Assessing the needs for ICT skills and competences in public administration personnel

Dragoș SMADA, Irina CRISTESCU

Institutul Național de Cercetare-Dezvoltare în Informatică – ICI București

dragos.smada@ici.ro, irina.cristescu@ici.ro

Abstract: The current challenge from the digital perspective is having a set of skills that will allow not only the enrolment in a certain job, but also the possibility of being involved in the permanent education and training process. In today's automated, globalized and extremely dynamic society, employees (and we refer here also to those in public administration) are put in new, non-standardized situations, which they must solve efficiently and quickly. It is also necessary that the staff employed could manage new information, but also be able to generate new knowledge. Roles which until now did not require a certain training or roles that needed only a basic training are subjected to a review process from the perspective of the competences that the staff employed must perform. Basically, employees must prove their digital skills and also improve them. Based on the analysis of the literature, the authors presented a set of requirements regarding the development of an online tool for measuring digital skills in public administration and also details regarding the chosen technical solution.

Keywords: digital skills, key competences, public administration, methodologic requirements, measurement instrument.

Evaluarea abilităților și competențelor TIC ale personalului din cadrul administrației publice

Rezumat: Provocarea actuală din perspectivă digitală o reprezintă deținerea unui bagaj de competențe care să permită nu doar încadrarea într-un anumit loc de muncă, ci și posibilitatea implicării în sistemul permanent de educație și formare destinat indivizilor. În societatea actuală automatizată, globalizată și extrem de dinamică angajații (și ne referim aici și la cei din administrația publică) sunt puși în situații noi, nestandardizate, pe care trebuie să le rezolve eficient și rapid. De asemenea, este necesar ca personalul angajat nu doar să gestioneze informații noi, ci și să genereze cunoștințe noi. Funcții care până în prezent nu necesitau o anumită pregătire sau funcții care necesitau doar o pregătire de bază sunt supuse unui proces de revizuire din perspectiva competențelor pe care personalul angajat trebuie să le îndeplinească. Practic, angajații trebuie să facă dovada competențelor deținute și, de asemenea, să le îmbunătățească. Pe baza analizei literaturii de specialitate în domeniu, autorii au prezentat un set de recomandări privind elaborarea unui instrument online destinat măsurării competențelor digitale în administrația publică și detalii privind soluția tehnică aleasă.

Cuvinte cheie: competențe digitale, competențe cheie, administrație publică, cerințe metodologice, instrument de măsurare.

1. Introduction

Nowadays, digital technologies are transforming every area of economic and social life. Digital skills are essential to guarantee that individuals can benefit of modern technologies and their potential for job creation. Moreover, digital skills are critical for the successful digitization of the industry, and for reducing the high level of unemployment in Europe (DigitalEurope and the EC's skills strategy, 2016).

Companies and public services are investing in advanced digital technologies such as mobile communications, cloud computing, big data analytics and smart devices in order to increase efficiency. The adoption of these technologies has a great transformative power, not only because it implies adding genuine value to society, but also due to the tools that are provided for the next generation of entrepreneurs across Europe.

https://doi.org/10.33436/v30i1y202004

The introduction of ICT competences arose in a particular socio-economic context. Due to the major changes that have occurred in the last decades, there has been a change in the model pertaining to the educational area, namely the shift from acquiring knowledge to training skills. The paradigm shift is dictated by the profound change of the society reflected in domains such as economy and information technology. The defining elements of the strategy and policies for the knowledge-based society involve the development of the IT infrastructure, the creation of appropriate software tools, the development of digital content and especially the creation of skills for the use of information, and its use for its own benefit (Anghel and Neagoe, 2015).

Although there is still a significant number of reluctant people concerning information development, most citizens are convinced of both the usefulness and the strength offered by new technologies. As long as the use of technologies brings an advantage or a gain, the citizens will accept the technological innovation. As a result, it is very important that the information society develops in accordance with the needs of its citizens (Banciu et al., 2019).

