Croatia vs EU from the perspective of digital skills

Jurun, Elza; Garbin Praničević, Daniela; Bašić Androja, Valentina

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Elza Jurun, Daniela Garbin Praničević and **Valentina Bašić Androja**
University of Split, Faculty of Economics, Business and Tourism
Cvite Fiskovića 5, Split, Croatia
E-mails: elza@efst.hr, daniela@efst.hr, vbasic95@gmail.com

Abstract: This paper deals with statistical analysis of digital skills in Croatia using modern methodological procedures of official institutions. Empirical research using two-step random sample with post stratification on the basis of sex, age, education level and working status proves statistically significant difference only in digital skills depending on the age and level of education of the Croatian respondents. The results of several comparative analyses of Croatia vs EU countries are presented with general conclusion that positions Croatia as the country with an intermediate level of digital skills and efforts in developing digitally empowered society.

Keywords: comparative analysis, digital skills in Croatia, hypothesis testing, public opinion survey

1 INTRODUCTION

The contemporary era is marked by the proliferation of Information and Communication Technology (ICT) appliances, leading to a significant increase in the demand for digital skills across various domains [13]. This work centers around the pivotal role of digital skills in driving scientific, technological, educational, and broader socioeconomic advancement. Moreover, raising the general level of digital skills is an unavoidable prerequisite for Croatia's inclusion in the modern European environment. For this reason, Croatia offers numerous opportunities to its population, especially the younger generations, through all levels of the education process. Employees recognize these efforts and take advantage of state incentives to open numerous newly founded, especially IT, companies. Even people from other parts of Europe choose Croatia and as "online nomads" live and work here, appreciating the Croatian climates, more favourable working conditions and characteristics of the mentality of Croatian natives.

Researches, the results of which are presented in this paper, follow the guidelines of the European Commission's Digital Education Action Plan (2021-2027) [7] which sets out a vision for quality, inclusive and affordable digital education in Europe. Besides, measurement procedures within the scope of these researches are based on [4] and [12]. After introduction, the second part of this paper is dedicated to the empirical findings interpretation. After interpretation of the public opinion survey results about Croatian digital skills, comparative analysis of Croatia vs EU countries from the same perspective was carried out. The third part of the paper contains concluding remarks and implications for further research. Cited literary units are at the paper end.

2 EMPIRICAL RESEARCHES

2.1 Public opinion survey results

In July and August, a survey was conducted in Croatia using a questionnaire to analyze the impact of age, sex, education level, and employment status on the digital skills levels of respondents. The survey targeted individuals between 18 and 65 years of age, representing the working-age population. Prior to developing the questionnaire, extensive research was conducted to ensure its alignment with the relevant standards and guidelines established in statistical literature and practices [10]. The survey design was based on the European Digital Competence Framework for Citizens and the Eurostat Digital Skills Indicator, ensuring consistency and comparability with European standards.

The questionnaire used in this study gathered sociodemographic data from the respondents, followed by fifteen closed-ended questions about various digital activities. Each question focused on a specific activity and offered three answer options representing different levels of digital skills. The questionnaire encompassed five competence areas: information and data literacy, communication and collaboration, digital content creation, digital security, and digital problem solving. For each competence area, there were three questions. The answer options represented skill levels as basic, intermediate, or advanced.

To determine the overall level of digital skills for each respondent, the quantified answers from the questionnaire were used to calculate the arithmetic mean. This mean value represented the individual's overall digital skills level. Respondents with an arithmetic mean ranging from 1 to 1.5 were classified as having a basic level of digital skills. Those with an arithmetic mean ranging from 1.5 to 2.5 were considered to have an intermediate level, while respondents with an arithmetic mean ranging from 2.5 to 3 were classified as having an advanced level of digital skills. The statistical analysis of the data collected from the questionnaire was performed using the TIBCO Statistica 14.0.0 software in 2020.

