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DOCTORAL THESIS

**CONTRIBUTIONS REGARDING THE
DEVELOPMENT OF A SYSTEM FOR
MONITORING THE IMPLEMENTATION OF THE
INFORMATION SOCIETY**

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ABSTRACT



In the current context of modern society, more and more aspects of citizen life, but also personal life, are computerized and carried out with the help of electronic means.

It can be said that the emergence of electronic services has led to the construction of a new social order which in turn creates a generation of citizens familiar with the services and operations of the information society.

The digital development that can be found in almost all plans and layers of society in recent years demonstrates that a system that centralizes and can provide a measure of the degree of implementation of ICT services in Romania is imperative.

More and more citizens carry out an important part of their daily activities in the online environment, as a result, they have expectations from the services they access in this environment. Taking advantage of the advantages offered by the European Union, we can travel and work anywhere in the EU, but the Internet is not limited by physical borders. It is normal to benefit from quality content and services, regardless of the physical position in the country or the European Union, and for this, it is necessary to ensure the interoperability of devices, applications, networks, and electronic services.

The present thesis aims to analyze the specific indicators of the information society and contribute to a system for monitoring the implementation of the information society in Romania, through the development and detailed presentation of two functional systems: IndMSI and DigComp. The work represents both a source of information and a methodology regarding management practices in the field of implementing projects specific to the information society.

The European Union supports the digitization area of its economies, societies, and citizens by establishing a new funding program called "Digital Europe". The program aims for institutions and companies to take advantage of digital transformation opportunities. A reduction of the existing digital divide is urgently needed, with a focus on increasing the competencies and knowledge needed by citizens to be an integral part of and fully benefit from the information society.

The novelty of the research consists in the analysis, identification, and synthesis of the best practices for monitoring the development of the information society and the development of functional systems in this endeavor. The work can be considered to be a source of information as well as a guide on good managerial practices in the development of useful tools for monitoring developments in the information society.

The research activity was capitalized through specialized scientific works in magazines in the field, as well as through participation in conferences, and scientific and technological events.

Methodology

The work includes a series of studies aimed at understanding the vision and processes that take place in the information society. We carried out multiple research activities based on documents issued by the European Commission, the Government

of Romania, the Ministry of Communications and for the Information Society, the National Authority for Administration and Regulation in Communications, the Agency for Digitization of Romania, publications from specialized literature, technical specifications, technical documentation, best practice guides, regulations and recommendations of the European Commission.

In the systems developed I used the results:

- I led the team of researchers and developers that developed a questionnaire in the field of digital competencies;
- I led the team of researchers and developers that implemented an online platform for monitoring the indicators provided for in SNADR, a platform that we made available, through ICI Bucharest, free of charge, to the Ministry of Communications and the Information Society.

The novelty of the research

This paper synthesized information on the implementation of projects specific to the information society. Based on the analyzed data, two operational IT platforms were created, through projects coordinated and managed by the author of this thesis.

Valorization of research results

The research activity was capitalized through the developed platforms and the elaboration of specialized scientific works published in journals in the field, as well as through participation in national and international conferences.

The results of the research were used by the Ministry of Communications and for the Information Society, later taken over by the Agency for Digitization of Romania, ICI Bucharest, the institutions involved in monitoring the indicators provided for in SNADR, but also other entities and persons interested in monitoring the implementation of the information society.

The work is structured into **5 main chapters and a chapter for conclusions**.

Chapter 1, The current state of the information society, is focused on defining the concept of "Information Society" and presenting a brief history of the information society. This history is made from the origins of the computer and the first computing engines to the microelectronics revolution and modern computers, culminating in the revolution of users and the Internet.

The issue of the current information society and the need for the sustainable development of electronic services for the benefit of citizens and the business environment were addressed. In the first part of this chapter, disruptive technologies are addressed with an emphasis on artificial intelligence (AI), and in the second part, informational globalization in Romania is discussed through the lens of communications infrastructure and strategic measures to increase digitization.

In *Chapter 2, Policies and strategies, national and international, regarding the information society*, the importance of the concept of e-government is presented. This emerges from fundamental considerations for actions that encourage the widespread adoption of digital technology as a key element for a competitive economy, enabling government to redefine its role and focus attention on citizens and reduce the costs of public services, without negatively affecting their quality. Important strategies at the European and national levels are presented as well as programs to support the implementation of electronic services.

