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PRELIMINARY REPORTS

Sustainable Development through Gender Equality – A Case of Higher Education of Data Scientists



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ABSTRACT

Information and Communication Technology (ICT) sector in Serbia is fast growing and in constant high demand for qualified workforce. In order to continuously fulfil the demand, the National strategy for gender equality defined as one of the actions, requalification of the unemployed women for different ICT profiles. Investing in education is the policy of creating human capital that influences the overall development of the society. Women empowerment through education is recognized as one of the prerequisites for sustainable ICT workforce generation. Data science represents particularly important field of ICT which is still in its development phase in Serbia. All industries with transaction-based processes and industries that use connected or mobile devices or similar, which generate high volumes of data on a daily basis can benefit from application of data science in terms of increased profits and ROI. While developing data science in Serbia and during the peak of productivity in the overall ICT sector, it is important to acknowledge the lack of women in technology, why that is detrimental to progres-

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sion, and to take intentional actions to overcome this issue. This paper addresses these issues and points to the large gender gap in ICT higher education which consequently shapes the ICT labor market and the workplace. In the paper we give an overview of the state of the art and perspective actions in the domain of higher education of female data scientists in Serbia, and highlight the opportunities for further improvements.

KEY WORDS: *gender equality, woman empowerment, education, ICT, workforce, regional development*

Introduction

Modern development trends have shown that education and the creation of human resources are at the top of the priorities of national strategies and policies of social, economic and technological progress. In the case of Serbia, reconstruction and transformation of education is one of the prerequisites for the overall sustainable development (Government of the Republic of Serbia [GORS], 2005). Investing in education and providing adequate human capital that can adapt to changed circumstances has the character of an investment, and education policy is not just a policy of creating human capital, but it is a part of the overall development policy of the society (GORS, 2005). Action plan for the implementation of the education development strategy till 2020 (GORS, 2015) suggests that some of the key actions for the higher education are: a) Development of programs for increasing the coverage in priority areas through the adoption of programs with established mechanism for monitoring market needs, analysis of annual or perennial labor market needs and the number of graduates, as well as through the establishment of a body which will assess development and market needs and priorities; b) Modernization of study programs in accordance with the needs of the labor market and with the level of achieved scientific and technological development; c) Encouraging the development and offering of quality study programs; d) Developing the interest of potential students to study at the Bachelor level of academic studies.

In this paper we focus on Information and Communication Technology (ICT) sector as one of the prominent and fast growing sectors in Serbia which is constantly in high demand for qualified workforce. Different national initiatives and strategies are encompassing requalification of the unemployed in order to drive this sector and within the National strategy for gender equality for the current period (GORS, 2014) one of the defined ac-

tions is requalification of the unemployed women for different ICT profiles. In order to continuously fulfil the demand for workforce in ICT sector, the need for women empowerment is recognized as one of the prerequisites for sustainable ICT workforce generation.

One of the areas of ICT with significant perspective is data science. All industries with transaction-based processes and industries that use connected devices, mobile devices, mobile applications, sensors, cameras, online shops, or similar, which generate high volumes of data on a daily bases can benefit from application of data science in terms of increased profits and ROI. Data science is well-established field in developed countries. In Serbia it has just recently become an area of increasing importance and interest, and still much work needs to be done to help the public and companies to truly recognize data science as the driving force of innovation in all sectors. However, important steps are taken and results are noticeable on the labor market as we are witnessing an increase in demand for data scientists, machine learning and AI (Artificial Intelligence) related roles. We can expect that with time the number of companies in Serbia that apply data science and machine learning to their business will increase even more. To successfully respond to this change in the labor market, higher educational institutions have responsibility to help this workforce development by creating and empowering individuals with data science skills. This requires a certain flexibility from universities to innovate and adapt curriculums. While developing data science in Serbia and during the peak of productivity in the overall ICT sector, it is equally important to acknowledge the lack of women in technology, as that is detrimental to progression, and to take intentional actions to overcome this issue. Therefore, the problem should be observed in its whole: from the lack of women in the ICT education, through unrepresentativeness of women on ICT jobs, to the gap in salaries.

