kruševac, Užice and Valjevo, indicating that our sample is also geographically fairly dispersed through the whole Serbia with one exception – students coming from Kragujevac as the fourth largest city in Serbia are not significantly present in our sample. This can be explained by the fact that CSISE faculties from the University of Kragujevac, have not participated in our survey.

Regarding secondary-level education, the largest fraction of our respondents finished secondary grammar school (78.78%), 11.67% of respondents finished secondary school in electrical engineering, while 9.55% of respondents obtained diploma from other vocational schools. We asked our respondents to indicate their secondary school average grade, where the grade scale is: 5 – excellent, 4 – very good, 3 – good, and 2 – sufficient. More than 86% of our respondents had excellent grades in their secondary schools suggesting that the best secondary school pupils enroll the CSISE faculties.

3.3. Reliability of Collected Data

The reliability of collected responses to our questionnaire was examined using the Cronbach's alpha coefficient [3]. This coefficient reflects the internal consistency of responses to different questions covering the same theoretical construct. The alpha coefficient higher than 0.7 signifies an acceptable level of internal consistency. Our questionnaire contains four large groups of questions reflecting four different constructs (items 5, 6, 8 and 9 in Table 1). Thus, we have computed four Cronbach's alpha coefficients:

1. α_1 – the internal consistency of responses to questions addressing faculty recommendations;
2. α_2 – the internal consistency of responses to questions assessing factors for enrolling a particular faculty;
3. α_3 – the internal consistency of responses to questions related to how students were informed about the chosen faculty prior to enrollment; and
4. α_4 – the internal consistency of responses to questions eliciting expectations from the enrolled faculty.

The obtained alpha values, $\alpha_1 = 0.6946$, $\alpha_2 = 0.7963$, $\alpha_3 = 0.7972$ and $\alpha_4 = 0.8813$, imply that the reliability of collected responses is at an acceptable level for further statistical analyses.

4. Results and Discussion

4.1. Motivation

The questionnaire contains three questions asking respondents why they have chosen to study different CSISE study programs (questionnaire item 4 in Table 1). The distributions of answers to those three questions are given in Tables 4, 5 and 6. We notice that a majority of respondents, more than 60%, feel or strongly feel informatics as their life's calling. The application of the KW ANOVA test showed that there are statistically significant differences in the distribution of responses of students from different institutions (H = 33.15, $p < 0.0001$). MWU post-hoc tests revealed that students from FEE-NI and SEE-BG more strongly feel informatics as their professional career than students from FOS-BG. Approximately 70% of FEE-NI/SEE-BG students are strongly attracted to informatics, while approximately 50% of FOS-BG students feel informatics as their life's calling.

Table 4. The distribution of responses to questionnaire item "Informatics has always attracted me and I feel it as my life's calling". SD – strongly disagree (1), D – disagree (2), N – neutral (3), A – agree (4), SA – strongly agree (5).

	SD [%]	D [%]	N [%]	A [%]	SA [%]	Mean [%]	Median [%]
FEE-Ni	6.8	5.78	16.67	36.39	34.35	3.85	4
SEE-Bg	3.69	6.68	21.89	34.33	33.41	3.87	4
FOS-Bg	5.6	14.18	27.24	35.45	17.54	3.45	4
FTS-NS	6.29	9.27	24.5	32.12	27.81	3.65	4
FS-NS	4.11	9.13	26.94	31.51	28.31	3.71	4
Total	5.21	8.7	23.07	34.08	28.94	3.72	4

Nearly half of the respondents from SEE-BG (47%) and more than half of the respondents from the rest of the institutions consider the global expansion of the IT industry as an important or very important motivating factor to study informatics (Table 6). The KW

Table 5. The distribution of responses to questionnaire item "I wanted to study something else, but I did not see any perspective of that profession in Serbia". SD – strongly disagree (1), D – disagree (2), N – neutral (3), A – agree (4), SA – strongly agree (5).

	SD [%]	D [%]	N [%]	A [%]	SA [%]	Mean [%]	Median [%]
FEE-Ni	37.41	20.75	14.29	13.27	14.29	2.46	2
SEE-Bg	47.24	16.59	12.9	16.82	6.45	2.19	2
FOS-Bg	41.79	16.42	13.43	11.94	16.42	2.45	2
FTS-NS	48.34	14.24	11.59	12.58	13.25	2.28	2
FS-NS	39.27	22.37	13.7	14.16	10.5	2.34	2
Total	43.44	17.73	13.12	14.04	11.67	2.33	2

Table 6. The distribution of responses to questionnaire item "I have chosen to study informatics since the IT industry is expanding globally and everyone talks about IT". SD – strongly disagree (1), D – disagree (2), N – neutral (3), A – agree (4), SA – strongly agree (5).

	SD [%]	D [%]	N [%]	A [%]	SA [%]	Mean [%]	Median [%]
FEE-Ni	11.56	11.56	18.03	32.31	26.53	3.51	4
SEE-Bg	12.9	10.83	29.26	34.33	12.67	3.23	3
FOS-Bg	8.96	8.58	16.42	38.81	27.24	3.67	4
FTS-NS	14.9	10.93	20.2	29.8	24.17	3.37	4
FS-NS	13.7	6.85	25.57	36.99	16.89	3.37	4
Total	12.46	10.02	22.48	34.21	20.83	3.41	4

ANOVA test indicates that there are statistically significant differences between the institutions (H = 28.43, $p < 0.0001$).The global expansion of the IT industry is significantly stronger motivating factor to study CSISE for students from FEE-NI and FOS-BG than for students from SEE-BG which incline towards a neutral opinion regarding this factor.

The most alarming finding we obtained by analyzing responses to the questionnaire Item 4. It is the percentage of CSISE students who wanted to study something else but enrolled CSISE faculties. Approximately one quarter of respondents from each institution, without statistically significant differences among institutions, wanted to study something else but they have not seen any perspective of desired professions in Serbia. This result indicates CSISE as a popular substitute for less paid university degree professions or professions that are not in demand in the local community.