The chapter continues with indicators specific to the information society, and the main areas for monitoring the implementation of the information society are

presented, with an emphasis on the Digital Economy and Society Index, DESI, and on the indicators established by the National Strategy for Romania's Digital Agenda. The situation of Romania in relation to other Member States is presented, as well as strong and weak points of Romania in the chapters Connectivity, Human capital, Internet use, Integration of digital technology, and Digital public services.

In *Chapter 3, Case study – Digital competencies and their evolution in the context of the information society*, the situation of the digital competencies of citizens facing the challenges of the information society is analyzed. In today's society - automated, globalized, and extremely dynamic - citizens are put in new, non-standard situations, which they have to deal with efficiently and quickly. It is also necessary for citizens not only to manage new information but to generate new knowledge. Positions that until now did not require specific training or positions that required only basic training are subject to a review process from the perspective of the competencies that the employed personnel must perform. Specialists working in a certain field are faced with various and complex problems. Many of these require the use of computer and software products. The complexity of the activities, competitions of all kinds, efficiency, and performance in the activity demand the use of the best performing hardware and software products.

This chapter also presents the DigComp platform (<https://digcomp.ici.ro>), the online survey platform on digital competencies in public administration, as well as the results of the questionnaire, with data collected from over 500 respondents.

Chapter 4, Integrated platform for monitoring the implementation of Information Society, presents the platform with its stages of development and management of the activities necessary for its realization, from conception to production. The presentation is made both from the technical point of view and the management of the project and the development team.

Information society monitoring at the level of a community, administrative-territorial area, country, etc. represents a difficult and complex process that involves the cooperation of several institutional entities. In addition to the inherent difficulties in institutional cooperation, there can be numerous factors that disrupt both the process as such and its results.

The use of an IT tool implicitly leads to the simplification of the process and eliminates elements that can vitiate the result. Thus, the realization of an integrated platform for monitoring the information society becomes an essential objective in supporting managerial decisions for the digital transformation of society. On the other hand, system planning and design is itself a complex IT process.

Chapter 5, Project Management, presents the management of the project team and follows the stages of planning, activation, control design, detail design, implementation, and project completion. The working methodology was Agile, with development in short cycles, thus ensuring reliability for a timely release. The management and treatment plan for the identified risks are also presented, as well as the communication plan.

Chapter 6, Conclusions, describes the conclusions identified following the realization of this work, the situation identified, the results obtained, the main limitations encountered, and the prospects for further development. The list of original works, by ISI and BDI categories, published during the doctoral studies is also included.

The thesis ends with the bibliography.



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The idea of an information society is far from being new. Alistair Duff (Duff, 2000) presents two disputed origins of the information society concept, namely North America and Japan. Regarding American origin, in the early 1960s, Fritz Machlup tried to measure the "production of knowledge" in the USA, trying to demonstrate the economic importance of information. Machlup included information industries such as the computer industry in his broad definition of knowledge industries.

The concept of "information society" was established more clearly by two authors: Alistair Duff and Frank Webster.

On the one hand, Duff proposes four different versions of the information society thesis (Duff, 2000): information technology, the information sector, information flows, and a synthetic view. On the other hand, Webster suggests five definitions of an information society, each with a defining character (Webster, 2014): technological, economic, occupational, spatial, and cultural. What is universally accepted is that information is a distinctive feature of the modern world. Economies used to be built on industry and conquest by military force, but now we are part of a global information economy. Mass media is everywhere, informational occupations are on the rise, and the development of the Internet and disruptive technologies convince many that living in an Information Society is everyone's destiny. The presence of information seems evident everywhere, from daily interaction in postmodern styles to waging information warfare, from information-intensive work to smart devices. Coping with an age of information flows, virtual relationships and rapid change is a challenge and a reality for all.

The information society has evolved in just a few decades from a simple term for a still unclear idea of the society of the future to a reality in which we live. In this short period of human evolution, the world has made remarkable progress in the field of information and communication technologies. Today's devices - smart devices, computers, televisions, home appliances, or automobiles are imbued with technology and tend to provide smart services to provide citizens with an optimal user experience. Currently, a universally accepted concept of the information society is not established. In a broad sense, it can be defined as a society dominated by the production and consumption of information based on information and communication technologies.

In general, we can say that the information society is a society based on information, a definition that is too vague to understand the depth of the current society. However, at every evolutionary stage of human society, there has always been a foundation of information.

