Introduction of joint short-cycle ICT courses for better employability of students and graduates – WICT

Report on in-depth analysis of the state-of-the-art in the area of DS and AI

Co-funded by the Erasmus+ Programme of the European Union

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V1	18/10/2022	Vladimir Ranković, Nenad Filipovic, Katarina Bogdanović, Neda Vidanovic Miletic (University of Kragujevac)	Final version

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List of abbreviations

Abbreviation	Explanation
RITEH	University of Rijeka
UNIKG	University of Kragujevac
IURC	Ionian University
PPKE	Peter Pazmany Catholic University
UEK	Krakow University of Economics
R1	Result 1 - Report on in-depth analysis of the state-of-the-art in the area of DS and AI
R2	Result 2 - DS/AI courses developed
R3	Result 3 - DS/AI courses realisation
HEI	Higher Education Institution
TPM	Transnational Project Meeting
DA	Data Science
AI	Artificial Intelligence
SQL	Structured Query Language
STEAM	Science, Technology, Engineering, Arts and Mathematics
SSH	Social Sciences and Humanities
GUI	Graphical User Interface

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1. Introduction

The core idea of the WICT consortium for the first project result, the *Report on in-depth analysis of the state-of-the-art in the area of DS and AI*, was to map the state-of-the-art in the DS and AI sectors across different areas of higher education at the partner universities. In order to achieve the planned result, the partners jointly planned and created a questionnaire that effectively enabled data collection from the target groups (students, recent graduates, especially women in higher education) at the partner HEIs and, provided expert inputs prior to formation of the Report.

The leader of R1 is UNIKG, led by prof. dr. Vladimir Ranković. This decision was made at the project preparation stage because UNIKG has required expertise in extensive mapping in the various fields, especially regarding statistical segments. UNIKG team collected and processed the data acquired by the partners during the first 9 months of the project. The results were discussed, analyzed, and disseminated at the consortium level. The achieved data and the conclusions stated in this Report will be used in preparation of the R2 - *development of the DS/AI courses.*

As it was stated in the project application, this Report strives towards innovativeness reflected in the fact that previous studies and analyses have not focused on factual issues seen in day-to-day interaction and work with students and alumni, i.e., the previous studies have not focused on practical knowledge STEM fields, such as DS and AI, could provide and that had been proven to be essential for better employability and a more successful academic career. Additionally, they did not recognize the specific requirements that are gender related. i.e., they did not differ skill requirements that stem from differences between men and women. This Report doesn't focus on digital skills in general on the institutional level, but on mapping the real potential for development of the practical skills that would strengthen the students, recent graduates and, most importantly, women to apply acquired DS/AI skills in their future careers in academia or labor market.

Intended impact of this Report is to provide the initial and facts-based inputs for the development of the short cycle courses at 5 participating universities. With gathered and analyzed data, content and quality of the developed programs will be more tailor-made toward

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the actual needs of the 5 HEIs. This Report is going to directly impact preparation of creative learning methods and modules that will be used and improved upon in the following years.

An important part of this report are the questionnaires[1] used for mapping the state-of-the-art in areas of DS/AI as the original idea behind the creation of this project was to create methodology, templates and good practice that can be shared on a national and international level.

[1] Available in Annex I of this Report.

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2. Towards the completion of R1 – details on realized activities

As it was planned by the project application, the Report is a final, fourth step in realization of the R1. Activities 1, 2 and 3 were planned for the first year of the project, in duration of 6 months, following the kick-off meeting held in April 2022, and establishment of the course of action among partners.

When it came to realization of each planned activity, WICT project team made dedicated efforts in providing enough space for each partner's input having in mind differences in the needs of each partner. A common ground was found despite the differences. With the guidance of UNIKG as the result leader, all WICT partners participated equally in the design of the questionnaire, dissemination of the questionnaire among target groups, and collection of data.

2.1 A1.1 Designing Mapping Questionnaires

To ensure the high-quality development of the questionnaire, the consortium tried to create the most efficient mapping tool in the form of a relatively short questionnaire. In the project development stage, the questionnaire was meant to be developed in such a way as to gather the information needed for additional education in the field, to inspect to what extent DS/AI skills are needed for the future academic or business careers of the target groups, what form of education the attendees of the courses would prefer, what teaching methods would have the strongest impact, what teaching material would be most attractive to them, how often they would like to attend classes, what are good/bad sides of current higher education in terms of the level to which the candidates are fully prepared to take the academic careers that require the application of DS/AI, etc. When it came to the actual design and distribution of the questionnaire, WICT project team opted for the most accessible form when it came to both inquiry approach and the data collection. This has proven to be very effective, as the results were more than satisfactory.

Development of the questionnaire started right after the kick-off meeting in April 2022, with the final form of the questionnaire in English, including its localized version in Serbian, being

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officially accepted in July 2022. At the approval stage, a minimum target of respondents was set to 25.

The questionnaire contains 16 default questions and 3 conditional questions. This number provided to be optimal, since the filling in of the questionnaire was not too time-consuming and focus was put on posing more precise questions, leaving space for a more personal input from the target groups via conditional questions. The questions were targeting information related to the: background of the person, gender of the person, IT level and previous experience in the field of DS/AI, available tools that can be used during the short course, interest in the level, duration, and topic.

2.2 A1.2 Mapping conducted in five countries

Mapping was conducted during July, August, and September of 2022. Despite having survey period overlapping with the summer vacation of both academic staff and target groups, survey process was successful, and each partner reached the minimum target of 25 respondents, agreed at the questionnaire approval stage.

To ensure efficient dissemination among the target groups at each HEI, the WICT project team decided to include the option of localization of the questionnaire for partners that deem it necessary, and to use Google Forms, a simple, free-of-charge online tool. This decision helped improve upon and speed up the survey process among the target groups at each of the 5 HEIs and made data collection effortless. UNIKG decided to localize the questionnaire, while other partners decided to stay with the English version.

The mapping was completed in September 2022, before the TPM in Corfu, with enough data to proceed onto assessment and planning of the R2.

2.3. A1.3 Data collected and assessed

Coming up with the idea of short-cycle courses in the areas of DS/AI was a practical way to overcome the existing state at the 5 HEIs where, outside of the study programs directly related

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to these areas, there's no opportunity for students to acquire practical skills that the industrial revolution 4.0 requires.

The data collected during the mapping stage was processed and statistically analyzed. This analysis was meant to obtain initial and facts-based inputs for the successful development and implementation of the short-cycle courses (R2 and R3), focusing on inquiring open questions such as: field of application, IT level of potential participants, prior knowledge in DS/AI of potential participants, preferred DS/AI skills, preferred DS/AI tool, preferred form of education, preferred teaching methods, preferred form of teaching material, etc. The collected data varies from partner to partner and creates a good direction towards the development of the short-cycle courses can go.

In total, there was 278 respondents (figure 1). The highest number of respondents was from UEK (138) and the lowest was from RITEH (29). The numbers vary between the countries, a fact coinciding with the mapping period being during the summer holidays. The presented numbers are a good indicator for a more intensive dissemination and promotion activities planned for year 2 and 3 of the project.

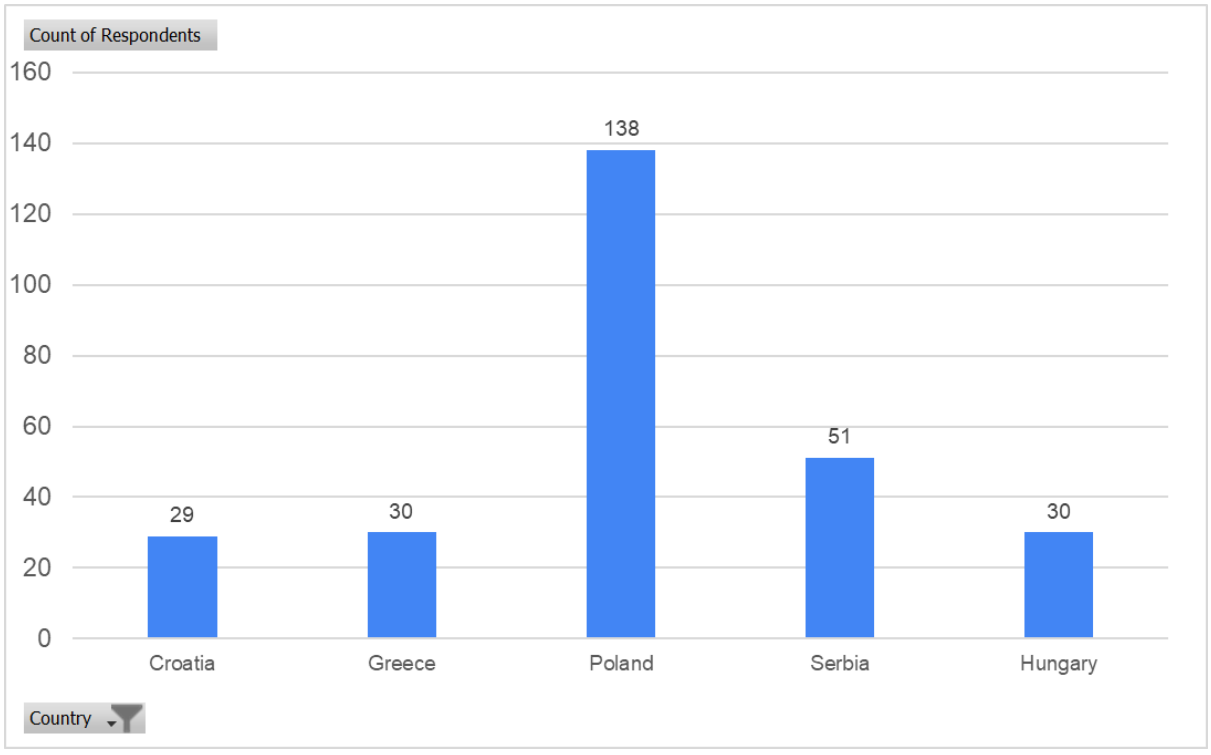

Figure 1 Number of respondents by country

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The data on gender of the correspondents (figure 2) shown the potential on which the success of the project will be built upon and potential issues to be tackled in the following months of the project lifespan. Since the project focuses particularly on women, a more intensive efforts must be made in Greece (only 8 females and 3 other) and Croatia (only 7 females and 1 other) to attract a pool of diverse participants in the upcoming short-cycle courses.