In terms of methodology, the study initially conducted the Kolmogorov-Smirnov test to determine whether the data followed a normal distribution. This test is essential for subsequent statistical procedures that rely on this assumption. In the second step of the statistical analysis, the results indicated that the overall arithmetic mean for digital skills in Croatia was 1.94, positioning the country at an intermediate level of digital skills. To examine the relationship between digital skills and sex, hypothesis testing was conducted using an independent samples t-test. This test was used to compare the means of digital skills between different sex groups. The results of the t-test showed that there was no statistically significant difference in the overall level of digital skills based on sex. This conclusion is supported by the findings presented in Table 1, which provides the final results of the statistical analysis.

Table 1: Statistical analysis results of the digital skills dependence on the sex of the respondents

Variable	T- test: Grouping: Gender (Total digital skills) Group 1: Female Group 2: Male										
	Mean Female	Mean Male	t- value	df	p	Valid N Female	Valid N Male	Standard deviation Female	Standard deviation Male	F- ratio Variances	P Variances
Digital skills	1,9259	1,9791	-1,0244	427	0,3062	241	188	0,51092	0,5619	1,2097	0,1649

The analysis of digital skills by age groups, completed level of education, and working status involved the use of One-Way Analysis of Variance (ANOVA). One-Way ANOVA is a statistical technique used to compare means across multiple groups. The results of the One-Way ANOVA analysis revealed a statistically significant difference in the overall level of digital skills based on the completed level of education. Similarly, the results for the age groups of the respondents also led to the same conclusion, indicating a significant difference in digital skills proficiency among different age groups.

Table 2 presents the final results of the One-Way ANOVA analysis, specifically focusing on the digital skills categorized by the completed level of education. This table provides the relevant statistical values and outcomes of the analysis, offering insights into the variations in digital skills across different educational backgrounds.

Table 2: Statistical analysis results of the digital skills by the completed level of the respondents 'education

Effect	Univariate results Sigma- restricted parameterization Effective hypothesis decomposition				
	Degrees of Freedom	Digital skills High school	Digital skills Bachelor's degree	Digital skills Master's degree (and above)	Digital skills p
Intercept	1	795,5601	795,5601	3903,339	0,00
Completed level of education	3	35,3774	11,7925	57,859	0,00
Error	425	86,6215	0,2038		
Total	428	121,9989			

2.2 Comparative analysis of Croatia vs EU from the Perspective of Digital Skills

As a pertinent depiction of digital skills presence in the life of the average Croatian citizen, the authors also conducted a Eurostat based [8] secondary data analysis of the purposes for which individuals utilize the Internet such as energy management in the households [9], intelligent security solution [2], intelligent household appliances [6], virtual assistant [1], Smart TV [11], cloud computing [3] and e-public/e government services [5]. The findings of this analysis are presented Table 3 and Table 4, which provide valuable insights into the diverse ways in which digital skills are employed in various aspects of life.