All the aforementioned findings lead to the conclusion that it is essential for key education stakeholders to provide adequate strategy of higher education in the CSISE domain and work continuously on its improvement. Such strategy is to be tightly coupled with a general strategy of the society digitalization, as well as the Strategy of the development of Artificial Intelligence in the Republic of Serbia, which is recently published at the time of writing this article.

4.2. Future Plans

Two questionnaire Items 2 and 14 asked respondents about their future plans. Future short-term plans of our students are summarized in Table 7. It can be seen that the largest fraction of respondents in each institution plan to continue with master studies at the same faculty, while the fraction of those students who plan to continue with master studies at some other faculty in Serbia is significantly lower. This result indicates that students are generally satisfied with CSISE studies in Serbia and their faculty choices. However, there is a relatively large fraction of students who see their future abroad: 18.79% of respondents want to apply for a master's degree abroad, while 7.45% respondents want to find a job abroad, which is nearly a quarter of the total number of respondents. Regarding the questionnaire Item 3, 14.5% of respondents considered to study abroad before enrolling a faculty in Serbia, which additionally signifies the fact that a relatively large fraction of Serbian CSISE students see their short-term future abroad. A similar situation can be also observed with long-term plans of Serbian CSISE students (Table 8) – more than a quarter of all respondents (26.44% of the total number) see their long-term future career abroad, where 10.94% of respondents want to work in a large IT company abroad, 8.9% want to start their own business abroad, and 6.6% see themselves as employees in small/medium IT companies abroad. The most dominant students in all five institutions are those who want to pursue professional careers in development centers of multinational IT companies that are located in the local community.

Table 7. The distribution of responses given in percentages to the questionnaire Item 2 (future short-term plans).

	All	FEE-Ni	SEE-Bg	FOS-Bg	FTS-NS	FS-NS
Master studies at the same faculty	41.33	37.07	42.17	41.04	47.35	37.44
IT job in Serbia	23.4	19.73	24.65	22.01	21.85	29.68
Master studies abroad	18.79	19.05	19.12	25	16.23	13.7
IT job abroad	7.45	10.2	6.91	7.46	5.63	7.31
Master studies in Serbia at other faculty	3.36	8.16	2.53	1.49	1.66	3.2
Do not know	2.77	2.72	2.53	1.49	3.64	3.65
Something else	3.5	3.07	2.09	1.51	3.64	5.02

Apart from having a strategy for higher education in the CSISE domain, a strong necessity is to improve the current structural characteristics and maturity of ICT industry. Despite that we have strong Research & Development (R&D) ICT companies, nowadays, local ICT companies are predominantly outsourcing profiled in regard to the business model being applied. However, it is crucial to shift a focus towards the improved structure and quality of job offers at labor markets. More creative and challenging jobs are needed to keep high-quality young professionals staying in the country. Consequently, it will lead to improvements of the common values recognized in the whole society, as a crucial requirement of young professionals to stay in the country.

Table 8. The distribution of responses given in percentages to the questionnaire Item 14 (future long-term plans).

	All	FEE-Ni	SEE-Bg	FOS-Bg	FTS-NS	FS-NS
IT job, MNC dev. center in Serbia	20.83	18.71	25.58	26.49	17.55	11.87
Entrepreneur, home	11.87	13.61	11.98	10.07	12.58	10.5
IT job abroad, large company	10.94	11.56	10.37	13.43	10.26	9.13
IT job home, outsourcing	9.23	11.9	8.99	6.72	8.28	10.5
Entrepreneur, abroad	8.9	10.88	8.53	7.09	9.93	7.76
IT job home, global market	8.17	7.14	8.29	7.84	9.93	7.31
IT expert in non-IT firms	7.71	4.08	4.61	13.81	7.62	11.42
IT job abroad, small/medium company	6.6	7.14	4.61	4.85	8.94	9.13
IT job home, local market	4.88	6.12	3.92	4.85	3.97	6.39
Freelancer	4.22	5.1	4.61	1.87	4.64	4.57
Other	6.65	3.76	8.51	2.98	6.3	11.42

4.3. Recommenders and Information Sources

When planning marketing activities to attract new students, it is useful to know who actually recommends a faculty and which information sources students use to be informed about the faculty and available study programs before enrollment. Thus, we asked students about faculty recommenders and information sources (questionnaire Items 5 and 9). Faculty recommenders sorted by their impact are shown in Table 9. It can be seen that parents and close family are the most important influencers when making faculty choice decisions for students from all five institutions. More than a quarter of the respondents enrolled faculty followed the advice from their parents and close family. Former students, current students, and persons working in the IT sector are also very influential recommenders ranked in the top 4 positions among students from all five faculties. Additionally, they have more than two times higher impact compared to the fifth ranked recommenders that are secondary school teachers.

Table 9. Faculty recommenders. W – the percentage of respondents for which the corresponding recommender strongly influenced faculty choice, r(F) – the rank of the corresponding recommender for students attending faculty F.

	W	r(FEE-Ni)	r(SEE-Bg)	r(FOS-Bg)	r(FTS-NS)	r(FS-NS)
Parents & close family	25.51	1	1	1	1	1
Former students of my faculty	22.35	2	2	2	2	3
Persons working in the IT sector	19.51	3	3	4	3	4
Current students of my faculty	19.25	4	4	3	4	2
Secondary school teachers	9.23	5	6	7	6	5
Secondary school friends	8.5	6	5	8	5	8
Former students of some other faculty	6.99	7	7	6	7	7
Current students of some other faculty	5.47	8	8	5	9	9
Teachers working at my faculty	4.8	9	9	9	8	6

Table 10 shows information sources sorted by their importance to students. It can be seen that faculty web pages are the most frequently used source to inform about a faculty and study programs. This is the top ranked information source for respondents from all five faculties. Current students of a faculty are also very important information source for novice students, ranked as the second most important by respondents from 3 faculties, and among the top five information sources in all five institutions. Interesting to notice is that respondents from different faculties differently value information sources. For example, students from FTS-NS find social media and official faculty accounts on social media very important (ranked as the 2nd and 3rd), while students from FEE-NI consider those two information sources significantly less important (ranked as 6th and 7th).