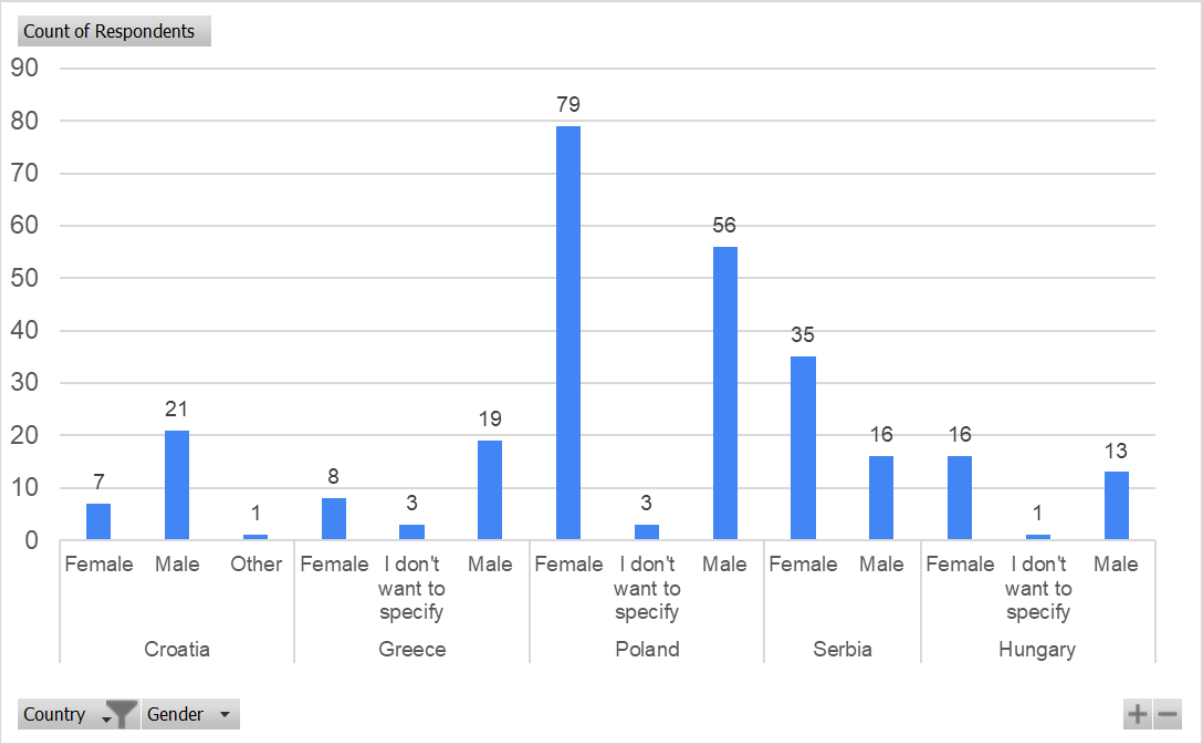

Figure 2 Distribution by gender

When data is sorted by the background of the respondents (figure 3), new possibilities for improvement and issues to be tackled can be seen. Most of the respondents were from the academic background (241 respondents), which was expected with the project's focus on the field of the higher education, with 3 respondents choosing option *Other* (Student and Education) that can be in a way considered as part of the academic share. Respondents from business background were in lesser number (33), which can be improved with better promotion once courses are developed.

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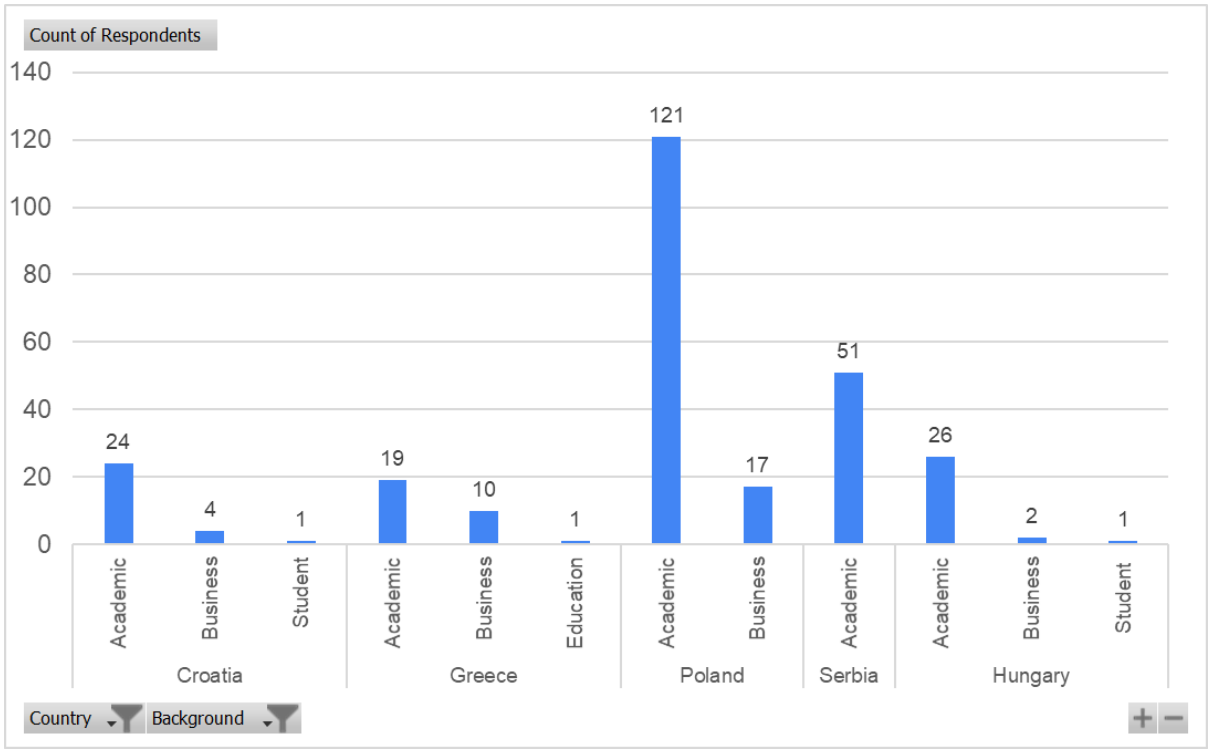

Figure 3 Distribution by background

The results of applicability of the courses (figure 4) were particularly encouraging - the diversity of fields shows high interest of potential short-courses' participants from both STEAM and SSH fields. However, the WICT project team plans to work intensively on attracting even more diverse set of participants from these fields.

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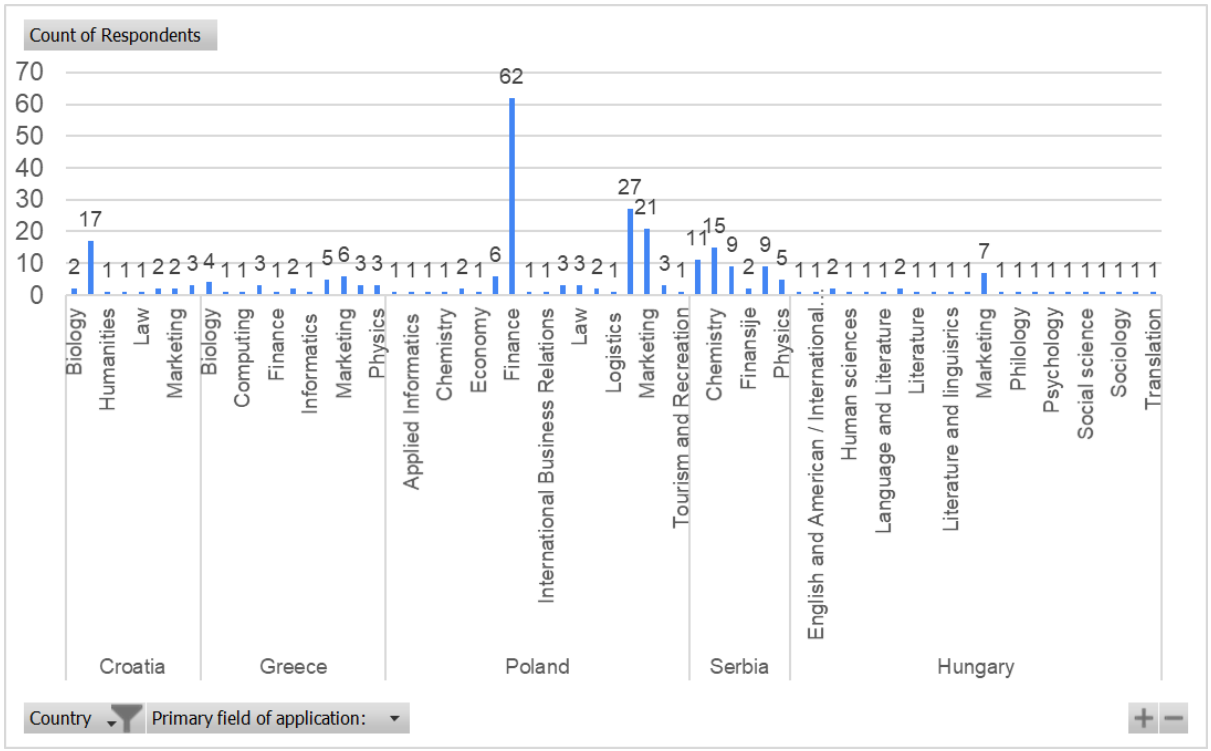

Figure 4 Primary field of application

When it comes to the IT level of the potential participants (figure 5), most of the participants (179 of 278 respondents) have a basic level of IT skills, meaning they are comfortable with using MO Excel. Respondents with intermediate level (62 of 278 respondents) are comfortable with using SQL or any PL, while respondents with advanced IT knowledge (37 of 278 respondents) have experience with Python and R.