The change arisen from the digital revolution can be addressed through the skills demand and the adapting working models. Thus, young people and employees must constantly increase their knowledge base, skills and competences throughout their life (DigitalEurope and the EC's skills strategy 2016). Education and training, both based on new information and communication technologies, aim to replace some of the current structures with a new and higher spectrum of performance in dealing with inherent changes in culture and civilization (Sandu and Dumitrache, 2019).

The European Commission has prioritized and supported the development of digital skills through a series of policies and actions, working with Member States to support learners, employees, jobseekers and innovators in all areas. The modernization and the efficiency of public administration are key objectives to be meet by Romania and other European countries in order to face the current and future economic and social challenges. These objectives are undertaken within the Europe 2020 Strategy and in the strategic documents at national level.

In Romania, the National Strategy for the Digital Agenda for Romania (SNADR) represents the national strategic framework for digital growth aimed at stimulating public and private ICT-based services. The points provided in this strategy must also be achieved through the digital competences of the central public administration personnel. This result represents the starting point for an original research on the digital competences needed in the central public administration for the effective implementation of SNADR.

The aim of this article is to contribute to the development of knowledge in the field by providing specific requirements for elaborating an online instrument (questionnaire) for measuring digital skills in public administration.

The article is structured as follows. Section 2 presents a theoretical approach of the digital skills. In section 3 the requirements for developing an online instrument (questionnaire) are highlighted. Section 4 describes an inventory of software tools that can be used for this development and for the management of the data provided by the online questionnaire. Conclusions and bibliography are provided in the final sections.

2. ICT competences and skills

Being digital competent refers to both accessing and using information and communication technologies, and possessing the adequate knowledge, skills and competences in relation to them. Digital competence is one of the eight key competences, bringing forth the confident and critical use of the entire ICT range in all areas.

The skills and knowledge in the field of Information and Communication Technology (ICT) are essential for the development of an efficient research and innovation system within an intelligent economy. In addition, ICT usage and development skills are new factors that stimulate employment and research and development in Europe. Excluding a part of the population from the society and economy based on digital information counteracts the important multiplier effect that ICT adoption has on innovation and productivity growth.

Digital skills have become key concepts in discussing the type of skills needed for citizens (both in Europe and outside Europe) to participate and thrive in today's society (European Commission, 2010; Ferrari, 2012; Gallardo-Echenique et al., 2015), not only in terms of regarding the social and digital inclusion of citizens, but also with regard to employment and economic growth (European Commission, 2016; Vuorikari et al., 2016; Ferrari, 2013; Lavin and Kralik, 2009; Lanvin and Bassman, 2008).

To better understand the nature of the digital competence, the European Commission has designed the European Digital Competence Framework also known as DigComp. DigComp was first published in 2013 as a reference framework to support the development of digital skills of people in Europe.

The Reference Framework (2013) sets out eight key competences: 1. Communication in the mother tongue; 2. Communication in a foreign language; 3. Mathematical competence and basic competences in science and technology; 4. Digital competence; 5. Learning to learn; 6. Social and civic competences; 7. The sense of initiative and entrepreneurial spirit; 8. Cultural awareness and expression. All the key competences are considered equally important, as each of them can contribute to a successful life in a knowledge society. Many competencies overlap and intersect, and aspects essential to one domain will support competency in another.

Digital competence involves the confident and critical use of information society technology (IST) for work, leisure and communication. It is supported by basic ICT skills such as: the use of computers for retrieval, evaluation, storage, production, presentation and exchange of information and communication and participation in collaborative networks over the internet (European Parliament and Council of the EU, 2006).

DigComp describes the competences needed to use digital technologies in a secure, critical, collaborative and creative way in order to achieve the objectives related to work, learning, leisure, inclusion and participation in our digital society. It can be used in different sectors, disciplines and systems in order to develop digital skills. Thus, digital competences imply the ability to search, collect and process information and use it in a critical and systematic way, assessing the relevance, while also recognizing the links between them, the use of tools to produce, present and understand complex information and the ability to access, search and use Internet-based services, use of IST to support critical thinking, creativity and innovation.