The remaining of this paper is structured in three subsections. The first section is devoted to gender equality and its importance for the regional development, with emphasize on gender gap in ICT sector in Serbia and gender gap at Serbian universities and faculties that educate ICT students. The second section describes the position of data science as a field of studies at University of Novi Sad. The last section provides some findings on what has been and could be done to promote women in ICT, and consequently in data science.

Importance of Gender Equality for the Regional Development

Gender-wise diversification of workforce and teams in general, has certain known benefits which point to the essential need of businesses to include women at all levels. Various studies indicate that women are better at assessing their capabilities and have less issues with suggestions coming from team members (Kuhn & Villeval, 2013; Williams Woolley and Malone, 2011). These threads contribute to overall improved collaboration within teams. According to the research (Phillips, 2014) women are better at problem solving, while authors of (Hunt et al., 2018; Hewlet, Marshall & Sherbin, 2013; Noland, Moran & Kotschwar, 2016) have identified better financial performance of gender diverse workforce and teams.

Regardless of knowing that benefits of including women in teams and at all levels in companies extend even further from previously stated, an alarming situation is still present in the STEM (Science, Technology, Engineering, and Mathematics) where, according to Boston Consulting Group (Taplett et al., 2010) women make up 25% STEM workers globally, and only 9% are at leading positions in those fields. Representation of women in STEM is characterized as one of the greatest challenges in women's education.

The subject of the research is the evaluation of gender equality at higher educational institutions in Serbia with particular focus on the higher educational institutions that educate ICT students, on the one hand, and the state of data science as a prominent field of ICT which is shaping and changing ICT labor market and will contribute to additional broadening of gender gap in the ICT field. In order to overcome this issue new curriculums in the field of data science must be developed and initiatives to attract women to the field must be practiced. To set the starting point, our first objective is to examine the current situation among ICT students and to evaluate the severance of the present gender gap. The other goal is to examine the situation at the higher education regarding the data science curriculums. For this we use official statistical data provided by Statistical office of the Republic of Serbia.

Gender Equality in ICT Sector

In this paper we are focused on the ICT field, as the part of the STEM, given that several facts will contribute to further widening of the gender gap in the ICT sector that will consequently impact the labour market and that

could be addressed through different approach to women throughout the education.

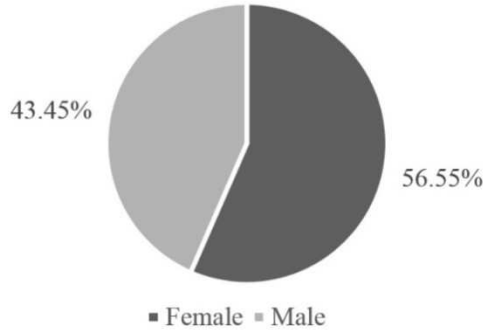
1. Not only that ICT organizations recruit less women than man, but the percentage of women who are leaving IT jobs is higher than percentage of man (Ashcraft, McLain & Eger, 2016; Scott & Kapor Klein, 2017). Therefore, organizations are losing women at a faster rate.
2. In the forthcoming years, automation will significantly influence labour market. It is estimated that within next two decades, it will displace 10% of jobs. International Monetary Fund researchers analysed 30 countries and predicted disproportionately higher losses among women given that particularly clerical jobs, which are more often performed by women, will be under the influence of automation (Brussevich et al., 2018).
3. On the other hand, automation will also lead to increase of certain IT and AI related roles which are highly paid (Brussevich et al., 2018). Given the previously said that women are less represented in the ICT sector this will additionally broaden the gap and contribute to denying women access to highly paid jobs.

The issue of gender equity is part of a cultural heritage. It is extremely hard to influence traditional perception on gender roles and universities may not have the power to do that on their own. However, educational institutions, at all levels of education not only universities, have a great responsibility to make necessary efforts to attract women to the field and to provide a steady stream of qualified female students. Without that the landscape of ICT sector is unlikely to change and improve.