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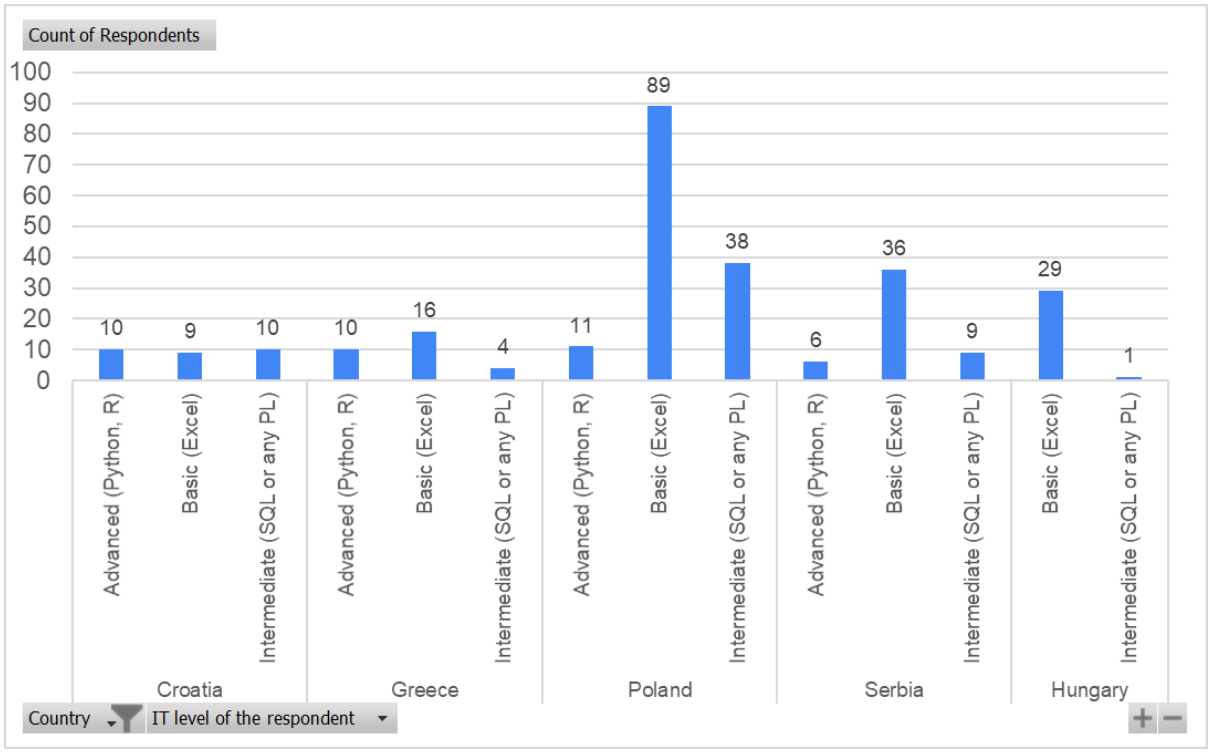

Figure 5 IT level of respondents

The collected data shows that most respondents had not completed any DS/AI related courses (figure 6), most respondents are interested in basic DS/AI courses (figure 7), and most respondents have scant knowledge of data science and artificial intelligence (figure 8). This type of data gives direction for the bounders within which the courses have to be designed with a clear division between beginners, intermediate and advanced users.

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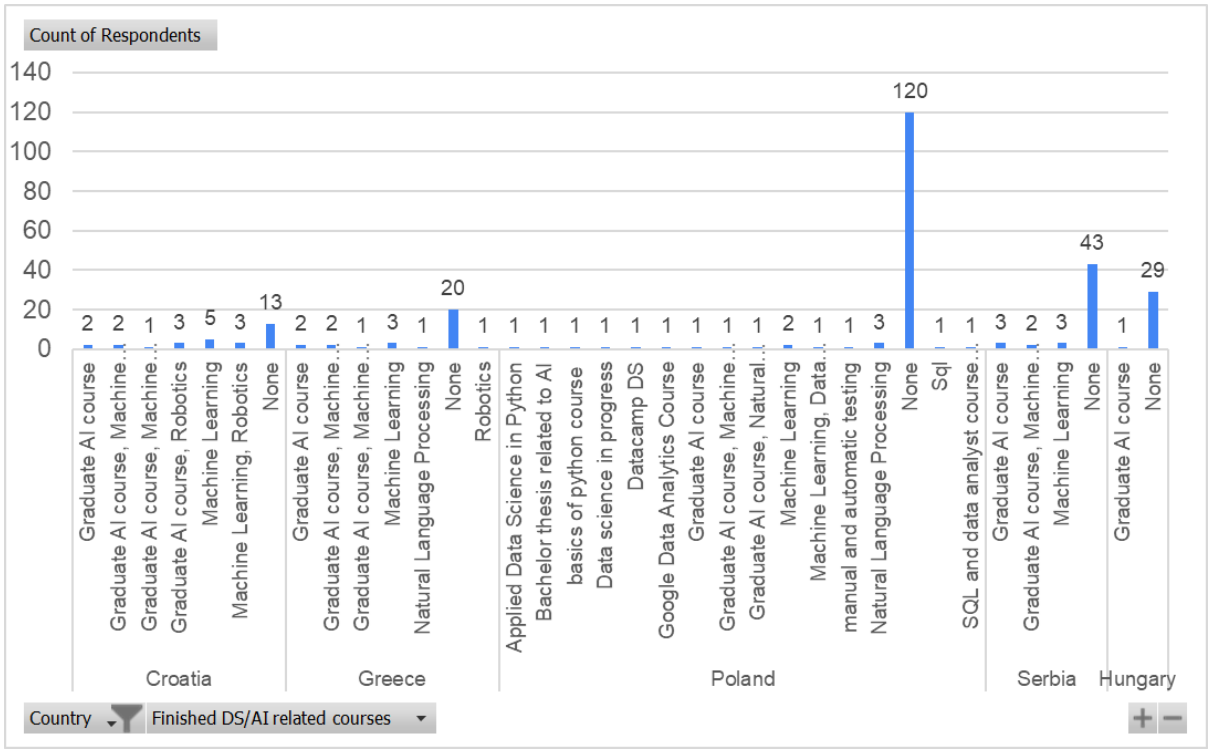