DigComp outlines five areas that define the competent digital citizen: (1) digital and information literacy, (2) communication and collaboration, (3) digital content creation, (4) security and (5) problem solving (table 1).

Table 1. DigComp areas and competences [adapted from Kluzer and Priego (2018)]

Competence areas	Competences
Information and data literacy	Browsing, searching and filtering data, information and digital content
	Evaluating data, information and digital content
	Managing data, information and digital content
Communication and collaboration	Interacting through digital technologies
	Sharing information and content through digital technologies
	Engaging in citizenship through digital technology
	Collaborating through digital technologies
	Netiquette
	Managing digital identity
Digital content creation	Developing digital content
	Integrating and re-elaborating digital content

	Copyright and licenses
	Programming
Safety	Protecting devices
	Protecting personal data and privacy
	Protecting health and well-being
	Protecting the environment
Problem solving	Solving technical problems
	Identifying needs and technological responses
	Creatively using digital technologies
	Identifying digital competence gaps

Developing digital skills means more than just using the latest device or software. The digital competence is a cross-cutting competence key that involves the use of digital technologies in a critical, collaborative and creative way, including aspects such as information storage, digital identity, digital content development and online behavior, work, shopping and social participation.

DigComp supports the global understanding of digital competence, including issues such as information storage, digital identity, digital content development and online behavior, work, shopping and social participation.

Two other approaches have been developed for the purpose of investigating and assessing the level of digital skills of the global workforce: Cedefop and the OECD. Cedefop European Skills and Jobs (ESJ) (2015) distinguishes between basic, moderate and advanced ICT skills, which refers to the different levels of competence and tasks exercised by the individual:

- *Basic ICT skills*: using a PC, tablet or mobile device for email, internet browsing;
- *Moderate ICT skills*: word-processing, using or creating documents and/or spreadsheets;
- *Advanced ICT skills*: developing software, applications or programming; use computer syntax or statistical analysis packages.

The Organisation for Economic Co-operation and Development (OECD, 2004) differentiates between basic users, advanced users and ICT specialists taking into consideration the employed workforce. The basic users are competent users of generic tools (e.g. office software, e-mailing and other internet-related tools) needed for the information society, e-government and working life. The advanced users refer to competent users of advanced, and often sector-specific, software tools. The ICT specialists imply users with the ability to develop, operate and maintain ICT systems.

In 2016, OECD has adopted the concept of generic, specialist and complementary skills to identify the three main lines along which new digital skills are required. The ICT generics skills are those necessary to program, develop applications and manage networks. The ICT generic skills are necessary when using such technologies for professional purposes, while the ICT complementary skills are needed to perform new tasks associated to the use of ICTs at work (e.g. to communicate on social networks etc.).

3. Requirements for developing an online instrument

Van Deursen, Helsper, Eynon (2014) identified three main basic methodologies used to investigate levels of digital skills, while pinpointing the main pitfalls and benefits of each method:

- *Surveys with questions that offer indirect evidence for the command of skills*: method used for large benchmark surveys with the downfall of not clearly identifying the relation between the use of an application and the skill;
- *Surveys with questions that request self-assessments of skills*: the most used method, which can originate bias in terms of overrating and underrating skills;

- *Performance tests*: the most reliable methods in terms of internal validity, but very costly, time consuming and difficult to implement on large scale.

For example, the OECD Programme for the International Assessment of Adult Competencies (PIAAC) survey offers a direct measurement of adult digital skills. It has been used to measure the demand for ICT skills at work (OECD 2015), and to measure and assess level of skills and mismatches in the workplace (Pellizzari, Biagi and Brecko, 2015).

The questionnaire represents a technique and, correspondingly, an investigative instrument consisting of a set of written questions which, by the administration by the survey operators or by self-administration, determine from the persons surveyed the answers to be recorded in writing (Chelcea, 2001). The technique of the questionnaire does not start with asking questions. The subject must be clearly defined and has to be translated into an operational definition, followed by the establishment of the set of indicators. These indicators are formulated as questions in the questionnaire. Of course, not all questions represent indicators: introductory questions, as well as passing questions, cannot have this significance.