Gender Equality at Universities in Serbia

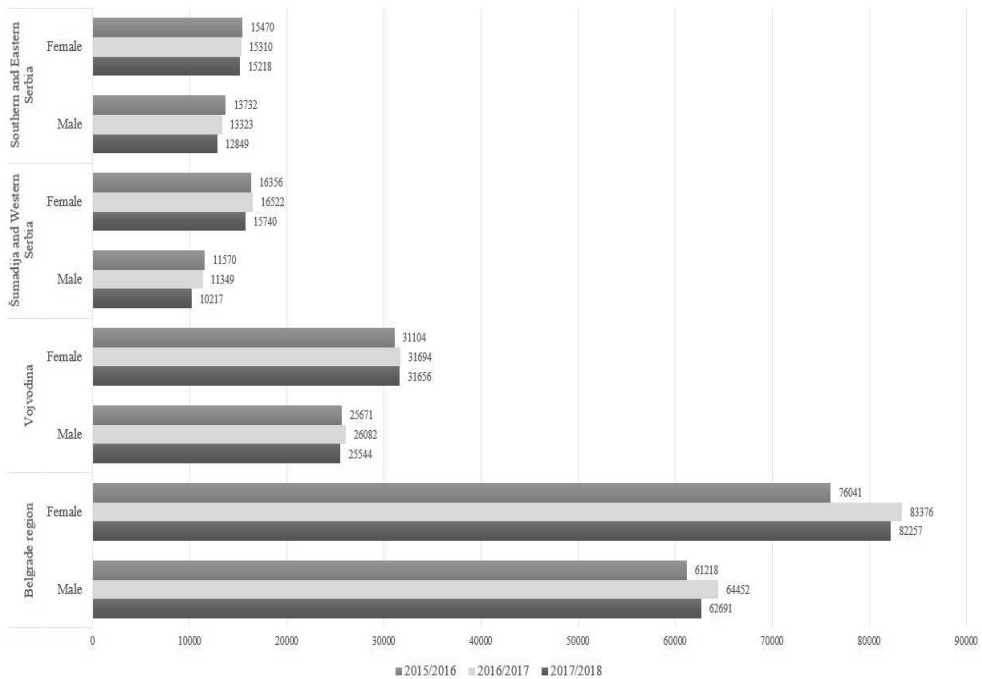
According to data provided by Statistical office of the Republic of Serbia (for 2017/18 school year), Serbia in all regions has more female students enrolled at all levels and types of higher education (bachelor, master, doctoral, vocational studies, public and private universities, faculties, or colleges) than male students. Figure 1 illustrates the distribution of students according to their gender in 2017/2018 school year. There was 57% of female students and 43% of male students. Similar distribution is present for previous years as well.

Figure 1: Percentage of students enrolled at all higher education studies and levels in 2017/2018



Source: Authors based on data provided by Statistical office of the Republic of Serbia

Figure 2: Distribution of students per gender and region



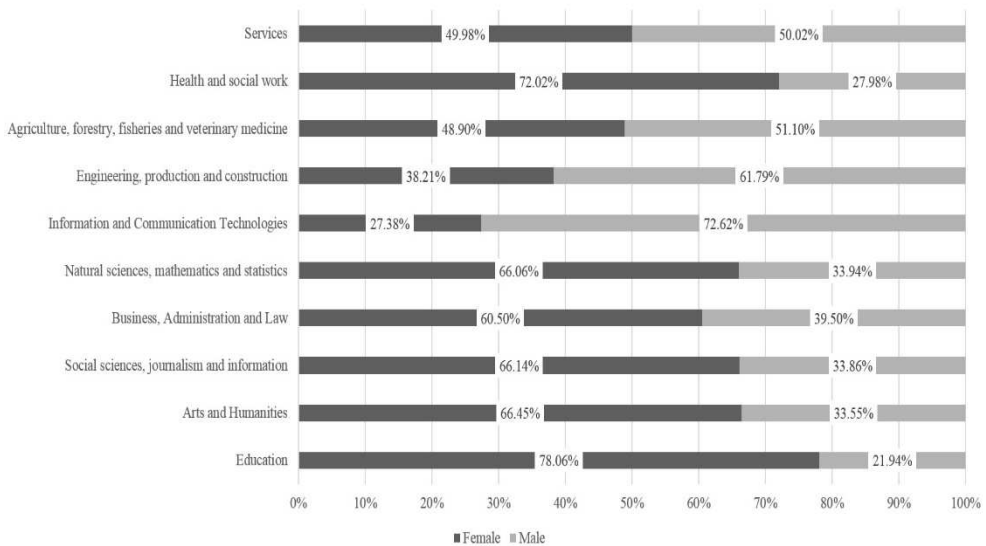
Source: Authors based on data provided by Statistical office of the Republic of Serbia

Figure 2 illustrates the distribution of students according to regions in Serbia and student's gender for the past three school years. We can see that

Serbia has more female students in all its regions and that this imbalance is the least pronounced in the South-East part of the country.