Figure 6 Finished DS/AI related courses

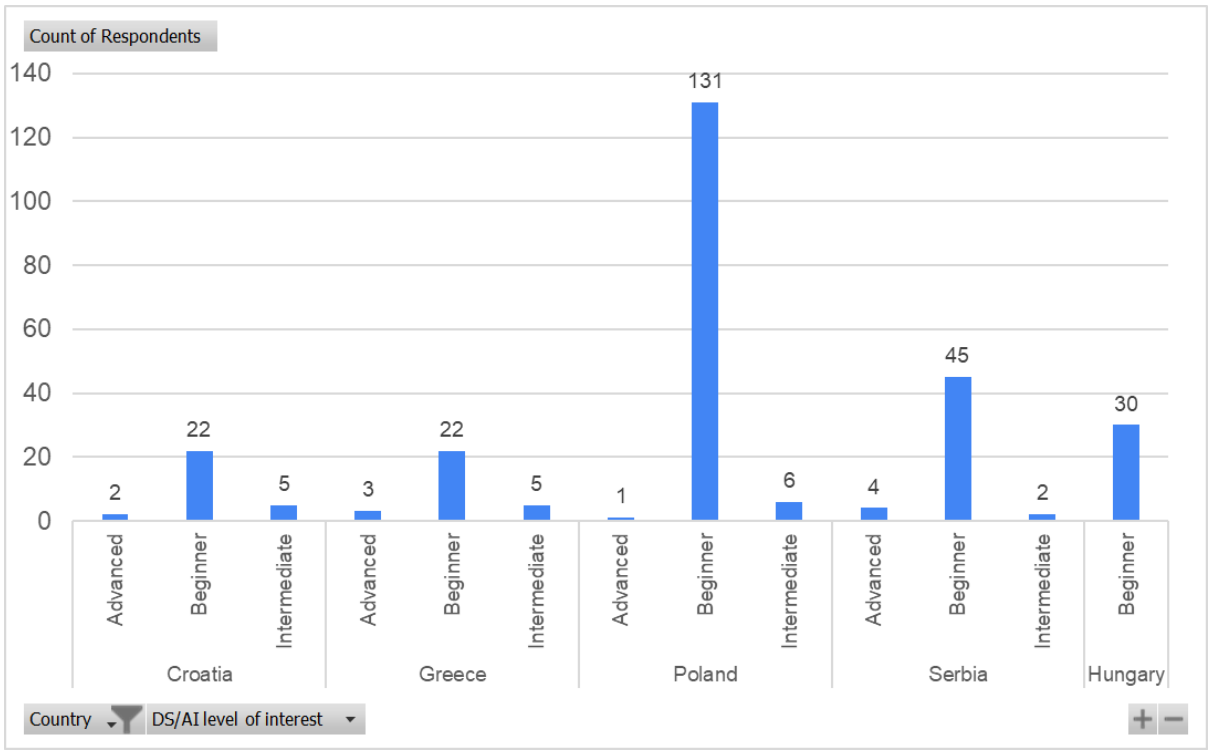

Figure 7 DS/AI level of interest

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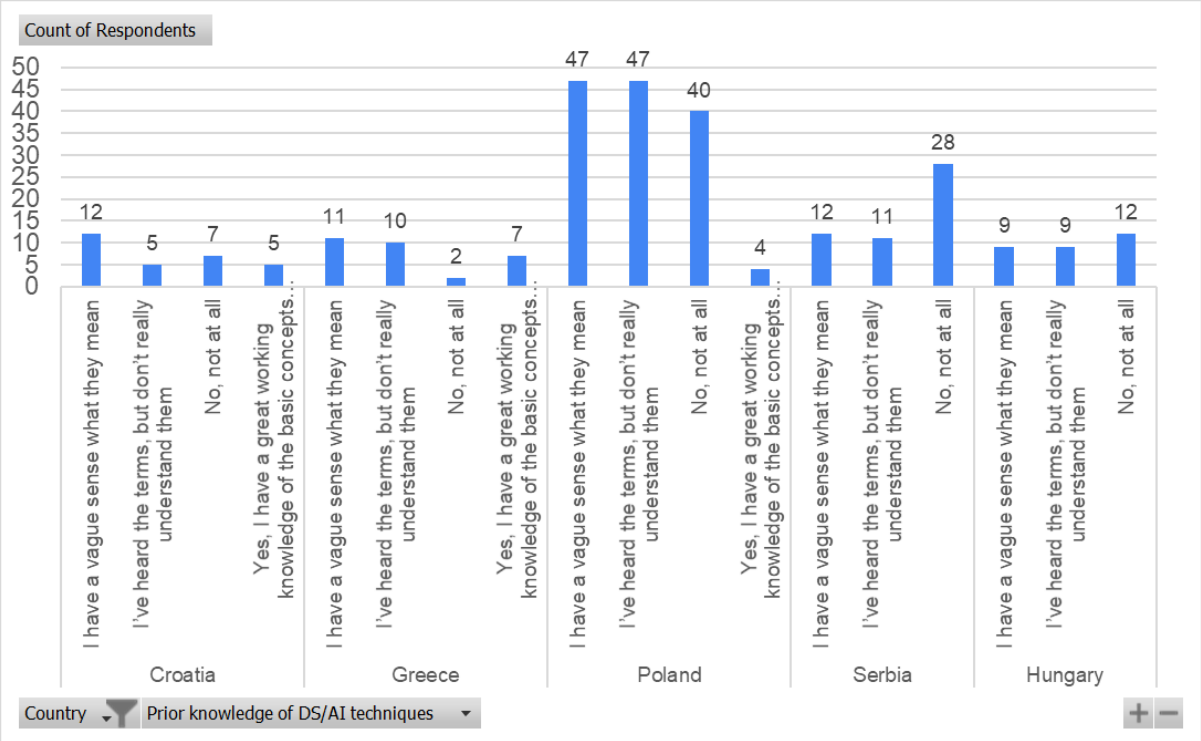

Figure 8 Prior DS/AI knowledge

The respondents' inputs confirmed the WICT team's thesis that practical knowledge and practical skills are of primary interest (figure 9). Two skills with most votes are the Data visualization (figure 10) and the Data storage and management (figure 11). Preferred DS/AI tools in the case of Serbia and Greece tools are tools with GUI, Poland, Hungary and Croatia tools in Python and R (figure 12). Most preferred form of the short program realization is online (figure 13). When it comes to teaching materials, the respondents prefer digital teaching material (figure 15). Duration of the courses (figure 14) preferred is in the format of 40-60 hours with 89 votes, followed by short 20h course - 87 votes, while only 45 votes for a two-day seminar (lasting 8-12 hours).

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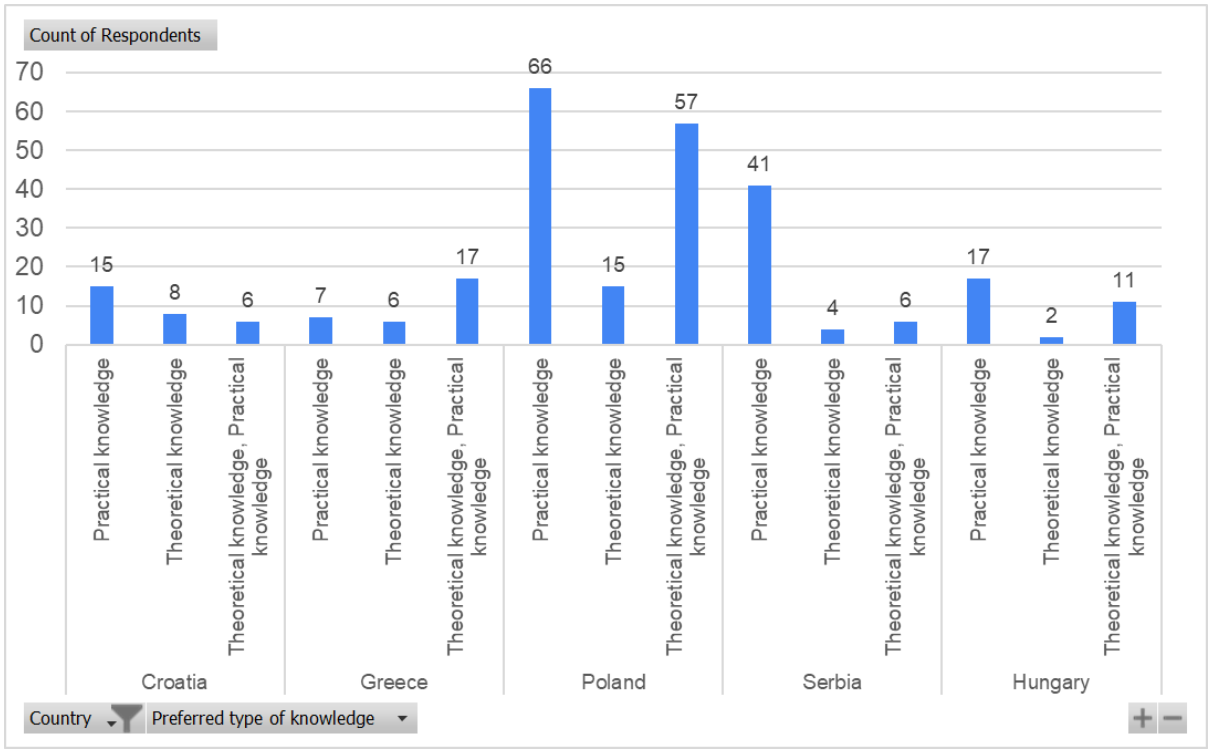