Table 10. Information sources. W – the percentage of respondents which were frequently informed by the corresponding information source or frequently used it to get information about the chosen faculty, r(F) – the rank of the corresponding information source for students attending faculty F.

	W	r(FEE-Ni)	r(SEE-Bg)	r(FOS-Bg)	r(FTS-NS)	r(FS-NS)
Faculty web page	42.58	1	1	1	1	1
Current students of my faculty	30.19	2	2	2	4	3
Social media	26.83	7	4	3	2	5
Official faculty accounts on social media	24.72	6	7	7	3	2
Former students of my faculty	24.65	3	3	4	6	4
High school friends	20.96	4	5	5	5	7
High school teachers	16.35	5	6	9	7	6
Classic media (TV, newspapers)	11.14	10	9	6	11	9
Educational fairs	9.62	8	12	8	9	8
Preparatory lectures for student competitions	8.64	9	8	13	10	9
Faculty promotional and advertising campaigns	7.84	11	13	10	8	9
Public science popularization lectures	5.87	12	10	11	13	12
Seminars, courses and extracurricular activities	5.01	13	11	12	12	13

An evident conclusion is that faculties, particularly those educating ICT professionals, must improve their promotional activities in order to attract more high quality newcomers. Before all, they must provide high quality information availability on their digital/Internet platforms. Then, they need to handle a high quality alumni section, and also further strengthen a good faculty's reputation, in general.

4.4. Faculty Choice Factors

We asked respondents to indicate the relevance of various faculty choice factors (questionnaire Item 6). The obtained results are summarized in Table 11. The table shows examined factors sorted by their relevance at the level of the whole sample, where respondents evaluated factors on the Likert scale from 1 to 5.The average value of responses is taken as

the measure of factor relevance, where a higher average value indicates a more relevant factor. The table also shows the rank of each factor and the median response for each institution. We notice that the importance of faculty choice factors varies between students from different institutions:

- Students from FEE-NI, FOS-BG and FTS-NS indicate the possibility to obtain well paid IT jobs after graduation as the most important factor to enroll those three faculties. This factor is also highly ranked by SEE-BG students (the 4th most important factor) and FS-NS students (the 3rd most important factor).
- Students from SEE-BG indicate the respectability of the institution as the most important reason to enroll this faculty followed by a better position at the labor market after graduation. The respectability of an institution is also important for FEE-NI and FTS-NS students, which indicate this factor as the second most important faculty choice factor.
- The most important faculty choice factor for FS-NS students is the study program and recommendation of the faculty from competent persons. The possibility to obtain well paid IT jobs is ranked as the third most important reason to enroll this faculty.

Table 11. Faculty choice factors. R – rank, M – median, from 1 meaning strongly disagree to 5 meaning strongly agree.

	All	FEE-Ni		SEE-Bg		FOS-Bg		FTN-NS		FS-NS	
	Avg.	R	M	R	M	R	M	R	M	R	M
well paid IT jobs	3.93	1	4	4	4	1	5	1	4	3	4
study programs	3.84	5	4	3	4	2	5	3	4	1	4
respectable institution	3.84	2	4	1	5	4	4	2	4	5	3
position at labor market	3.76	6	3	2	4	3	4	4	4	4	4
recommended by competent persons	3.59	2	4	5	4	5	4	5	4	2	4
job/master abroad	3.43	4	4	7	4	7	4	7	4	8	3
high quality courses	3.36	9	3	5	4	9	3	8	3	6	3
student practice	3.25	8	3	8	3	5	4	6	4	9	3
professional teachers & IT trends	3.14	7	3	9	3	8	4	9	3	7	3
easy to finish	2.07	11	2	11	1	10	3	10	2	11	2
state financing	1.91	10	2	10	1	11	1	11	1	10	3

Aforementioned results obviously indicate that a primary goal of each faculty is to increase its reputation in the following areas: a) reaching high quality and modern study programs; b) adjustments of the programs so as to follow the local industry needs and requirements; and c) attracting young, high-quality staff capable of creating better and well-motivating study conditions in the future. On the other hand, the main problem is to provide high-quality teaching staff in circumstances of significantly low salaries in academia compared to industry, while rigorous requirements for defending PhD theses and further promotions are to be met.

4.5. Expectations

Respondents were also asked to indicate their expectations from enrolled faculties and study programs (questionnaire Item 9). The obtained responses are summarized in Table 12. The table shows the examined expectations sorted by their importance that is determined according to the average response, i.e. higher values of average responses indicate more important expectations for students. It can be seen that knowledge enabling an easier adaptation to the labor market needs is the most important for students from all five institutions. Students tend to agree or strongly agree with a large majority of statements listed in the questionnaire Item 9 with one exception: SEE-BG, FTS-NS and FS-NS students have a neutral opinion about learning entrepreneurial knowledge and skills.

Table 12. Students' expectations from enrolled faculties. R – rank, M – median, from 1 meaning strongly disagree to 5 meaning strongly agree.