The beginnings of the information society, as we know it today, can be found concretely in the 1970s, when IT concepts and products gave birth to informational ideas and trends. The IT leap was generated by the invention of the microprocessor, and gradually the notion of the Information Society gained ground and became a reality from the moment of the explosion of the Internet, the main vector of this society.

The process of fully building the information society was still seen, in Romania at the beginning of the 21st century, as extensive, complex, and long-lasting. The main components of the construction process are technological, financial, economic, social, and cultural in nature.

ICT innovations have proven that a state that wants to keep up with development cannot afford the luxury of "time", and Romania, as an EU and NATO member state, must at least face the new requirements imposed by European and world development.

Digitization is shaping and even transforming both the location and nature of entrepreneurial opportunities in the economy and the practices of pursuing them. To help maximize the productivity potential of digitally enhanced entrepreneurial dynamics in countries, policymakers need to understand the state of their countries' digital framework conditions for entrepreneurship.

To effectively capitalize on the opportunities offered by digitalization, EU governments need information on how well their countries can support the entrepreneurial discovery process driven by digitalization. The digital entrepreneurial transformation of the economy is a broad systemic phenomenon that cannot be satisfactorily captured by measures based on the number of entrepreneurial actions at the individual level. As an infrastructural trend, digitization not only shapes opportunities for demand-side entrepreneurial action but also shapes the context in which action takes place. Therefore, it is important to monitor the general and systemic conditions of the framework that regulates the process of entrepreneurial discovery set in motion by digitization.

At the end of the communist period, Romania also suffered from a large technological gap, since during the period 1980-1989 the exchange of technical-scientific information was extremely difficult, public institutions had little funds to subscribe to foreign research and development journals and, they generally had little contact with institutions and researchers from other countries. For reasons related to the administration's policy, economic technologization, including in ICT fields, was far below the level of international development. Thus, only in December 1992 was the first online connection established between ICI and the University of Vienna (Banciu, Petre, & Sandu, 2017), using the TCP/IP protocol. The .RO domain became operational in Romania on February 26, 1993, with the protocols telnet, FTP, gopher, wais, netfind, and www.

To evaluate how Romania, like other countries in the world, has put the digitalization concept into practice, it is necessary to develop appropriate tools that consider all the components that define the information society and that consider all the administrative structures and economic.

At the decision-making level, governments act through policies, strategies, and various e-government practices to optimize the efficiency, quality, supervision, and control of public services designed to ensure the interaction between public administration and citizens and private organizations.

From the point of view of e-government, these interactions are of the type:

G2C - Government to Citizen, digital interactions between citizens and administration,

G2G - Government to Government, interactions between the administration and other government agencies,

G2B - Government to Business, interactions between the administration and the private economic environment,

G2E - Government to Employee, interactions between government and civil servant.

E-governance is a new paradigm for the organization of society in which laws and social norms remain unchanged, but how they are applied and the values attributed to them are changing. The importance of the concept of e-government is given by several fundamental considerations regarding actions that encourage the widespread adoption of digital technology as a key element for a competitive economy, allowing the government to redefine its role and focus attention on citizens and reduce the costs of

public services, without negatively affecting their quality. Ensuring that government works for the public good requires informed, organized, active, and peaceful citizen participation. Therefore, citizens need to understand ideas about citizenship, politics, and governance. They need the knowledge to make decisions about political choices and the proper use of authority. The digital society is the advanced society or community in the field of adoption and integration of digital technology in people's daily life (home, work, recreation). In this context, e-government can be defined as the development, distribution, and enforcement of policy, laws, and regulations necessary for the functioning of the digital society, and the economy. A significant feature of e-government is the attraction of proactive citizenship through the e-Participation component, in the management and development of public services and their provision in the digital environment.