Figure 9 Preferred type of knowledge

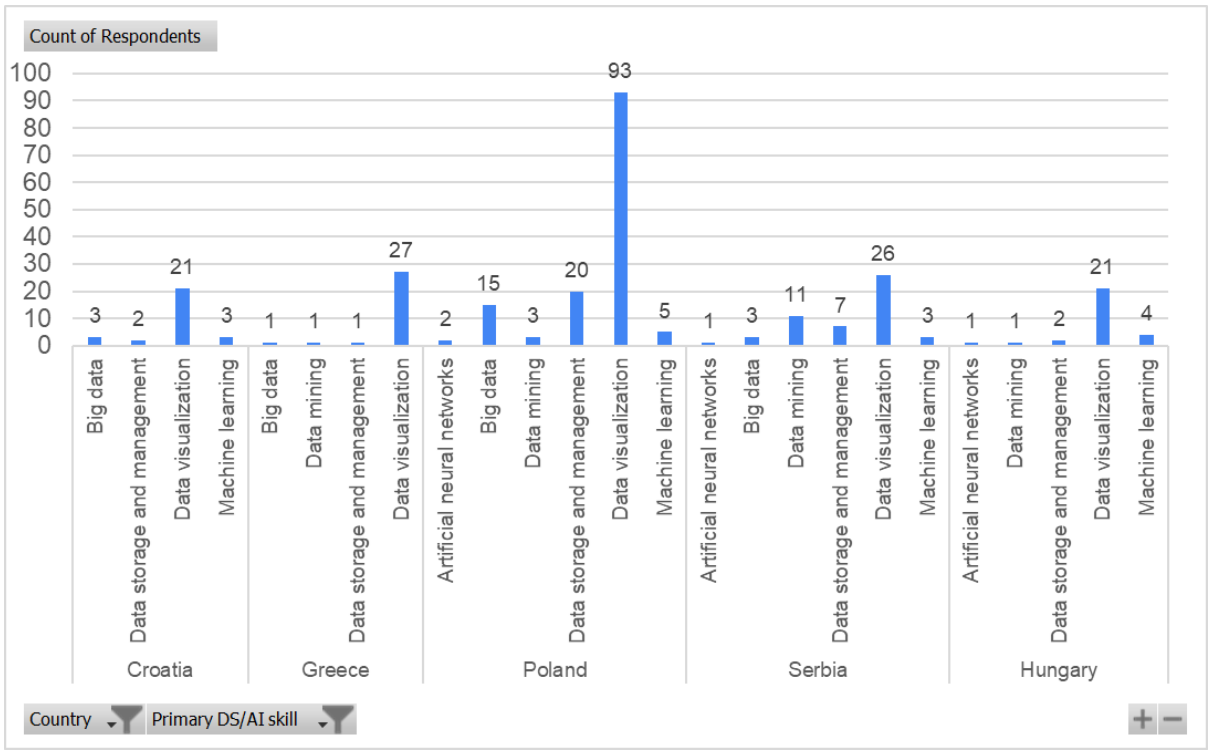

Figure 10 Primary preferred DS/AI skill

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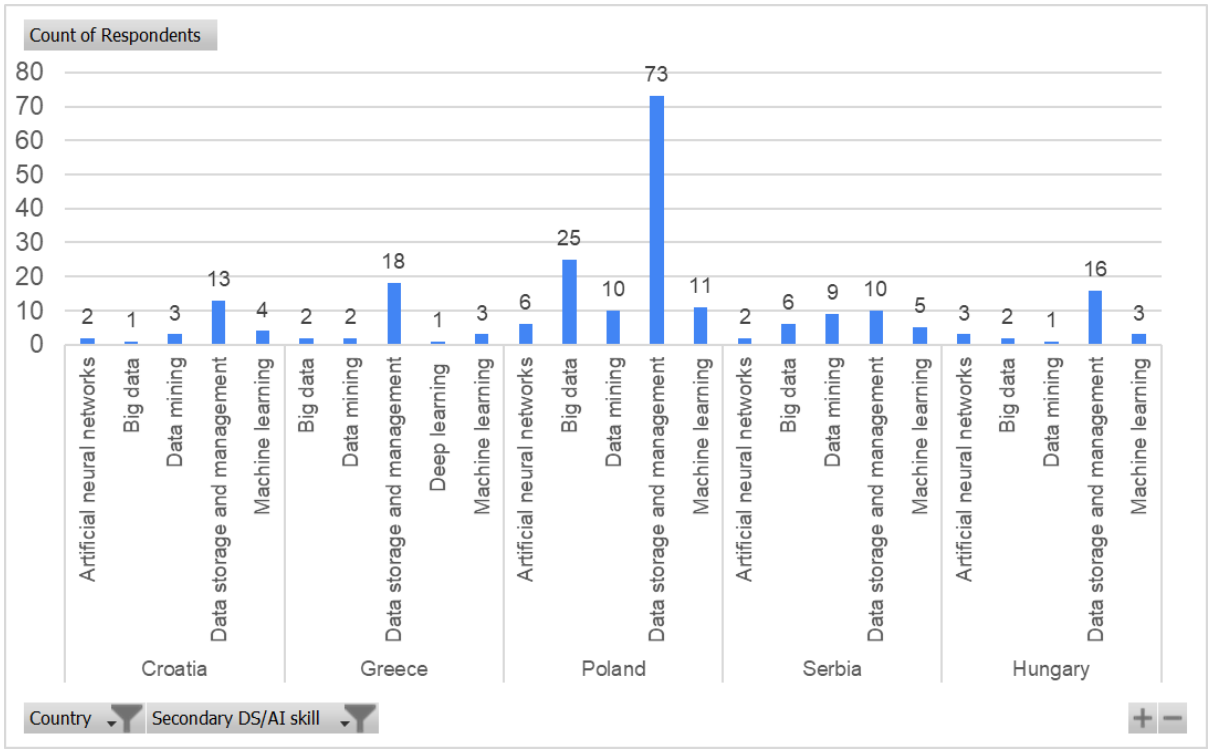

Figure 11 Secondary preferred DS/AI skill

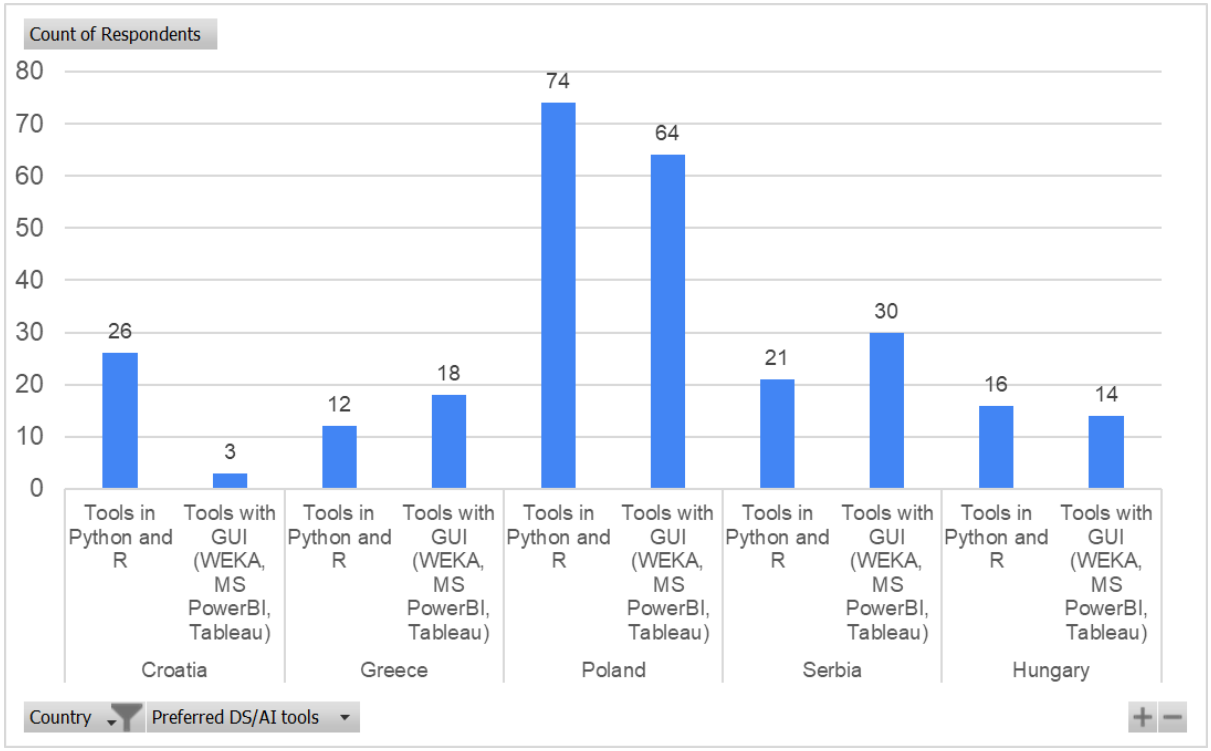

Figure 12 Preferred DS/AI tools

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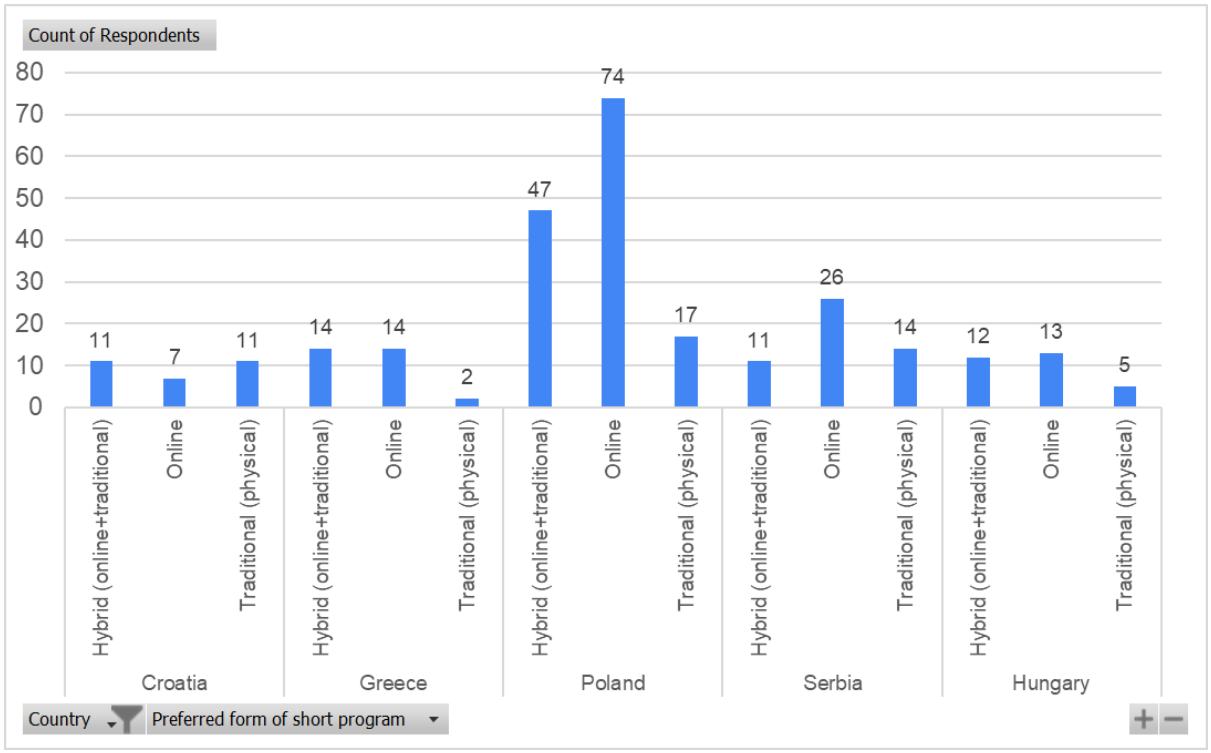