The formulation of the questions must be clear, simple, without stylistic flourishes, grammatically correct, respecting the topic of the sentence or sentence. The use of negations in the formulation of questions makes it difficult to codify the answers. The degree of abstraction of the questions should correspond to the level of education of those included in the survey. In the case of international comparative research, the adjustment of the questionnaire should also be considered. The questionnaire structure and presentation must lead to valid and reliable data from respondents. It should ask relevant questions so the data can be collected efficiently and with minimum errors, while facilitating the coding and capture of data and minimizing the amount of editing and imputation that is required (Brancato, 2005).

The development of the questionnaire aimed to identify the need for ICT skills in the public administration must be based on the specifications highlighted in table 2. The specifications are based on the recommendations and best practices proposed in the specialized literature (Chelcea, 2001; Marginean, 2000).

Table 2. Requirements for developing an online questionnaire

Measurement instrument (questionnaire) requirements
The measurement instrument must be defined by considering the theme of the project and the entities to be evaluated
The measurement instrument has to be developed taking into consideration the project's objectives
The measurement instrument must be developed on the basis of preliminary documentation
The measurement instrument must take into account the population to which the project is addressed to
The elaboration of the measurement instrument is based on the development of the theoretical framework of the study (problem theory)
When elaborating the measurement instrument, the hypotheses (that are to tested by applying the instrument) need to be taken into consideration
Selection of information sources: specifying the sources that will be used for data collection
Requirements regarding the specification of the studied population - the fulfillment of the requirements that demand the compatibility between the strategy used and the investigated population.
Requirements regarding the construction of variables (qualitative description) - process of transition from concepts to dimensions, indicators and empirical indices.
Requirements regarding the quantification (quantitative description)
Requirements regarding the research methods that are chosen according to the proposed objectives
Establishing the working techniques - meeting the requirements regarding the suitability of each working technique and the objectives pursued.

Data collection requirements
Identifying the sample
Applying the measurement instrument
Control of the data collection process
Data processing requirements
Fulfillment of the requirements regarding the resulting information: completeness, accuracy and uniformity
Fulfillment of the requirements related to the data processing techniques
Meeting data processing requirements: the existence of licensed statistical tools
Data analysis (hypothesis verification): explaining the hypotheses around which the explanation and interpretation of the research results are built.
Data processing requirements
Interpretation of research results
Drafting and finalizing the analysis report: meeting the requirements regarding analyzing and interpreting the data, explaining the phenomenon, proposals for solving the studied problems
Solution implementation

4. Technological stack

Although there are many options for developing such tools, based on the team's experience, the solutions which are presented below were chosen. The Agile methodology is integrated in the team's development style and was for developing the system for generating questionnaires. Specifically, the Scrum methodology - a subset of Agile - was used, which is one of the most popular iterative approaches to software development today. The work is accomplished in fixed development cycles, called sprints, which in this case are planned for two weeks and allow the development team to deliver results rhythmically. At the end of each sprint the team members meet to plan the next steps and assign tasks between team members.

4.1. Django Rest Framework

Django Rest Framework (DRF) was used for developing the Middleware. DRF is an open-source web application development framework, written in Python, which follows the Model-View-Controller architectural model.

Python is a multifunctional language used both for programming a wide range of application, largely used in the research community. At its core, Django is based on a collection of libraries, written in Python, that assist the rapid development of websites by reusing the code and modularity. The advantage is that it handles of a lot of web development difficulties which often appear when writing the code from scratch.

The main advantages that have to be taken into consideration when using Django, are as follows:

- *Security:* Django helps developers to avoid many security errors by allowing protection against most vulnerabilities by default. From the secure way to manage user accounts and passwords to the SQL Injection protection, cross-site scripting, cross-site request forgery;
- *Portability:* being written in Python, applications developed in Django can run on any platform such as Linux, Windows, Mac OS X;
- *Versatility:* Django can be used for the development of almost any type of website such as content management, news sites, e-commerce sites, social networking sites, wiki, etc.