Not all fields of studies are equally interesting to female students. Figure 3 illustrates the distribution of students for the school year 2017/2018 according to the field of studies and student's gender. We can observe that ICT field is the least interesting for female students and that women currently represent 27% of Serbia's ICT students. When they enter the business world this number will decrease due to attrition that is present along the career trajectory and the fact that there are large gender gaps from graduation, the entry-level through to the top-executive positions (Taplett et al., 2018).

Figure 3: Distribution of students in 2017-2018 according to the field of studies

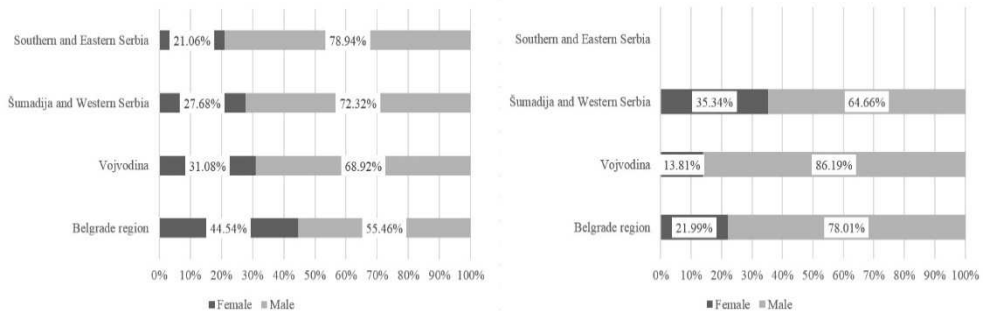


Source: Authors based on data provided by Statistical office of the Republic of Serbia

Gender gap in ICT education varies through different regions of Serbia. Figures 4a and 4b illustrate gender gap at universities in Serbia according to the region. We can see that gender gap at public universities (Figure 4a) is more pronounced in Southern parts of the country. Public universities from Belgrade and Vojvodina educate half of the overall Serbia's ICT students, while the rest of the students is distributed over other educational institutions. It is promising that Belgrade universities have reached almost equal distribution of female and male students. The gender gap is more pro-

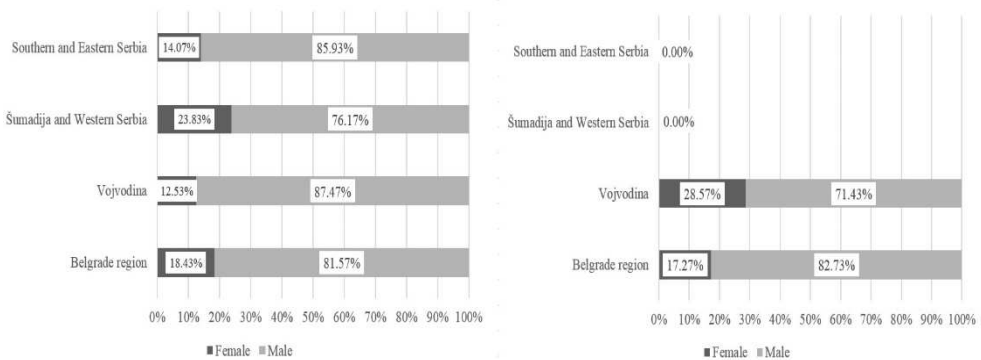
nounced at private universities, and particularly at professional studies (Figure 5a and 5b) than at universities and faculties. Considering that professional higher schools or colleges educate approximately 21% of overall ICT students these numbers are not to be neglected.