Figure 13 Preferred form of short program

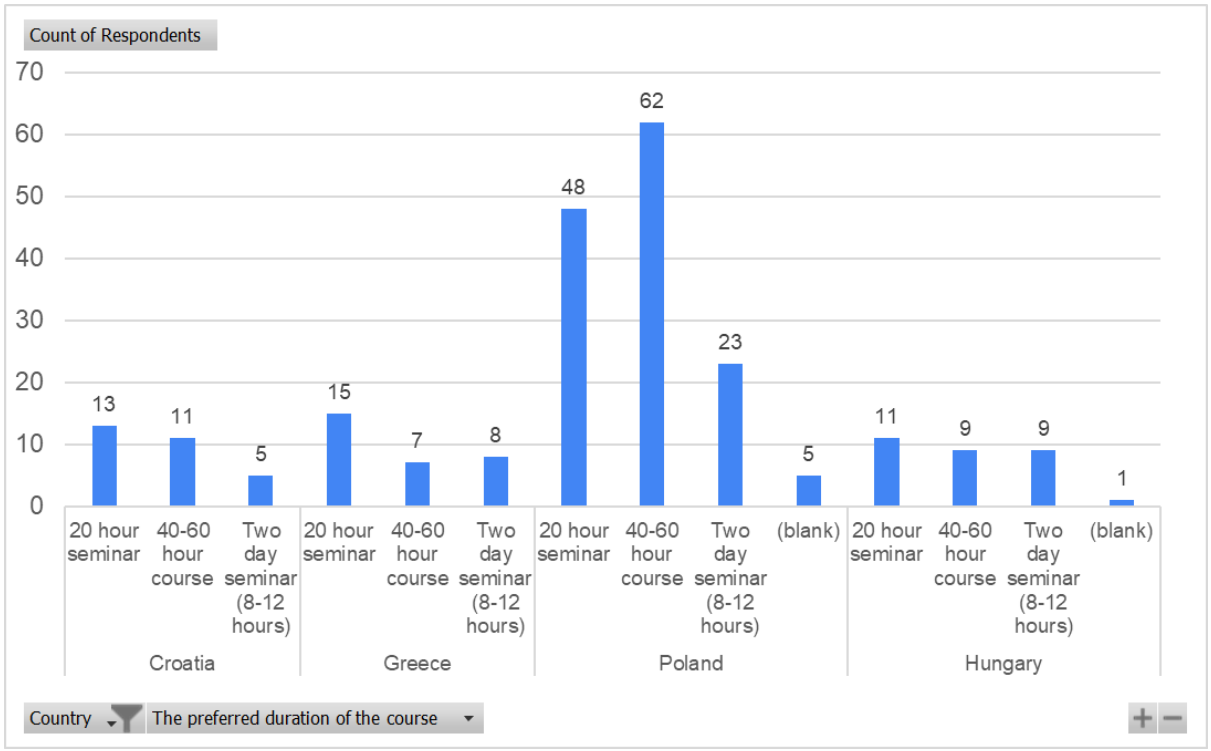

Figure 14 Preferred duration of courses

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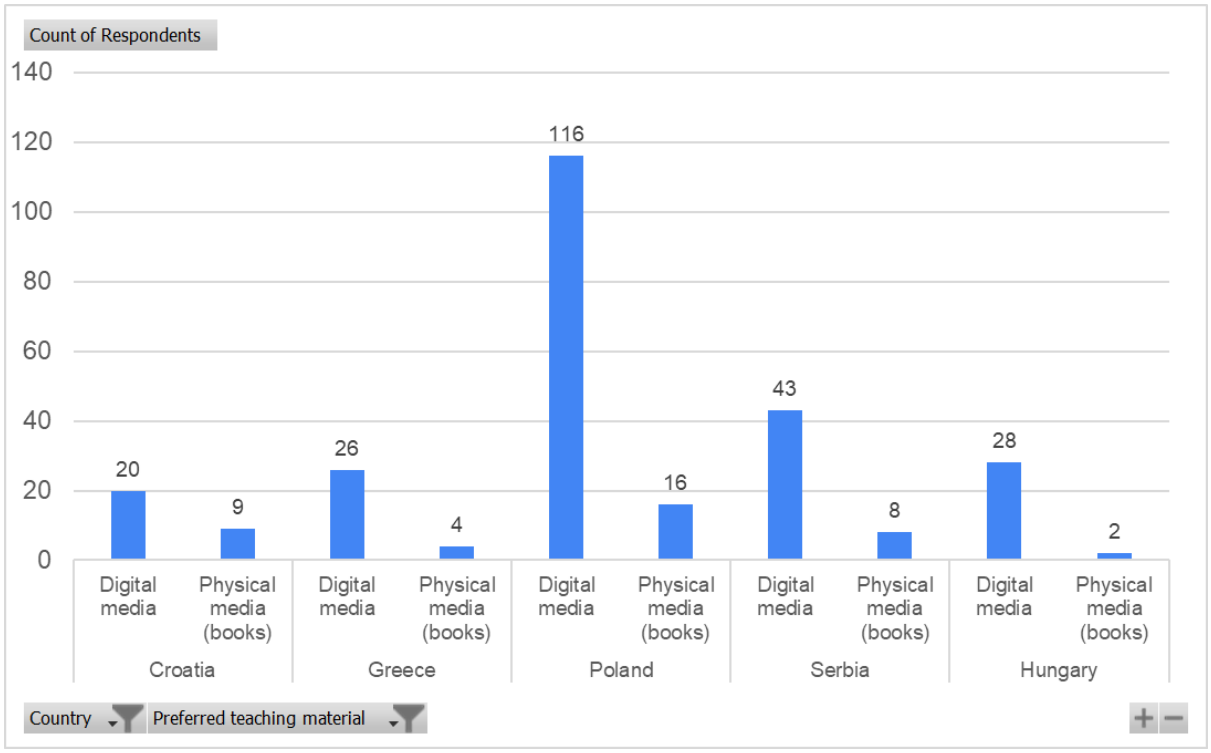

Figure 15 Preferred type of teaching material

Since the possibility of hosting the short-cycle courses online in the times of pandemic was great, the WICT project inquired the available computer infrastructure, know-how of software installation, administrative access, and availability of data of the potential participants (figures 16-19). The available computer infrastructure for most respondents is consisting of classic *Office* computers and laptops. Most of them have a relatively solid know-how of software installation and no problem with administrative access, however, support must and will be provided to those who need it in order to attend the courses. The responses regarding availability of data were quite mixed. This part of the questionnaire might have to be inquired among the participants and additionally re-assessed after the first piloting of the short-cycle courses.

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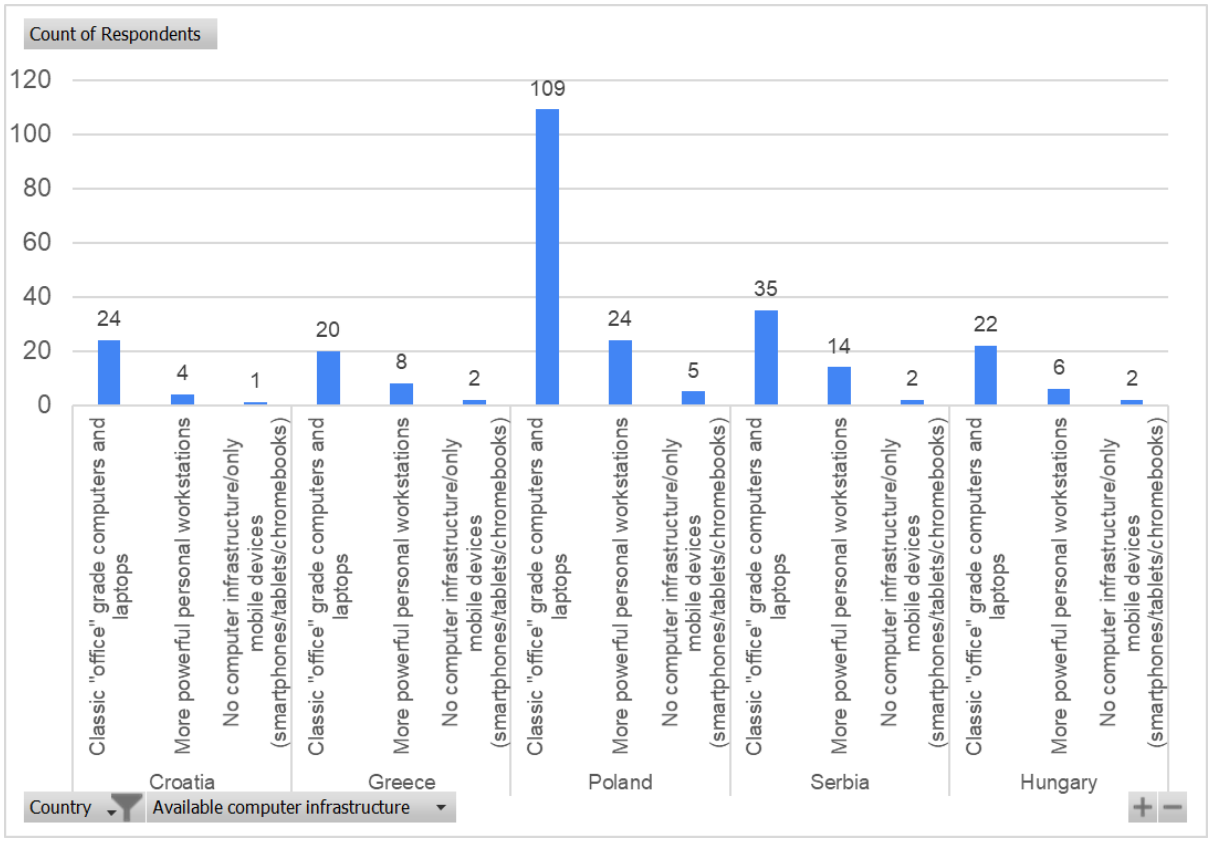