Using the MVC paradigm, each distinct part of a Django application has a key purpose and can be independently modified without affecting the other parts. A developer can change the URL for a particular part of the application without affecting the basic implementation, a designer can change the HTML of the page without interfering with the Python code that runs it, a database administrator can rename a database table and specify the change in one place, rather than searching for and replacing them in a multitude of files (Holovaty and Moss, 2008).

Django also offers an administrative panel, optional, through which you can easily create, read, update and delete the related information from the database. This management panel is generated based on the tables in the database and the links between them. It also has support for relational databases like PostgreSQL, MySQL, Oracle or SQLite, but different community libraries offer support for other SQL and NOSQL databases.

Django Code Structure

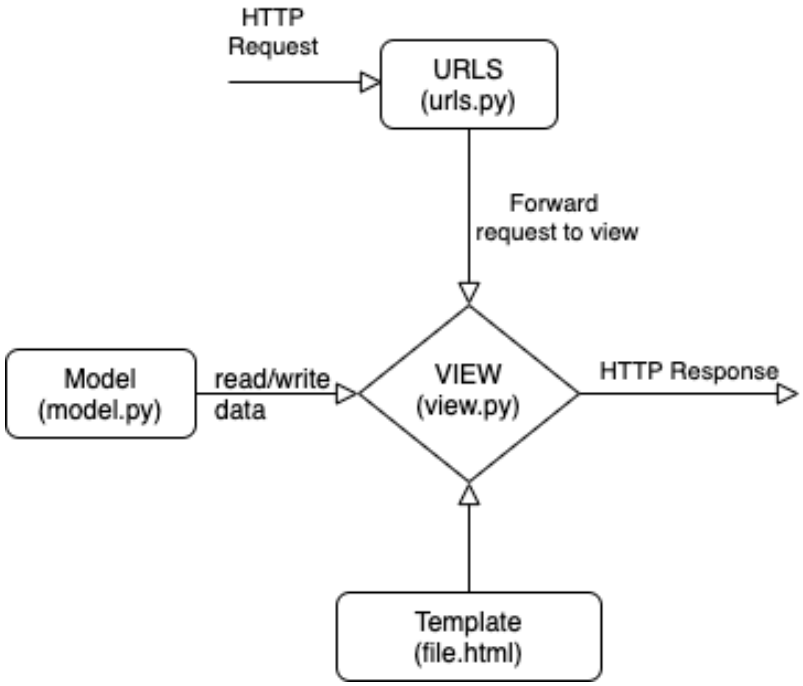

Figure 1. Django Code Structure

The *URLS* mapping component redirects HTTP requests and forwards the patterns of strings or numbers as data to the functions of the VIEW component. *The View* component handles HTTP requests and returns responses. Through its functions, it accesses the data needed to satisfy the requests through the models and formats the template responses. The *Models* are Python objects that define application data structures offering data management (create, update, read, delete) from the database. A *Template* is a text file that defines the structure of a file. For example, a view can dynamically create an HTML page using an HTML template or any other file type, populating it with data from a template.

4.2. MySQL

MySQL is a relational database management system based on SQL (Structured Query Language). In MySQL data is stored in multiple tables that are connected by unique keys.

A relational database management system uses a logical database model called the entity / relationship model described by Chen (1976). This model is represented by entity / relationship diagrams and has the following objects:

- *Entity*: the object that is uniquely identifiable;
- *The property*: defines a feature of the entity or relationship, being able to take;
- *The relationship:* defines an association between entities. The number of entities that appear in a relationship is called the degree of the relationship. Relationships can be one-to-one, one-to-many or many-to-many.

Database systems in particular have three types of information representation structures at operational and logical level: the tree model, the relational model and the network model.

The relational model considered most important comprises three main components:

- Composition of data by determining relationships;
- Data integrity through strict use of restrictions;
- Manipulation of data by using relational calculus or operations in relational algebra.

The database schema is the set of all the relational schemas corresponding to an application, while the content of the relations at a given moment is called the relational database.