	All	FEE-Ni		SEE-Bg		FOS-Bg		FTN-NS		FS-NS	
	Avg.	R	M	R	M	R	M	R	M	R	M
To obtain knowledge enabling easier adaptations to labor market needs	4.28	1	4	1	4	1	5	1	4	1	4
To learn how to solve problems from real IT practice	4.1	2	4	4	4	5	4	3	4	2	4
To obtain theoretical knowledge necessary for understanding and solving problems from real IT practice	4.1	5	4	2	4	6	4	4	4	4	4
To master practical techniques and tools used in IT companies	4.09	3	4	5	4	3	5	2	4	3	4
To obtain a broad education in the field necessary for further academic advancement (master & doctoral studies)	4.07	4	4	3	4	4	4	5	4	5	4
To obtain also knowledge from other scientific fields applicable in IT practice	3.89	7	4	6	4	2	5	7	4	7	4
To obtain advice from my professors regarding my further professional development	3.77	6	4	7	3	7	4	6	4	6	4
To obtain knowledge that can help starting own IT businesses	3.36	8	4	8	3	8	4	8	3	8	3

A common problem in the CSISE education all over the world is to find a good balance between current labor market needs and ICT industry requirements on one hand side, and long-lasting fundamental knowledge that students are to gain during their study, on the other hand side. In this very dynamic area and rapid technological changes it is not easy always to cope with more technical and technological requirements of industry. Students predominantly perceive that just current technology knowledge is important for them, often neglecting long-lasting, theoretical and fundamental knowledge. Also, we notice the lack of students' entrepreneurship knowledge, which is also important for those who like to act in a proactive way in the labor market.

The phenomena of neglecting long-lasting fundamental knowledge is negatively influenced by students' and companies' expectations expressed that faculties must adjust

their study programs just to highly support emerging technologies, while limiting the fundamental, theoretical knowledge and disciplines. Nowadays, educators must cope with quite complicated role of creating a good balance between salable and conceptual knowledge, as they have to prepare students to quickly and easily switch to new technologies and emergent software tools.

4.6. Satisfaction

Three questions in questionnaire address students' satisfaction with enrolled faculties and study programs. When asked whether they would enroll the same faculty again, 88.07% of respondents answered "yes", while 11.93% of them answered "no". The distribution of responses considering individual faculties is shown in Table 13. We notice that a vast majority of students from all five institutions would again enroll the same faculty. This result is the first indicator that students are generally satisfied with CSISE faculties.

Table 13. The distribution of responses given in percentages to the question "If you could go to the past, would you enroll the same faculty?"

	FEE-Ni	SEE-Bg	FOS-Bg	FTS-NS	FS-NS
Yes	86.05	87.56	91.42	90.73	84.02
No	13.95	12.44	8.58	9.27	15.98

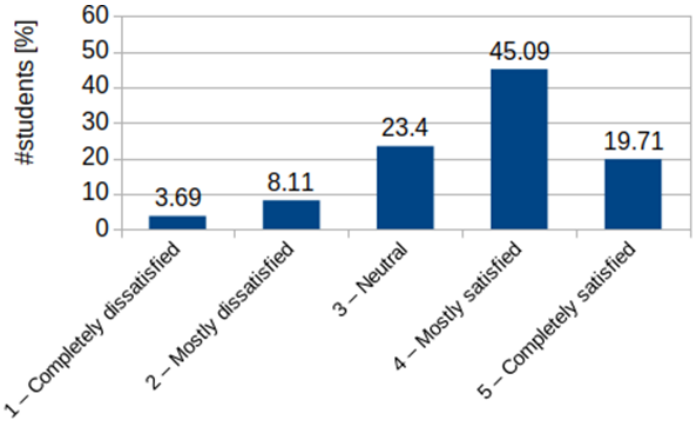
Respondents were also asked to indicate whether their opinion about enrolled faculties changed during studies. The distribution of responses is given in Table 14. There are more students whose opinion about enrolled faculties and study programs changed to better (31.05%) than those whose opinion changed to worse (26.99%). Also, it is important that in all five faculties the percentage of students whose opinion about the enrolled faculty changed to worse is higher than the percentage of students who would not again enroll the chosen faculty. Considering the whole sample, 18.39% of respondents are students who would again enroll the same faculty although their opinion about it has changed to worse. This means that at all five institutions we have a significant fraction of unsatisfied students who still think that they made the best possible choice of the faculty, i.e. they do not see any better alternative to the enrolled faculties.

Table 14. The distribution of responses given in percentages to the question "Has your opinion about your faculty and study program changed during your studies?"

	FEE-Ni	SEE-Bg	FOS-Bg	FTS-NS	FS-NS	All
Yes, to better	23.47	22.35	39.55	35.1	42.47	31.05
No	48.3	43.78	38.81	40.07	36.53	41.99
Yes, to worse	28.23	33.87	21.64	24.83	21	26.99

Students were also asked to indicate the degree of their satisfaction with chosen faculties and study programs on the scale from 1 (completely dissatisfied) to 5 (completely satisfied). The distribution of responses is shown in Figure 1. It can be noticed that the largest fraction of respondents are students who are mostly satisfied with the Serbian CSISE faculties followed by students who are neither satisfied, nor dissatisfied. Every fifth respondent is completely satisfied with CSISE studies at the chosen faculty. Less than 12% of students are mostly or completely dissatisfied with our faculties, while it is the same percentage of students that would not enroll the chosen faculty if they could go back to the past. The trend observed for the whole sample is present at the level of individual faculties (Table 15): a majority of students are mostly or completely satisfied, while 15% of students or less are completely or mostly dissatisfied with chosen faculties. Consequently, we conclude that our students generally tend to be satisfied with Serbian CSISE faculties.

Fig. 1. Students' satisfaction with chosen faculties and study programs – the distribution of responses to the questionnaire Item 11, given in percentages.



We also examined whether students' satisfaction with chosen faculties and study programs depends on the study year. The obtained results are summarized in Table 16. The table shows the average satisfaction on the scale-from 1 (completely dissatisfied) to 5 (completely satisfied) for students from different study years, as well as the results of the statistical comparison by the KW ANOVA test followed by post-hoc MWU tests for pairwise comparison. We notice that for 4 out of 5 faculties (all except FS-NS) there are statistically significant differences in satisfaction with the enrolled faculty between students from different study years. Statistically significant differences are also present at the level of the whole sample. Thus, students' satisfaction with chosen faculties is not independent of the study year. The post-hoc testing revealed that students of lower study years tend to be significantly more satisfied than students of higher study years.