Table 3: Intelligent internet solutions used by EU countries

	Energy management in the household		*Intelligent security solutions*		*Intelligent household appliances*		*Virtual assistant*		*Smart TV*	
	2020	2022	2020	2022	2020	2022	2020	2022	2020	2022
Austria	5,46	14,57	4,28	7,33	4,80	9,33	17,49	18,67	45,91	60,03
Belgium	10,25	14,13	12,14	12,67	3,57	9,56	8,84	6,46	:	51,16
Bulgaria	2,08	1,15	2,06	2,26	1,06	4,29	0,83	0,82	23,19	30,12
Croatia	**3,52**	**5,58**	**3,90**	**5,87**	**4,36**	**7,46**	**8,23**	**2,98**	**44,96**	**34,71**
Cyprus	1,07	6,59	11,11	10,62	0,85	10,25	4,31	5,44	48,14	65,67
Czechia	2,85	5,13	4,78	7,81	2,39	6,75	3,86	5,99	36,20	47,85
Denmark	11,45	14,57	14,53	16,61	12,05	19,72	19,35	21,68	62,50	65,51
Estonia	14,79	16,07	9,21	15,72	8,45	18,02	6,18	6,35	41,37	51,76
Finland	7,78	12,35	10,27	11,97	4,09	8,55	17,41	15,02	53,41	64,17
France	:	10,88	:	11,39	:	13,79	:	15,69	:	53,84
Germany	8,06	7,11	3,87	4,32	5,25	7,08	16,56	14,94	50,71	49,15
Greece	1,70	3,65	4,43	5,85	2,27	5,84	0,75	1,11	29,37	38,62
Hungary	4,44	5,18	5,67	6,54	3,86	6,53	3,82	3,02	37,71	49,04
Ireland	13,63	21,41	12,96	15,96	3,95	5,78	17,74	38,89	37,58	67,64
Italy	1,63	4,38	5,37	9,13	1,93	4,19	11,80	15,09	29,54	49,05
Latvia	3,44	4,69	4,27	5,40	3,39	8,60	4,02	2,33	46,43	48,59
Lithuania	2,45	5,31	4,86	8,08	4,50	12,12	1,70	3,03	31,24	42,66
Luxembou	12,39	10,74	13,15	14,81	7,99	12,19	12,12	14,59	57,02	60,98
Malta	8,25	8,67	13,11	13,95	11,34	19,80	16,79	16,92	72,19	77,76
Netherland	68,72	65,69	11,52	22,68	5,72	15,05	19,51	24,85	56,57	64,13
Poland	2,27	3,33	2,42	3,01	3,26	5,73	1,75	2,09	30,87	37,55
Portugal	4,00	6,34	5,19	5,85	4,42	8,71	7,62	7,33	43,85	52,43
Romania	0,66	2,09	1,65	3,30	0,93	3,79	0,90	1,41	24,92	39,75
Slovakia	2,53	3,94	4,24	6,26	4,06	11,89	3,56	4,32	42,96	59,37
Slovenia	10,03	9,28	6,01	8,45	13,91	17,54	14,32	13,88	40,86	49,29
Spain	7,85	11,77	8,88	11,48	10,09	16,34	16,86	23,51	66,39	69,34
Sweden	13,30	15,94	16,81	18,23	6,53	12,65	17,85	18,93	62,27	67,96

According visualized data (Table 3) related to the intelligent internet solutions, Croatia is statistically significantly behind Belgium, Denmark, Germany, Estonia, Ireland, Spain, France, Luxemburg, Slovakia, Finland and Sweden. On the other hand, Croatia is positioned as medium developed in relation to use intelligent internet solutions, since the mentioned solutions are used twice as small in Greece and five times less in Romania.

In the observed period (2020-2022) grows only the use of energy management in the households, intelligent security solutions and intelligent household appliances while virtual assistants and smart TV record a decline. While the level of adoption varies compared Croatia to other EU countries, Croatia evidently makes significant efforts to promote available energy management in households. More specifically, in Croatia, several initiatives have been implemented to promote energy efficiency, such as encouraging energy-efficient renovations,

utilizing renewable energy sources, deploying smart meters for better energy consumption management, and implementing Energy Performance Certificates for residential buildings. There is also a growing adoption of Energy Management Systems and Smart Home Technologies in the country, enabling homeowners to monitor and control energy usage, optimize heating and cooling, and automate energy-saving measures.

Notwithstanding the implementing of intelligent security solutions vary in terms of the scale and sophistication in Croatia compared to other EU countries, Croatia has made specific efforts in the following areas: (i) expanding video surveillance systems in public spaces and transportation hubs, (ii) utilizing surveillance technologies, biometrics, and border control systems to enhance border security and manage the flow of people and goods, (iii) establishing national cybersecurity strategies and initiatives to enhance cyber resilience, (iv) implementing, intelligent emergency response systems to improve public safety and response capabilities and (v) using intelligent security solutions, including access control systems, intrusion detection systems, and surveillance technologies, to protect critical infrastructure such as power plants, transportation networks, and telecommunications systems.