Figure 16 Available computer infrastructure

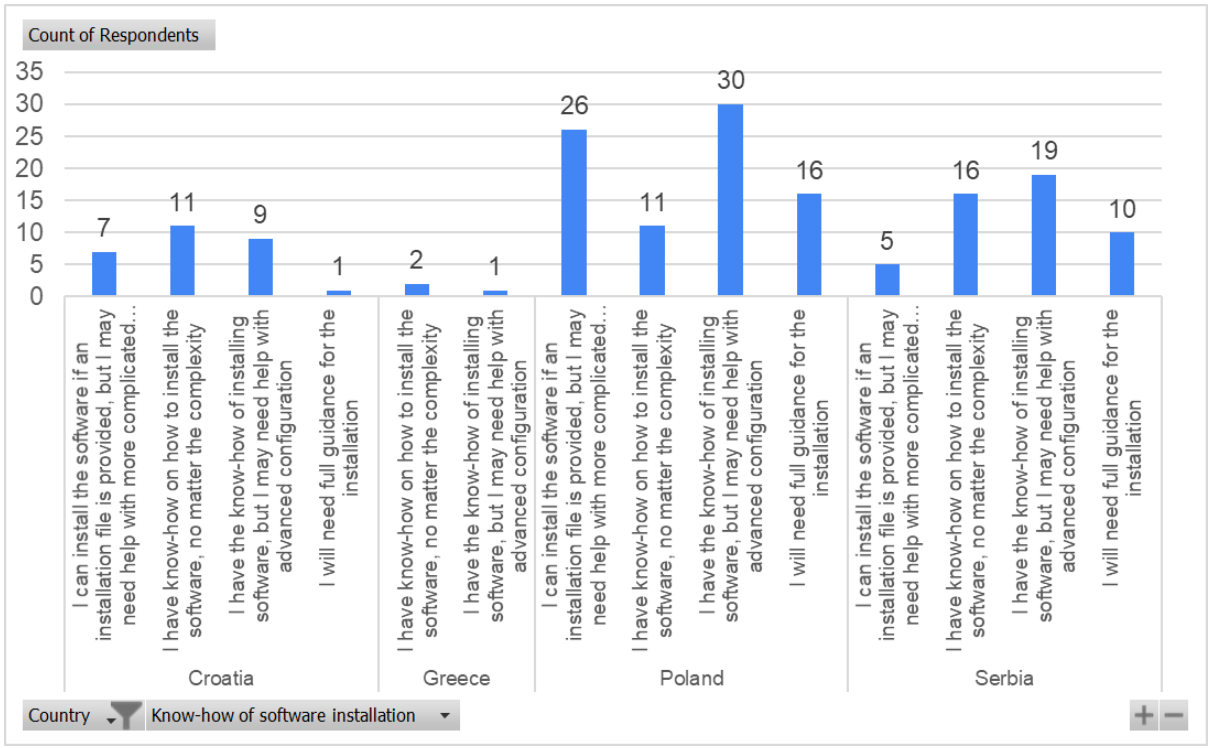

Figure 17 Know-how of software installation

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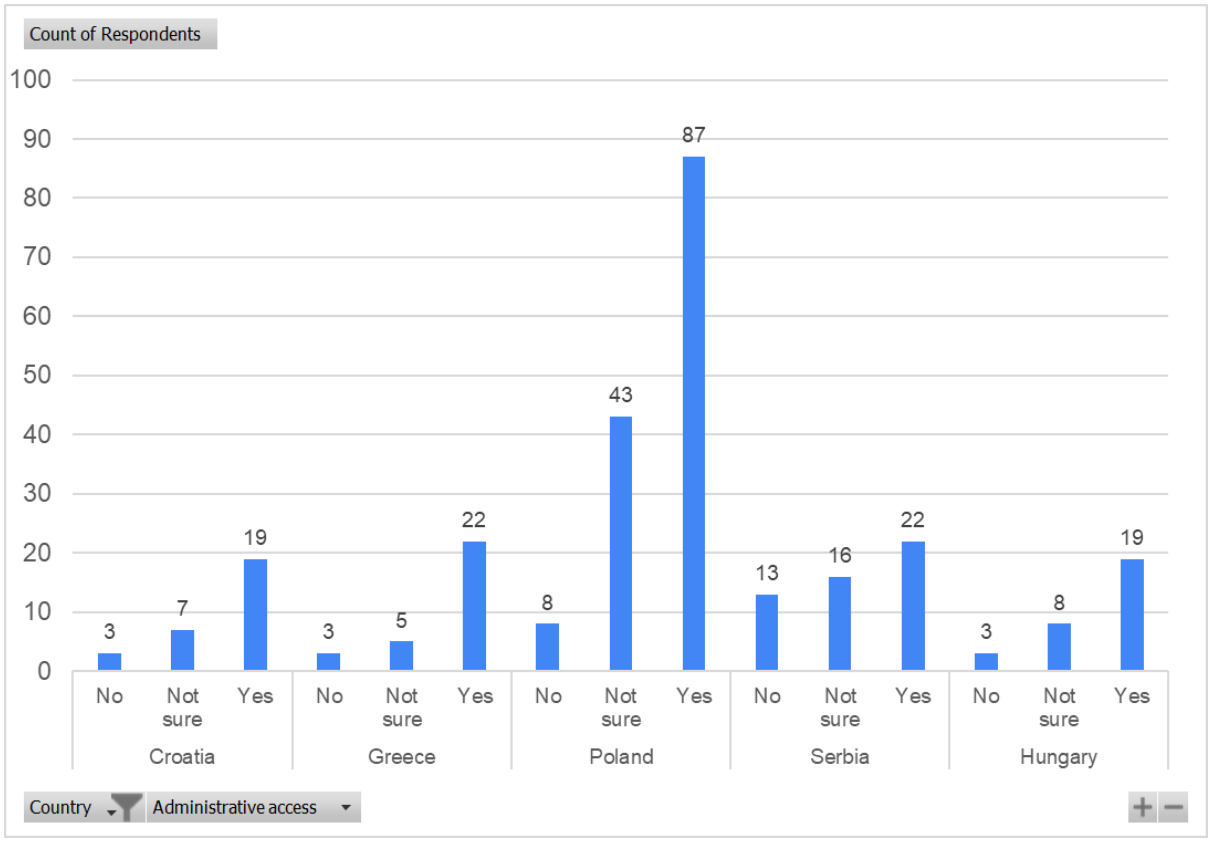

Figure 18 Administrative access

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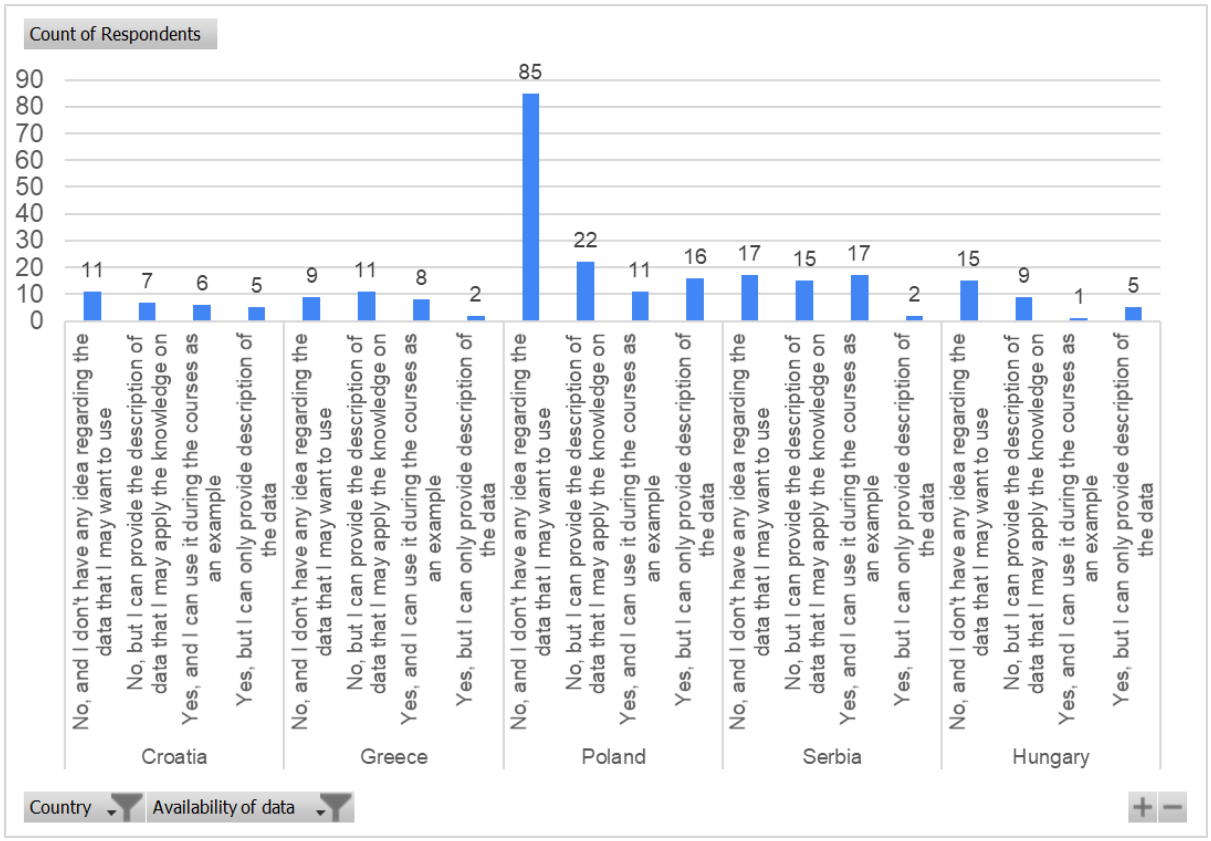

Figure 19 Availability of data

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3. Conclusions

During the TPM held in Corfu, Greece on September 6th, 2022, first analysis of the collected data was presented to the consortium. The presenter, prof. dr. Vladimir Ranković, was also the moderator of the discussion on the findings that followed the presentation (*Analysis of the state-of-the-art in the area of DS and AI*).

The main conclusions of the discussion were:

- Having most respondents from the academic background, the expected participants in the short cycle courses are students of bachelor, master, and PhD studies. To attract the recent graduates, involvement of alumni clubs will be necessary. Efficient promotion and dissemination of the short cycle courses will be conducted to attract sufficient number of attendees. Focus will be put to attract a diverse pool of attendees.
- Because most respondents had not completed any DS/AI related courses, and they are mostly interested in basic DS/AI courses (beginner level), the organized courses will be beginner level courses.
- Having in mind that most respondents have scant knowledge of artificial intelligence, prefer practical knowledge, are primarily interested in skills related to Data visualization and Data storage and management, prefer realization of short program online in the duration of 40-60 hours with digital material being shared during the implementation.
- Analysis has shown that preferred type of DS/AI tools differ between countries, which will be held in mind when it comes to design of short cycle courses. Potential attendees in Serbia and Greece prefer tools with GUI, and in Poland, Hungary and Croatia tools in Python and R. This fact will be considered for the tailor-made approach at the level of each HEI.