Table 15. Students' satisfaction with chosen faculties and study programs per institutions, given in percentages. "Mean" shows the average satisfaction on the scale from 1 (completely dissatisfied) to 5 (completely satisfied).

	FEE-Ni	SEE-Bg	FOS-Bg	FTS-NS	FS-NS
Completely dissatisfied	7.14	3.69	0.37	3.64	3.2
Dissatisfied	8.5	9.22	9.7	5.96	6.39
Neutral	26.19	25.35	21.27	22.52	19.63
Mostly satisfied	46.26	47.93	41.42	43.71	44.29
Completely satisfied	11.9	13.82	27.24	24.17	26.48
Mean	3.47	3.59	3.85	3.79	3.84

Table 16. Statistical comparison of students from different study years regarding their satisfaction with chosen faculties and study programs (questionnaire Item 11). The column "SSD" indicates whether there are statistically significant differences. $P > Q$ in the column "Post-hoc testing" means that P-th year students tend to be significantly more satisfied than Q-th year students.

Year	1	2	3	4	5	KW ANOVA	SSD	Post-hoc testing
All	4.05	3.73	3.56	3.41	3.59	$H = 86.2, p < 10^{-4}$	yes	$1 > 2, 1 > 3, 1 > 4, 2 > 4$
FEE-Ni	3.91	3.5	3.39	2.96	3.55	$H = 25.11, p < 10^{-5}$	yes	$1 > 2, 1 > 3, 1 > 4$
SEE-Bg	4.07	3.69	3.52	3.38	3.25	$H = 22.01, p < 10^{-4}$	yes	$1 > 3, 1 > 4, 2 > 4$
FOS-Bg	4.12	3.96	3.6	3.58	3.57	$H = 16.82, p = 0.002$	yes	$1 > 3, 1 > 4$
FTS-NS	4.06	3.88	3.86	3.28	3.61	$H = 30.3, p < 10^{-6}$	yes	$1 > 4, 2 > 4, 3 > 4$
FS-NS	4.04	3.73	3.56	4	3.71	$H = 6.37$, p = 0.17	no	

The results of statistical comparison of male and female students regarding their satisfaction with chosen faculties and study programs are presented in Table 17. The table shows the average satisfaction of male and female students, results of the MWU and KS tests, as well as the values of probabilities of superiority PS(M) and PS(F). PS(M) is the probability that a randomly selected male respondent is more satisfied with the chosen faculty and study program than a randomly selected female respondent. Oppositely, PS(F) is the probability of superiority of female respondents, considering responses to the questionnaire Item 11. The null hypothesis of MWU and KS tests can be accepted considering the whole sample: $p(U) > 0.05$, $p(D) > 0.05$, PS(M) $\approx$ PS(F). The null hypothesis of the MWU test can be also accepted for all faculties except for SEE-BG, where male students express a significantly more positive opinion about the faculty compared to female students. The difference in the probabilities of superiority, PS(M) $-$ PS(F), for SEE-BG is 0.12 and it is slightly higher than the second largest difference in the probabilities of superiority (0.09 at FTS-NS) implying that the observed difference between male and female students, although statistically significant, is not too drastic. Thus, we conclude that significant differences between Serbian male and female students regarding their satisfaction with the Serbian CSISE faculties and study programs are absent.

In general, the expressed satisfaction of the Serbian CSISE students with their selection of study programs and faculties is quite positive. However, we are facing an evident

Table 17. Statistical comparison of male and female students regarding their satisfaction with chosen faculties and study programs (questionnaire Item 11). M(Male) – the average satisfaction of male respondents, M(Female) – the average satisfaction of female respondents, U – the MWU test statistic, $p(U)$ – the p-value of U, D – the KS test statistic, $p(D)$ – the p-value of D, PS(M) – the probability of superiority of male students, PS(F) – the probability of superiority of female students. The column "SSD" indicates whether there are statistically significant differences.

	M(Male)	M(Female)	U	$p(U)$	D	$p(D)$	PS(M)	PS(F)	SSD
All	3.65	3.73	269315	0.32	0.03	0.77	0.33	0.36	no
FEE-Ni	3.42	3.59	8480.5	0.23	0.06	0.94	0.30	0.38	no
SEE-Bg	3.64	3.46	17915.5	0.03	0.10	0.33	0.40	0.28	yes
FOS-Bg	3.83	3.86	8229.5	0.86	0.07	0.92	0.36	0.35	no
FTS-NS	3.73	3.88	9871	0.15	0.10	0.43	0.30	0.39	no
FS-NS	3.84	3.84	5789	0.77	0.03	0.99	0.36	0.33	no

issue of a decreased level of satisfaction by study progress through higher study years. To discover exact reasons of such trend, we need to perform a deeper analysis and try to identify exact causes of the problem. The problems might be in students' greater expectations concerning study courses and covered topics, non-adequate knowledge of educators, non-adequate motivation of educators or students, general study conditions, etc. One of strongly influential reasons is the fact that many students join companies even for full time work during the third and fourth year of Bachelor studies. Evidently, we face here with numerous questions requiring an additional comprehensive analysis.

4.7. Primary Motivating Factors

Our respondents can be divided into two groups concerning primary motivating factors for enrolling the CSISE studies:

- Students strongly attracted by CSISE (denoted by G_1), i.e. students who responded with "agree" or "strongly agree" to the questionnaire item "Informatics has always attracted me and I feel it as my life's calling", and
- Students weakly attracted to CSISE (denoted by G_2), i.e. students who responded with "strongly disagree", "disagree" or "neither agree nor disagree" to the previously mentioned questionnaire item.