Furthermore, although the market is in developing phase compared to some larger EU countries, Croatia evident increase in the adoption of intelligent household appliances.The main drivers behind Croatia's progress include: (i) growing interest among homeowners in integrating smart devices for enhanced comfort, convenience, and energy efficiency, (ii) increasing demand for appliances with high energy ratings and smart features that optimize energy consumption and enable better control of energy usage, (iii) expanded availability of connected appliances, allowing remote control and monitoring, (iv) rising popularity of intelligent household appliances for home security and safety and (v) continual expansion of the availability and variety of intelligent household appliances in the Croatian market.

According data in Table 3, in terms of virtual assistants the market is still in developing phase compared to some larger EU countries. Insights into Croatian society reveal the following: (i) citizens frequently adopt virtual assistants for tasks such as voice commands, information retrieval, and home automation control, (ii) availability of Croatian language support slowly becomes crucial factor for virtual assistant adoption, (iii) Croatian homeowners increasingly use virtual assistants to control connected devices like lights, thermostats, and appliances through voice commands, (iv) virtual assistants in Croatia offer various services and skills, including general information, weather updates, news briefings, and basic tasks like setting reminders and timers, (v) concerns about personal data collection, storage, and usage are prevalent among Croatian users, leading to increased attention to data privacy regulations and user consent.

Onwards, Smart TV technology markets is also still in developing phase compared to some larger EU countries. Despite positive trends, the key points regarding Smart TVs in Croatia are: (i) increasing consumer interest in Smart TVs due to advanced features and internet connectivity, (ii) Smart TVs in Croatia provide access to streaming services, social media platforms, and online content, (iii) many Smart TVs in Croatia support the Croatian language, allowing users to access localized content and apps, (iv) Smart TVs offer interactive features such as web browsing, gaming, and social media integration, and (v) pricing and availability of Smart TVs in Croatia may vary based on brand, model, and screen size.

In addition, Table 4 presents cloud computing, public administration and usage of e-government by EU countries. Croatia in these digital skills types of use also stably maintains a middle positon in front of Bulgaria, Greece, Spain, Latvia and Hungary. It is interesting that in the most EU countries in 2022 in comparison with 2021 year, usage of internet in public administration as well as in e- government records a decline. The mentioned types of intelligent internet solutions during the period 2015 – 2021 records growth in all EU countries.

Table 4: Cloud computing, public administration / e-government usage and ICT experts by sex, by EU countries

	Cloud computing usage			Public administration / e-government			ICT experts bx sex					
							Man			Women		
	2015	2020	2021	2015	2020	2021	2015	2020	2021	2015	2020	2021
Austria	:	38,4	37,1	51,04	61,58	62,67	85,7	79,7	81,0	14,3	20,3	19,0
Belgium	:	:	:	41,96	46,22	58,55	84,9	82,6	80,4	15,1	17,4	19,6
Bulgaria	4,4	8,7	9,7	16,04	19,02	19,13	69,4	71,8	71,8	30,6	28,2	28,2
Croatia	**19,4**	**40,0**	**34,8**	**32,24**	**35,72**	**42,49**	**82,8**	**81,9**	**79,2**	**17,2**	**18,1**	**20,8**
Cyprus	6,0	27,1	43,9	31,00	48,01	55,87	79,2	81,8	80,7	20,8	18,2	19,3
Czechia	:	26,8	38,9	30,62	53,02	57,94	90,2	89,7	90,0	9,8	10,3	10,0
Denmark	34,5	66,6	62,8	85,51	88,63	90,60	79,6	77,0	77,1	20,4	23,0	22,9
Estonia	:	54,9	58,2	70,56	66,67	68,73	77,6	77,3	77,4	22,4	22,7	22,6
Finland	52,3	83,0	85,2	72,96	85,30	85,76	77,7	76,7	76,1	22,3	23,3	23,9
France	:	25,1	27,7	44,31	:	51,49	84,2	79,9	79,1	15,8	20,1	20,9
Germany	:	30,8	38,8	52,35	64,83	46,30	83,7	82,4	81,0	16,3	17,6	19,0
Greece	6,7	:	18,7	42,22	52,08	52,27	81,8	72,3	79,0	18,2	27,7	21,0
Hungary	9,4	23,3	24,8	38,56	59,57	72,14	87,9	87,7	86,0	12,1	12,3	14,0
Ireland	35,9	60,5	67,4	40,96	37,43	67,40	79,8	79,3	80,0	20,2	20,7	20,0
Italy	:	39,4	61,9	20,29	21,70	26,20	85,3	84,3	83,9	14,7	15,7	16,1
Latvia	7,7	19,1	26,7	51,76	68,19	67,78	73,4	77,2	77,4	26,6	22,8	22,6
Lithuania	14,5	30,6	35,3	42,31	53,71	56,84	79,5	76,4	76,3	20,5	23,6	23,7
Luxembourg	:	26,4	36,2	46,92	30,35	48,35	86,3	80,0	80,3	13,7	20,0	19,7
Malta	19,9	:	53,4	38,11	45,53	51,23	83,0	89,3	74,3	17,0	10,7	25,7
Netherlands	:	48,7	62,0	70,72	81,40	81,86	86,1	82,4	82,5	13,9	17,6	17,5
Poland	6,3	23,3	28,2	19,07	27,22	29,36	86,4	85,0	84,5	13,6	15,0	15,5
Portugal	:	24,2	29,4	39,61	39,13	41,80	82,4	78,8	79,3	17,6	21,2	20,7
Romania	6,0	15,7	11,2	9,01	10,05	10,81	72,7	73,8	74,0	27,3	26,2	26,0
Slovakia	19,4	24,5	33,8	43,71	51,39	51,84	88,1	84,2	85,1	11,9	15,8	14,9
Slovenia	16,2	38,9	42,9	41,12	56,50	60,79	83,8	82,8	83,4	16,2	17,2	16,6
Spain	12,7	24,6	27,9	45,25	54,10	56,10	81,9	80,7	80,6	18,1	19,3	19,4
Sweden	:	75,4	76,9	69,21	79,21	85,46	81,1	78,7	78,1	18,9	21,3	21,9