Figure 4: Gender gap at public universities (a) vs. private (b) universities



Source: Authors based on data provided by Statistical office of the Republic of Serbia

Figure 5: Gender gap at public schools of professional studies (a) vs. private schools of professional studies (b)



Source: Authors based on data provided by Statistical office of the Republic of Serbia

Based on official statistics, the gender gap is evident at Serbia's higher education institutions. Although universities do not have the sole power to break society's or perceptual barriers regarding ICT sector as a male-dominated field, they should take mitigating steps through support system and role-model representation. This will be discussed in more detail in the following sections.

The Representation of Data Science as a Field of Studies in Serbia

Within ICT, data science as a field of studies is still in a developing phase in Serbia. Some of the first steps that universities can do, is to work on developing data science curriculums to provide steady stream of data science workforce. This position allows universities in Serbia to make gender diversity in data science a priority from the start.

Most of the higher education institutions in Serbia, which educate ICT students, offer data science related courses, while study programs fully devoted to data science are predominantly at master level. This leaves tremendous space for further development of data science curriculums. At the University of Novi Sad four faculties educate ICT students.

- Faculty of technical science is one of the largest educators of ICT students in Serbia. Approximately 20% of overall ICT students in Serbia are enrolled at this faculty. They are the only faculty at the University of Novi Sad that offer data science program at Bachelor level with the option to follow through to the Master studies. This study program is available since 2015.
- Since 2017 Department of Mathematics and Informatics at the Faculty of Science offers two years Master program in Applied Mathematics and data science.
- Aside of these studies which are fully devoted to data science, both faculties offer various data science related courses within other Bachelor and Master study programs. The same applies for two other faculties at University of Novi Sad which educate ICT students: Technical faculty „Mihajlo Pupin” in Zrenjanin and the Faculty of Economics in Subotica.

The University of Novi Sad, alongside other universities from Serbia, is part of the project called Advanced Data Analytics - ADA. Within this project the University of Novi Sad will accredit a new master program in Advanced Data Analytics in Business and make significant contribution to further development of curriculums in data science.

Development of Data Science and Gender Equality at Serbia's Universities

Apart from a really important job of universities, to develop necessary curriculums, universities should address two key challenges:

1. To increase the number of female students who are studying data science or ICT in general
2. To develop business climate that will help retention and support of women.

The big question is how to achieve these goals. Some of the institutionalized initiatives are: a) requalification of women for ICT within National strategy and action plans for gender equality and a certain number of faculties are involved in this initiative; b) opening IT programs in high schools. Other initiatives are either sporadic or non-institutionalized, while initiatives concerning gender equity most often come from associations, non-government entities or projects, or companies devoted to promotion of women in ICT. Potential directions that will allow academic community and higher education institutions to be more involved include, but are not limited to the following:

1. Mentoring programs. Having a good mentor who can provide support and adequate challenges is essential both during education and for career advancement (Ragins & Cotton, 2017; Hoa et al., 2019). It is only natural that universities take part in this initiative. By including and connecting prominent scientists and academics, with alumni students and successful women in practice to mentoring other women in ICT, to contribute through various workshops and training, a platform for female role models and advocates is created.
2. Positive social message around women in data science should be sent to prospective female students that will point to successful women involved in data science, as well as that data scientists work in various fields and people with different preferences can find their place.
3. Retention requires proactive development of professional structures, curriculums, trainings, advancement mechanisms, and support that strategically and intentionally promote gender diversity.
4. Well established and ongoing scholarships dedicated exclusively to women in ICT.

Conclusion

To assure development of higher education curriculums that are in line with market trends and changed demand in ICT sector, data science should

be one of the fields in focus. Although data science is still in a developing phase in Serbia, an expansion of its use in various sectors is expected within the next several years. To proactively address these changes, which are already happening in more developed countries, new data science curriculums should be developed now. This starting position allows universities to set gender diversity a priority from the start. It is essential to promote women in data science and ICT, not only because of financial benefits which are linked to gender diversification of teams, but because of the evident lack of qualified workforce and increased demand for ICT and data science professionals. Gender gap is evident at higher education institution that have ICT study programs and issue an ICT related diploma, and educational institutions should take more actions to promote women in ICT and acquire more women to the field. In this paper we have identified potential starting directions for increased involvement of universities with respect to this important issue.

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