The results of statistical comparison of G_1 and G_2 regarding their satisfaction with chosen faculties are given in Table 18. We notice statistically significant differences between the groups at all faculties except FTS-NS. FTS-NS students strongly attracted to CSISE tend to be more satisfied with the faculty compared to FTS-NS students weakly attracted to CSISE ($M(G_1) = 3.83$, $M(G_2) = 3.72$, PS(G_1) > PS(G_2)), but the difference is not statistically significant by both employed non-parametric statistical tests ($p(U) = 0.44$, $p(D) = 0.95$). Statistically significant differences are also present between groups G_1 and G_2 at the level of the whole sample. Thus, the students strongly attracted to CSISE tend to be significantly more satisfied with Serbian CSISE faculties than students weakly attracted to CSISE.

Table 18. Statistical comparison of students strongly attracted to CSISE (group G_1) and students weakly attracted to CSISE (group G_2) regarding their satisfaction with chosen faculties and study programs. $M(G_i)$ – the average satisfaction of group G_i (i = 1 or i = 2).

	$M(G_1)$	$M(G_2)$	U	$p(U)$	D	$p(D)$	PS(G_1)	PS(G_2)	SSD
All	3.78	3.53	230978.5	0.00	0.10	0.00	0.42	0.28	yes
FEE-Ni	3.58	3.22	7057	0.00	0.21	0.01	0.46	0.25	yes
SEE-Bg	3.67	3.41	17511	0.01	0.11	0.18	0.42	0.27	yes
FOS-Bg	3.97	3.72	7435.5	0.01	0.17	0.04	0.44	0.27	yes
FTS-NS	3.83	3.72	10404.5	0.44	0.06	0.95	0.37	0.32	no
FS-NS	4.07	3.51	4102.5	0.00	0.20	0.03	0.50	0.21	yes

We additionally examined the relationship between students' satisfaction with chosen faculties and primary motivating factors for studying CSISE by comparing responses to questionnaire Item 11 between students from the following two groups:

- Group G_1 – students for which CSISE was not a desired career choice. A respondent is included in G_1 if she/he responded with "agree" or "strongly agree" to the questionnaire item "I wanted to study something else, but I did not see any perspective of that profession in Serbia".
- Group G_2 – students for which CSISE studies were the first option or one among equally desired options. G_2 encompasses students who responded with "strongly disagree", "disagree" and "neither agree nor disagree" to the previously mentioned questionnaire item.

The results of statistical comparison of G_1 and G_2 regarding their satisfaction with enrolled faculties are given in Table 19. The average satisfaction of students from G_1 is less than the average satisfaction of students from G_1 at all five faculties ($M(G_1) < M(G_2)$, PS(G_1) < PS(G_2)). Statistically significant differences between G_1 and G_2 are present at the two faculties: SEE-BG and FS-NS, while absent at the other three faculties. Statistically significant differences between G_1 and G_2 are also present at the level of the whole sample.

Thus, students who wanted to study something else but enrolled CSISE tend to be less satisfied with Serbian IT/CS compared to students who wanted to study CSISE. Taking into account the previous result, i.e. the comparison between students strongly attracted to CSISE and students weakly attracted to CSISE, we conclude that students' satisfaction with chosen faculties and study programs is not independent of primary motivating factors for enrolling CSISE.

4.8. Correlation Analysis

For each pair of questions expressed on a numeric scale or on an a scale that can be converted to numeric (e.g., yes-no and yes-neutral-no questions) we have computed the Person's correlation coefficient considering given students' responses. The clustered heatmap

Table 19. Statistical comparison of students who wanted to study something else, but enrolled CSISE (group G_1) and students for which CSISE studies were either the first option or one among equally desired options (group G_2) regarding their satisfaction with chosen faculties and study programs. $M(G_i)$ – the average satisfaction of group G_i (i = 1 or i = 2).

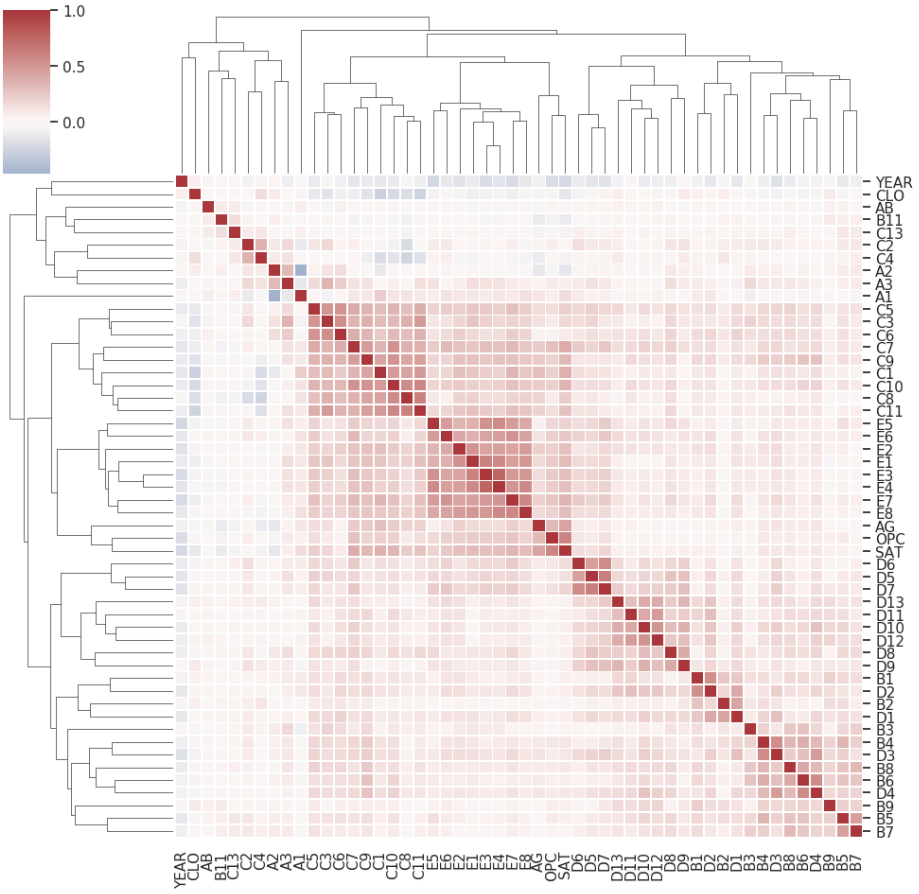
	$M(G_1)$	$M(G_2)$	U	$p(U)$	D	$p(D)$	PS(G_1)	PS(G_2)	SSD
All	3.48	3.76	184657.5	0.00	0.14	0.00	0.27	0.43	yes
FEE-Ni	3.36	3.52	7783.5	0.17	0.09	0.72	0.30	0.40	no
SEE-Bg	3.14	3.73	11371.5	0.00	0.26	0.00	0.20	0.52	yes
FOS-Bg	3.75	3.89	6501	0.14	0.10	0.67	0.30	0.41	no
FTS-NS	3.68	3.82	8214.5	0.41	0.05	1.00	0.32	0.38	no
FS-NS	3.63	3.92	3642	0.03	0.15	0.26	0.26	0.45	yes