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Annex I

Annex I.1 Questionnaire for short-cycle programs in DS/AI (English version) – main version in an offline form

Project type: Erasmus + project, call: Cooperation Partnership

Project title: Introduction of joint short-cycle ICT courses for better employability of students and graduates

Project acronym: WICT

Coordinator: University of Rijeka, Croatia

Partners: University of Kragujevac, Serbia, Ionian university, Greece, Pázmány Péter Catholic University, Hungary and Cracow University of Economics, Poland

Questionnaire for short-cycle programs in DS/AI

The aim of this questionnaire is to map the needs of the market and obtain important input information for the development of short-cycle programs in the area of data science and artificial intelligence.

List of questions

1. **Country of origin of the informant:**

   a) Croatia
   b) Greece
   c) Hungary
   d) Poland
   e) Serbia
   f) Other

2. **Background of the informant:**

   a) Academic
   b) Business
   c) Other (specify): _____

3. **Gender of the informant:**

   a) male
   b) female

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c) other
d) I don't want to specify.

4. Field of application:

a) Medicine
b) Biology
c) Chemistry
d) Physics
e) Marketing
f) Management
g) Finance
h) Engineering
i) Law
j) Other (specify): _____

5. IT level of the respondent:

a) Basic (Excel)
b) Intermediate (SQL or any programming language)
c) Advanced (Python, R)

6. Finished DS/AI related courses. Select all that apply.

a) None
b) Graduate AI course
c) Machine Learning
d) Robotics
e) Natural Language Processing
f) Other (specify): _____

7. DA/AI level respondent apply for:

a) Beginner
b) Intermediate
c) Advanced

8. Prior knowledge of DS/AI techniques

a) Yes, I have a great working knowledge of the basic concepts and terms
b) I have a vague sense what they mean
c) I've heard the terms, but don't really understand them
d) No, not at all

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9. Type of knowledge respondent is interested in:

a) Theoretical knowledge (theoretical background)
b) Practical knowledge (tools and applications)

10. The DS/AI skills respondent is interested in:

a) data visualization
b) data storage and management
c) big data
d) data mining
e) machine learning
f) artificial neural networks
g) other (specify) _____

11. Preferred DS/AI tools:

a) Tools with GUI (WEKA, MS PowerBI, Tableau)
b) Tools in Python and R

12. Preferred form of short program realization:

a) Online
b) Traditional (physical)
c) Hybrid (online+traditional)

13. The preferred duration of the course (if applicable)

a) Two days seminar (8-12 hours),
b) 20 hour seminar,
c) 40-60 hour course

14. Teaching material

a) Physical media (books)
b) Digital media (ppt. presentation/video presentation)
c) Other (specify): _____

15. What kind of computer infrastructure is available to you for use during and after the courses?

a) No computer infrastructure/only mobile devices (smartphones/tablets/chromebooks)
b) Classic "office" grade computers and laptops.
c) More powerful personal workstations
d) HPC servers/workstations

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16. Do you have know-how of software installation?

a) I have know-how on how to install the software, no matter the complexity.
b) I have the know-how of installing software, but I may need help with advanced configuration.
c) I can install the software if an installation file is provided, but I may need help with more complicated configuration and installation.
d) I will need full guidance for the installation.

17. Do you have the administrative access to the machines on which you would want to run the software?

a) Yes.
b) No.
c) Don't know.

18. Do you have data within your organization that you want to apply the DS/AI knowledge in?

a) Yes, and I can use it during the courses as an example.
b) Yes, but I can only provide description of the data.
c) No, but I can provide the description of data that I may apply the knowledge on.
d) No, and I don't have any idea regarding the data that I may want to use.

Please only answer the following questions if you have selected (b) Intermediate or (c) Expert

19. Please list the primary goals/outcomes for your ICT course.

_____

_____

_____

_____

_____

_____

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_____

_____

20. Which DS/AI topics (techniques) do you think should be covered in an introductory course? Please list them in order of importance.

_____

_____

_____

_____

_____

_____

_____

_____

21. What kind of data would you be interested in applying DS/AI skills for?

a) Image data
b) Numerical data (table)
c) Numerical time-series data
d) More than one data type.
e) A combination of data types (e.g. image with additional numerical data)
d) Other (specify): _____

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Annex I.2 Questionnaire for short-cycle programs in DS/AI (version in Serbian language)

Upitnik za ciklus kratkih programa iz oblasti nauke o podacima i veštačke inteligencije

Cilj ovog upitnika je analiza potreba tržišta i dobijanje informacija važnih za razvoj kratkog programa iz oblasti nauke o podacima (DS) i veštačke inteligencije (AI).

Kratak program se realizuje u okviru Erasmus+ projekta koji finansija EU.

Tip projekta: Erasmus+

Poziv: Cooperation Partnership

Naziv projekta: Introduction of joint short-cycle ICT courses for better employability of students and graduates

Akronim projekta: WICT

Koordinator: University of Rijeka (Croatia)

Partneri: University of Kragujevac (Serbia), Ionian University (Greece), Pázmány Péter Catholic University (Hungary) i Cracow University of Economics (Poland)

1. Zemlja *

- ◯ Serbia
- ◯ Croatia
- ◯ Greece
- ◯ Hungar
- ◯ Poland
- ◯ Other

2. Oblast u kojoj ste angažovani: *

- ◯ Naučno-obrazovni sektor
- ◯ Privreda
- ◯ Other: _____

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3. Pol *

- ◯ Muški
- ◯ Ženski
- ◯ Drugo
- ◯ Ne želim da se izjasnim

4. Oblast u kojoj želite da primenjujete DS/AI tehnike: *

- ◯ Medicina
- ◯ Biologija
- ◯ Hemija
- ◯ Fizika
- ◯ Marketing
- ◯ Menadžment
- ◯ Finansije
- ◯ Inženjerstvo
- ◯ Prava
- ◯ Drugo _____

5. Koji nivo IT veština posedujete? *

- ◯ Osnovni (Excel)
- ◯ Srednji (SQL ili neki drugi programski jezik)
- ◯ Napredni (Python, R)

6. Da li ste pohađali neki kurs iz oblasti DS/AI? Označite sve koje ste pohađali: *

- ◯ Nijedan
- ◯ Kurs iz Veštačke inteligencije (AI)
- ◯ Kurs iz Mašinskog učenja (ML)
- ◯ Robotika

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- ◯ Obrada prirodnih jezika
- ◯ Drugo _____

7. Koji nivo DS/AI programa želite da pohađate? *

- ◯ Početni *Pređi na pitanje 11*
- ◯ Srednji *Pređi na pitanje 8*
- ◯ Napredni *Pređi na pitanje 8*

Pitanja za one koji žele da pohađaju "srednji" ili "napredni" nivo DS/AIprograma

8. Navedite veštine/znanja koja želite da steknete na DS/AI programu *

9. Koje DS/AI teme (tehnike) po Vašem mišljenju treba da budu obuhvaćene ovimprogramom? Navedite teme po važnosti.

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10. Na koje tipove podataka želite da primenjujete DS/AI tehnike? *

- ◯ Slike
- ◯ Numerički podaci (tabele)
- ◯ Numeričke vremenske serije
- ◯ Kombinovani podaci (npr. slike i numerički podaci)
- ◯ Drugo _____

11. Koliko poznajete osnovne koncepte iz DS/AI? *

- ◯ Poznajem osnovne koncepte i termine iz DS/AI
- ◯ Imam samo maglovitu predstavu o tome šta znače
- ◯ Nisu mi poznati koncepti i termini iz DS/AI

12. Koju vrstu znanja iz DS/AI želite da steknete na kratkom programu? *

- ☐ Teorijska znanja
- ☐ Praktična znanja (poznavanje alati i njihova primena)

13. Koje DS/AI veštine želite da steknete? *

- ◯ Vizuelizacija podataka
- ◯ Skladištenje i upravljanje podacima
- ◯ Obrada velikih količina podataka (Big data)
- ◯ Istraživanje podataka (Data mining)
- ◯ Mašinsko učenje (Machine learning)
- ◯ Veštačke neuronske mreže (Artificial neural networks)
- ◯ Drugo _____

14. Za koji tip DS/AI alata ste zainteresovani? *

- ◯ Alati sa grafičkim okruženjem (WEKA, MS PowerBI, Tableau).
- ◯ Biblioteke u programskim jezicima Python i R.

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15. Koji način realizacije kratkog programa Vam odgovara? *

- ◯ Onlajn
- ◯ Tradicionalni (uživo)
- ◯ Hibridni (onlajn+uživo)

16. Medijum nastavnog materijala: *

- ◯ Fizički materijal (knjige)
- ◯ Digitalni materijal (PPT prezentacije, Video lekcije)
- ◯ Drugo _____

17. Koju vrstu računarske infrastrukture posedujete za potrebe pohađanja kratkog programa? *

- ◯ Nemam računar, samo mobilni uređaj (pametni telefon/tablet)
- ◯ Klasičan "kancelarijski" računar
- ◯ Lični računar sa naprednim performansama
- ◯ HPC server/radna stanica.

18. Da li posedujete znanje instalacije softvera? *

- ◯ Umem da instaliram bilo koji softver, nezavisno od složenosti postupka
- ◯ Umem da instaliram softver, ali mi možda zatreba pomoć u slučaju složenog postupka
- ◯ Umem da instaliram softver ako dobijem instalacioni fajl ali mi možda zatreba pomoć u slučaju složenog postupka
- ◯ Ne, potrebna mi je pomoć za instalaciju softvera

19. Da li posedujete administratorske privilegije na računaru na kojem želite da koristite softver za DS/AI?*

- ◯ Da
- ◯ Ne
- ◯ Nisam siguran

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20. Da li imate pristup podacima Vaše organizacije na koje želite da primenite DS/AI tehnike?*

- ◯ Da, mogu da ih koristim tokom programa
- ◯ Da, ali mogu da koristim samo opis podataka (ne i same podatke)
- ◯ Ne, ali mogu da obezbedim opis podataka
- ◯ Ne, ne mogu da obezbedim podatke iz organizacije u kojoj sam angažovan(a)

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