4.3. CodeIgniter

CodeIgniter is a PHP framework containing a set of tools to create full-featured web applications. It contains many libraries, helpers, plug-ins and other resources that handle complex PHP procedures and functions, and it simplifies the PHP syntax and rationalizes code underlying webpages.

Like other web scripting languages, PHP allows the provision of dynamic web content, (automatically changes from day to day or from minute to minute). PHP runs on the Web server having access to files, databases, and other resources.

CodeIgniter is a Model-View-Controller (MVC) based system with some major benefits like:

- Complete database classes integrating support for multiple platforms;
- Active database support (ORM);
- A custom routing system;
- Validation of forms and data and XSS security and filtering;
- Cache-in system etc.

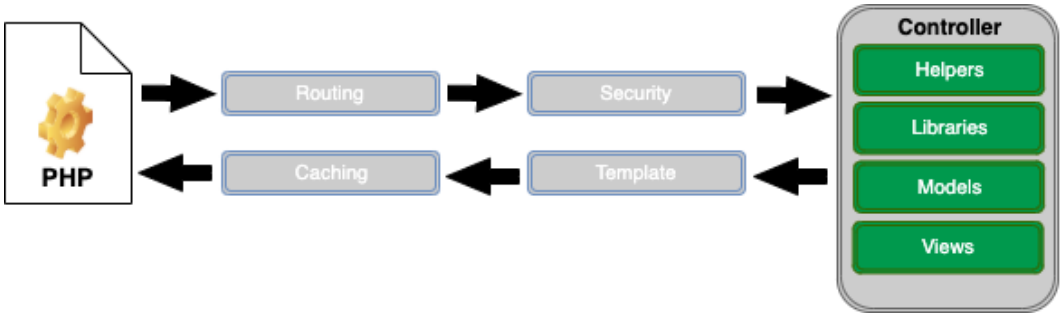

Figure 2. Work flow on CodeIgniter

4.3.1. Bootstrap

Bootstrap is one of the most popular JS, HTML and CSS frameworks for web application development. Bootstrap is based on a large collection of tools consisting of CSS and HTML templates for various buttons, navigation, forms, typography, and other interface related components:

Table 3. Major Bootstrap Properties

Scaffolding	Components	CSS	JS Plugins
Layout Grid systems Fluid grid Responsive design	Dropdowns Navigation bar Breadcrumbs Alerts Progress bar Reusable components	Typographic Tables Forms Buttons Icons	Modals Tabs Carousel Typeahead

Bootstrap is built on 12-column grids, layouts and components. Divide the web page into 12 columns with percentage values equal. By merging these columns, you can get the boxes you want to add content to the site.

The grid system has 12 columns at a width of 940px. The grid adapts to 724px and 1170px, depending on the width of the device you are viewing. Below 767px the columns become fluid and order vertically.

4.3.2. Highcharts JS

Highcharts is a pure JavaScript based charting library and a SVG-based multi-platform, which can add interactive, mobile-optimized diagrams for web applications. For example, line charts, spline charts, area charts, bar charts, pie charts and so on.

Among the important features are:

- Support for most popular languages, such as .Net, PHP, Python, R, and Java, as well as iOS, and Android, and frameworks like Angular, Vue and React;
- Data can be handled over to *Highcharts* in any form, even from a different site, and a callback function used to parse the data into an array;
- The free *Highcharts Editor* enables developers to embed a full-featured charts editor to a web app with just a few lines of code;
- The *Highcharts Debugger* will help you speed up development by providing instantaneous warnings and error reports above your charts;
- The largest developer community of any premium charting tool;
- Extendable and pluggable for experts seeking advanced animations and functionality etc.

The solution can be further enhanced by applying the questionnaire periodically (for example each year) and use the stored results for future retrieval and processing using machine learning algorithms suited for solving classification and regression problems. The main objective of this process is to obtain a personalized profile which can be continuously updated and improved (Boncea et al., 2019).