plot of the correlation matrix is shown in Figure 2. The clusters of highly correlated responses were determined by the complete-linkage hierarchical agglomerative clustering procedure. The labeling of questions on the plot is as follows:

1. YEAR is the study year;
2. AB is questionnaire item 3 (IT-related studies abroad);
3. AG is item 12 (enrolling the same faculty again);
4. OPC is item 10 (the change of opinion about the chosen faculty during studies);
5. SAT is item 11 (satisfaction with the chosen faculty);
6. A labels mark questions given within item 4 (primary motivating factors to study informatics);
7. B labels correspond to questions given within item 5 (faculty recommenders);
8. C labels represent questions from item 6 (factors for enrolling the chosen faculty);
9. D labels are questions addressing information sources prior to faculty enrollment (item 8); and
10. E labels represent questions assessing expectations from the chosen faculty (item 9).

It can be seen that there are moderate to strong correlations within responses related to factors for enrolling the chosen faculty (C labels), within responses related to students' expectations from the chosen faculty (E labels) and within responses related to information sources (D labels). This result additionally confirms the reliability of collected data. Considering response variables belonging to different categories, moderate to strong correlations are present for B_1 and D_2 ($r = 0.54$), B_4 and D_3 ($r = 0.55$), and B_6 and D_4 ($r = 0.56$), where B_i denotes the i-th question in the category B (questionnaire item 5 related to faculty recommenders) and D_i denotes the i-th question in the category D (questionnaire item 8 addressing information sources). Those correlations indicate that secondary school teachers (B_1 and D_2), current students (B_4 and D_3) and former students (B_6 and D_4) providing a large amount of information about prospective faculties were the most influential recommenders of chosen faculties.

Fig. 2. The clustered heatmap plot of the correlation matrix for students' responses to questionnaire items.



5. Conclusion

The performed analysis shows that in majority of cases the main motivating factor to select CSISE study programs at almost all faculties is the students' motivation to study just that topic, while in FOS-BG it is significantly less important. We notify a significant number of students who initially wished to study something else but chose CSISE due to a possibility of finding easier well-paid jobs in software industry. The most important influential factors for a selection of CSISE study programs are firstly originating from family members, and close relatives, and then from current and past students of the same faculty. The perceived brand and reputation of a faculty also has a notable influence on particular selection. Students prevalently tend to be satisfied with the institutions and study programs they have chosen. However, it is worrying and important alert for key educational

stakeholders that many of them see themselves leaving the country in a near (19%) or far future (26%).

Having in mind the main findings of our analysis, as well as all our previous long-year experience in the problem domain, we further discuss lessons learned in the context of research questions Q1 – Q6, given in Introduction section.

Q1: What is a real impact of the increased number of CSISE students to local software industry?

As it is a case in many emerging societies, Serbian government perceives information technologies and software industry as a strategic goal towards achieving economic sustainability and stopping brain drain. In the last decade, numerous software companies from abroad recognized a high potential of information technology and software industry in Serbia. In this way, they established their branch companies here or acquired local software companies, and by this outsourced software development activities in Serbia. It raises future expectations for constantly increasing needs for software and IT specialists in the next decade. In such circumstances, local universities are trying to find adequate ways to cope with such demands. We see that a much better approach in the future is to motivate their cooperation, instead of simple competition, as it is demanding profession with rapid development of new knowledge and technologies that require adequate education of high-quality specialists.

The outsourcing business model of software companies that seems to be predominant in economies as Serbia is, nevertheless whether a software company is R&D or just service oriented one, opens new and emergent questions:

a) Do such companies, and in what extent, really need high-quality educated professionals having fundamental knowledge and capabilities of applying critical thinking and problem solving skills necessary for long-lasting career?
b) Alternatively, do they just need employees with a deep knowledge of a particular currently popular technology?
c) What are the ratios of numbers of companies and the needs for professionals of a profile a) per numbers of companies and the needs for professionals of a profile b)?
d) How to adapt professionals of a profile b) to the new technologies, after several years when current technologies become outdated?
e) How many of university capacities are to be assigned to academic studies, and how many to professional studies to adequately address the needs for professionals of the profiles a) and b)?

Those are very sensitive and still poorly analyzed questions in such economies that lead to the conclusion of the necessity of having a sustainable and long-lasting educational strategy that will provide a maximization of positive outcomes of the local software industry for the society.

Q2: Can academic institutions keep to the satisfactory level of quality with drastically increased number of CSISE students?