Although cloud computing adoption in Croatia is still in the early stages compared to larger EU countries, the current status in Croatia are: (i) global cloud service providers like Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform are present,(ii) many organizations in Croatia utilize cloud services for storage, data backup, SaaS applications, and IaaS solutions, (iii) the Croatian government promotes cloud computing adoption in the public sector, (iv) data protection and compliance with EU regulations, particularly GDPR, are essential in Croatian cloud computing and (v) Croatia is increasingly focusing on developing local cloud capabilities, including national cloud infrastructure and data centers.

Croatia makes efforts to advance e-government services and digitize public administration too. Regarding the digitization of public services in Croatia: (i) the Croatian government has focused on providing online access to government services through the e-Citizens portal, (ii) the e-Citizens system offers a secure digital identity for citizens to access e-government services, (iii) efforts have been made to enhance interoperability among government systems and improve data exchange between agencies, and (iv) the government has encouraged citizen participation and engagement through online channels. Croatia's digital maturity level in public administration seems at an earlier stage compared to some EU countries. The pace of adoption and breadth of digital services may vary across different government agencies and regions.

As far as sex representation in ICT is considered, data in Table 4, in the observed period, every EU country records more than three or four times less women than men in ICT sector. Historically, the representation of women in the ICT sector has been relatively low in Croatia, as is the case in many countries worldwide. However efforts have been made in Croatia to promote sex diversity in ICT careers through educational programs, scholarships, and initiatives [14]. The government, along with organizations and industry stakeholders, implements initiatives to encourage women's participation in ICT education and careers, address sex biases and provide mentorship and networking opportunities.

3 CONCLUSION REMARKS

This paper presents a comparative analysis of digital skills between Croatia and other EU countries. It is part of an ongoing research project that aims to address various scientific questions related to digital skills in Croatia. The research conducted by the authors includes statistical analysis and interpretations of empirical research results. Croatia's participation in EU initiatives, along with the anticipated expansion of intelligent household appliances, virtual assistants, Smart TVs, cloud computing, and e-government capabilities, demonstrates the country's potential for further digital advancement. By embracing these trends and aligning with best practices, Croatia can foster a digitally empowered society and drive socio-economic growth.

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