5. Conclusions

One of the EU's goals is to increase the digital skills and competences of adults by creating the necessary framework for adult people to be able to develop and update their key competences throughout their lives. Hence the obvious need to create a favorable environment for lifelong learning, allowing people to adapt, to change, and to develop their skills so that every adult can meet a wide range of demands imposed by the contemporary society.

Digital skills are an important part of the larger professional key skills. When we refer to them, we see them as conditional means to successfully combine knowledge, skills and attitudes with a view to completing the tasks that must be performed in the workplace.

The development of measuring instrument in order to be applied in specific context, requires a coherent approach that includes evaluation criteria, procedures, methods and techniques of evaluation. In this study different topics were presented from a methodological perspective, thus contributing to the development of knowledge in the field and the creation of a general framework for the development of online instruments in the public administration field.

The requirements for developing specific measurement instruments (e.g. questionnaire) and the inventory of software techniques provide a general framework that can be used in academic research for conducting empirical studies to investigate the levels of digital in public administration.

REFERENCES

1. Anghel, M., Neagoe, A. (2015). *Nivelul de digitalizare al guvernării electronice din România*. Romanian Journal of Information Technology and Automatic Control, 25(4), 19-26.
2. Banciu, D., Petre, I., Smada D., Sandu I. (2019). *Online system for assessing the implementation of the Digital Agenda in Romania*. Romanian Journal of Information Technology and Automatic Control, 29(3), 7-18.
3. Boncea, R., Petre, I., Vevera, V., Gheorghita, A. (2019). *Machine Learning Based Methods Used for Improving Scholar Performance*. The International Scientific Conference eLearning and Software for Education, 2, 471-478.
4. Brancato, G. et al. (2005). *Handbook of Recommended Practices for Questionnaire Development and Testing in the European Statistical System*, European Commission, 142 p.
5. Chelcea, S. (2001). *Metodologia cercetării sociologive. Metode cantitative și calitative*. București, Editura Economică, 656 p.
6. Chen, P. (1976). *The Entity-Relationship Model - Toward a Unified View of Data*. ACM Transactions on Database Systems, 1(1), 9-36.
7. DIGITALEUROPE and the EC's skills strategy 2016. (2016). *Recommendations from DIGITALEUROPE Boosting the skills for the future of digital Europe*. https://www.digitaleurope.org/wp/wp-content/uploads/2019/01/DIGITALEUROPE%20-%20Position%20paper%20on%20Digital%20Skills.pdf.
8. European Commission (2016). *Europe's digital progress report 2016*. https://ec.europa.eu/digital-single-market/en/download-scoreboard-reports.
9. European Commission. (2010). *Europe's Digital Competitiveness Report*. Luxembourg: Publication Office of the European Union.
10. European Parliament and Council of the EU. (2006). *Recommendation of the European Parliament and of the Council on key competences for lifelong learning*. https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:394:0010:0018:en:PDF.
11. Ferrari, A. (2012). *Digital Competence in Practice: An analysis of Frameworks. JRC Technical Report, European Commission - Joint Research Centre*. Luxembourg: Publications Office of the European Union, 95 p.
12. Ferrari, A. (2013). *DIGCOMP: A Framework for Developing and Understanding Digital Competence in Europe.* European Commission Joint Research Centre, Institute for Prospective Technological Studies. Luxembourg: Publications Office of the European Union.

13. Gallardo-Echenique, E., Minelli de Oliveira, J., Marques-Molias, L. and Esteve-Mon, F. (2015). *Digital Competence in the Knowledge Society*. MERLOT Journal of Online Learning and Teaching, 11(1), pp. 1-16.

14. Holovaty, A., Moss J.K. (2009*). The Definitive Guide to Django: Web Development Done Right*, 536 p.

15. Kaczmirek, L. (2005). *Web Surveys. A Brief Guide on Usability and Implementation Issues*. In M. Hassenzahl, & M. Peissner (ed.), Usability Professionals, 102-105. German Chapter of the Usability Professionals Association.