As we already face the increasing number of students enrolling CSISE study programs, and as it is a dynamically changing profession, we need increasing number of

teachers who are ready to constantly update their knowledge and courses to be in line with current technological and professional trends and industry needs. However, this is a very demanding activity for several reasons:

- Teachers at Serbian CSISE faculties usually have enormous number of classes and handle huge numbers of students, often significantly over predefined quota. Besides, they cope with the diversity of courses that should be delivered to students. They have been working for many years with maximal or often over maximal number of classes per week, which is 2 to 4 times higher than in majority of recognized world-wide universities.
- The process of developing teaching assistants and assistant professors is time consuming both for candidates and supervisors. For assistant professors, typically, it takes more than 10 years from the time a candidate approaches undergraduate studies to the time of a promotion to the level of assistant professor. Moreover, there is a necessity to further support a candidate during the period of an assistant professor, to gain valuable experience in teaching and research. However, in the last decade in Serbia we are facing a significant brain drain problem, where young staff leaves academia soon after obtaining their Ph.D. degrees, or even during their Ph.D. studies, as they collect their first teaching experiences as teaching assistants. One of the reasons is in significantly lower salaries comparing to the salaries of professionals in local software companies, or generally abroad. Moreover, most of them are additionally demotivated with constantly increasing and more severe requirements for promotions or even keeping current positions at Serbian faculties, from year to year. Besides, as our faculties with CSISE programs are not dedicated as "pure" computer science faculties, often criteria for promotions are much stronger or different in nature, as they are tailored from the other research disciplines, while the teaching staff from other disciplines, as a rule, is not as charged with teaching hours, as the CSISE staff.
- Increasing number of students require significantly more classes and teachers' time. They cannot manage to innovate teaching materials and include in them emergent topics, technologies, or tools.

Q3: How academic institutions can preserve a sustainable education process of CSISE students?

Evidently, strong to even radical changes in the whole educational ecosystem in a society as Serbia are necessary. One of the primary steps is to establish a sustainable system that will provide a significant increase of salaries for all education staff at faculties, as majority of education staff nowadays need to be employed in other additional jobs to increase their living standard. Consequently, they could not give an appropriate contribution in all academic activities and addressing the requirements of modern software industry. In the near future a brain drain of academic staff is expected to increase, which will make the situation even worse. Keeping in mind that budget level financing system supported by Ministry of Education, Science, and Technological Development of Republic of Serbia is of a limited capacity, a stronger and systematic involvement of interested (software) companies can contribute to the changes that will improve a position of the university teaching staff.

Q4: How academic institutions can prevent a significant drop-off of education staff, and retain the majority of students at master level studies?

This is a complex problem requiring considerable and long-lasting efforts to be solved, starting from a strategy of higher education in the CSISE domain. As a consequence of rather unfavorable economic situation in developing economies, as Serbia is, students of CSISE study programs get opportunity and decide to find a job during studies, even on the second and mostly on the third year. Being satisfied with salaries, working conditions and having no demand of employers to finish master studies, majority of them decide not to enroll master studies, and some of them even drop out of bachelor studies. The best students incline to continue with master studies abroad, expecting more academic and professional ambitions and opportunities there. Much better economic situation and living standard in well-developed countries motivate them to move and live abroad.

Q5: How to overcome or even temper significant differences in a position of academic institutions in the main city centers, compared to the academic institutions from other, usually less developed regions of the same country?

Considering example of Serbia, despite that there are three big universities in Serbia, Belgrade, Novi Sad and Niš, as well as smaller ones in other Serbian cities, it is noticeable that majority of new students incline to study in Belgrade, as a capital of Serbia. On the other hand, Belgrade is the most expensive city in Serbia, and accordingly not always convenient for young people to begin their future academic careers. The similar situation is in other countries of the region, as well as in many other developing countries.

Again, it should be a strategic goal of the government and educational policy makers to provide sustainability and better financial conditions for teaching staff at all universities throughout the country. Additionally, it is important to strengthen higher education capacities, initiate propositions of new and more attractive study programs that will support the better diversification of students at whole educational space of the country.

Q6: How to raise the level of motivation of CSISE students, keeping in mind that not all of them selected such study programs as their primary wish, but as a consequence of strong economical reasons?

Several aspects of this question are already identified in previous findings. Increasing students' motivation, generally, is not an easy task. Different technology enhanced learning tools, attractive presentations, challenging tasks, teamwork on real-life projects, practical placement in companies and real-working environments are among the numerous ways to motivate students. Obviously, all such efforts are highly time consuming and majority of educational staff is not always highly motivated to cope with them. Despite some negative factors, the results of our research indicate that students are generally satisfied with CSISE studies and their faculty choices. Besides, students see that just the knowledge enabling an easier and early adaptation to the labor market needs is the most important for them.

To conclude, a good balance between the following issues is very important:

- Higher salaries for faculty educational staff;
- Improvement of teaching methods, a balance between fundamental and technology knowledge, and continuous adjustment of teaching materials to the software industry needs;

- Cooperation and exchanges of teaching experiences among staff from all CSISE faculties, as well as the involvement of industry experts in the teaching process in a smaller extent;
- Regular meetings with company representatives and alumni to hear about their needs, expectations, wishes, to achieve continuous changing and improving education in the CSISE area; and
- Initiating and constant improving cooperation and strengthening educational and scientific networking with high quality European and world-wide universities, to improve a visibility of local universities in the area of CSISE.

Finally, if we analyze the situation in Serbia that can be generalized to the similar, particularly neighboring economies, we can say that potentials of Serbian software industry and ICT market are evident, quite strong, and constantly growing. Officially published data about the export of software products and services of Serbian software industry show that, expressed in €, it was about 100M in 2008, 300M in 2013, and even 1,1B in 2018. In 2011, there were 1,704 software companies with almost 15,000 employed and business revenue of 1,3B €, while in 2018 there were 2,349 software companies, with about 28,500 employed, and almost the doubled business revenue of 2,5B €. All of this can influence a general improvement of the society. All identified problems are seen mostly as a consequence of non-strategic decisions, or some kind of chaotic movements and actions. Therefore, a sustainable and long-lasting educational strategy is needed that will utilize the potentials of the local software industry and academic institutions to maximize the positive effects for the society. To come to the successful and sustainable strategy, more extensive analyses of not only Serbian academic education in the CSISE area, as well a local software industry, are needed, to give a better justification of the research questions discussed in this section of the paper.

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