16. Kluzer, S., Priego, L.P. (2018). *DigComp into Action - Get inspired, make it happen. A user guide to the European Digital Competence Framework*. Joint Research Center. Luxembourg: Publications Office of the European Union, 140 p.

17. Kuk, K., Petar, M., Spalevi, M., Goci, M. (2019). *Algorithm design in Python for cybersecurity*. Electrotechnical and Computer Science Conference, ERK, Slovenia.

18. Lanvin, B. and Bassman, P. (2008). *Building E-skills for the Information Age.* The Global Information Technology Report 2007-2008, 77-90.

19. Lavin, B., Kralik, M. (2009). E-Skills: *Who Made That Big Dent in My Flat World?* Information Technologies and International Development, 5(2), 81-84.

20. Marginean, I. (2000). *Proiectarea cercetării sociologice*. Iași: Ed. Polirom, 256 p.

21. OECD (2004). *The ICT productivity paradox - evidence from micro data*. OECD Economic Studies No.38. http://www.oecd.org/eco/growth/35028181.pdf.

22. OECD (2015). *Digital Economy Outlook 2015*. Paris: OECD Publishing.

23. OECD (2016). *Key ICT Indicators*. http://www.oecd.org/internet/ieconomy/oecdkeyictindicators.htm

24. Pellizzari, M., Biagi, F. And Brecko, B. (2015). *E-skills Mismatch: Evidence from PIAAC*. Digital Economy Working Paper, Institute for Prospective Technological Studies.

25. Sandu, I. E.; Dumitrache, M., *E-Learning Process through Cloud Facilities*, Proceedings of the 15th International Scientific Conference "eLearning and Software for Education" (eLSE); Bucharest Vol. 2, pp. 487-493. Bucharest: "Carol I" National Defence University. (2019) DOI:10.12753/2066-026X-19-137, ISSN 2066 – 026X, WOS:000473324400067.

26. Van Deursen, A., Helsper, E. and Eynon, R. (2014). *Measuring Digital Skills. From Digital Skills to Tangible Outcomes project report.* https://www.researchgate.net/publication/267037582_Measuring_Digital_skills_From_Digital_Skills_to_Tangible_Outcomes_project_report.

27. Vuorikari, R., Punie, Y., Carretero, S., Van den Brande, L. (2016). *DigComp 2.0: The Digital Competence Framework for Citizens*. Update Phase 1: The Conceptual Reference Model. Joint Research Centre. Luxembourg: Publication Office of the European Union.

Dragoș SMADA a absolvit Facultatea de Electronică, Telecomunicații și Tehnologia Informației, Universitatea Politehnică din București. Absolvent de Master în Managementul Informațiilor și Documentelor din cadrul Universității București. În prezent este cercetător științific la ICI București. Principalele sale domenii de interes sunt Big Data, Internetul obiectelor, inginerie software, securitate informatică, arhitectură software. A participat în proiecte de cercetare naționale și internaționale din domeniul TIC și a publicat rezultatele în articole de specialitate din reviste și conferințe IT.

Dragoș SMADA graduated the Faculty of Electronics, Telecommunications and Information Technology at the Polytechnic University of Bucharest. He has a Master's Degree in Information and Documents Management at the University of Bucharest. He is currently a scientific researcher at ICI Bucharest. His main areas of interest are Big Data, Internet of Things, software engineering, information security, software architecure. He participated in both national and international research projects in the IT&C. He published as author and co-author of journal articles and scientific presentations at conferences.

Irina CRISTESCU este cercetător științific în cadrul departamentului "Sisteme și aplicații pentru societate" din ICI București. A obținut titlul de doctor în Sociologie la Universitatea din București în anul 2011. Principalele domenii de interes pentru activitatea de cercetare includ: e-Health, internetul obiectelor, acceptarea tehnologiei, metode statistice avansate.

Irina CRISTESCU is a scientific researcher in the "Systems and Applications for Society" department of ICI Bucharest. She received the PhD degree in Sociology from the University of Bucharest in 2011. Her research interests include: e-Health, Internet of Things, technology acceptance, advanced statistical methods.