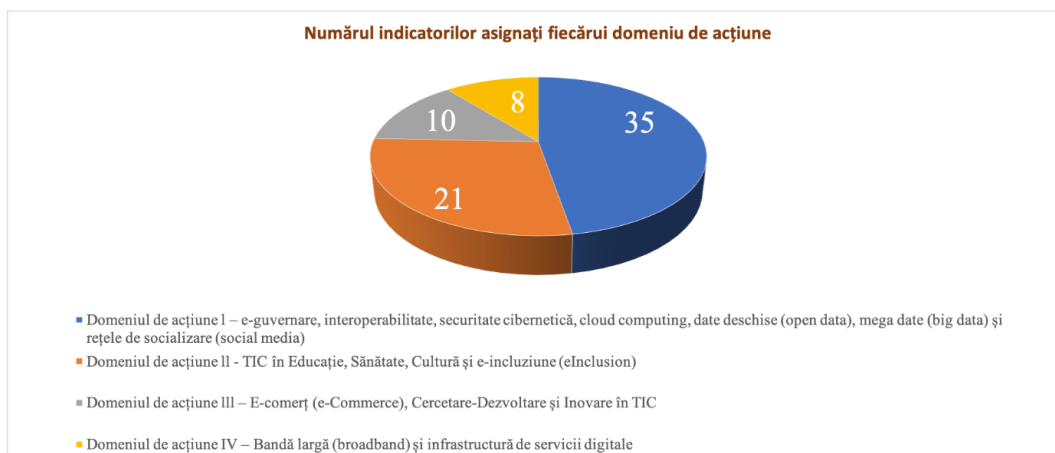
E-Governance, or government based on new technologies, has numerous definitions in the specialized literature. In essence, the electronic government is attributed to the set of systems and resources specific to public management that aim to optimize administrative action through the use of new information and communication technologies (Banciu, Information services for citizens in the information society, 2001).

The National Strategy regarding the Digital Agenda for Romania 2020 (SNADR), adopted by Government Decision no. 245/2015: SNADR was developed to align our country with the strategic directions set out in the Europe 2020 Digital Agenda, which aims to strengthen the digital single market.

Starting from the premise, already proven in several cases, that ICT investments contribute to the growth of the economy, SNADR addresses four key areas (including e-government), respectively:

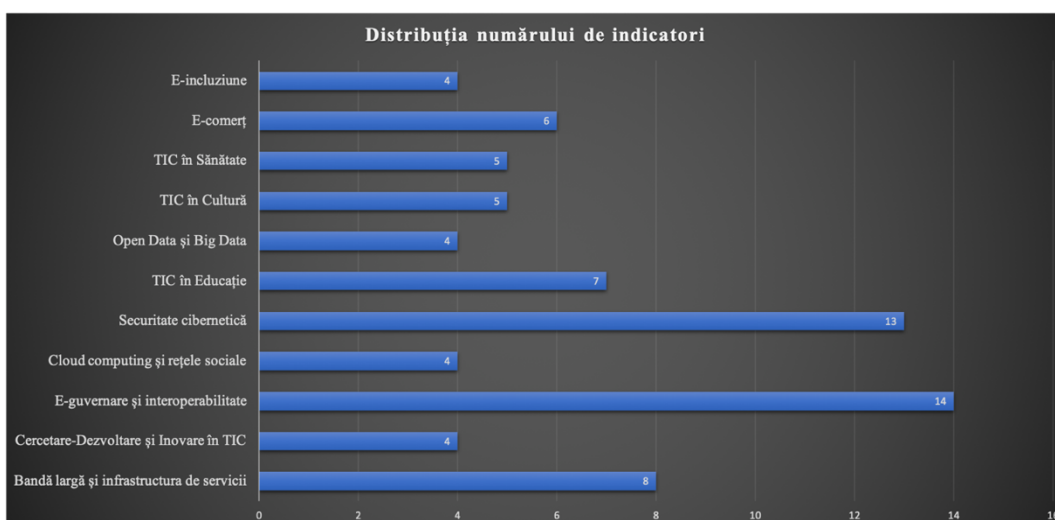
- Action domain 1 – e-Government, Interoperability, Cyber Security, Cloud Computing, Open Data, Big Data, and Social Media. It seeks to reform the way government operates, disseminates data, engages with citizens, and delivers services to external and internal customers, both for the benefit of the government and the citizens it serves.
- Action domain 2 – ICT in Education, Health, Culture, and e-Inclusion. It pursues investments in people's digital knowledge and competencies to improve citizens' quality of life.
- Action domain 3 - E-commerce, Research-Development, and Innovation in ICT. It aims at improving the existing framework for the operation of electronic commerce, ensuring a transparent legal framework for companies and consumers, but also promoting investments in innovation;
- Action domain 4 – Broadband and digital services infrastructure. Broadband has an important role not only in the ICT sector but also in the development of the country, both economically and in terms of increasing the degree of social inclusion.

In the field of e-government, SNADR is focused on services that contribute to life events and the growth of these services to at least level 4 sophistication. A list of indicators that must be monitored to obtain an overview of the implementation and achievement of the proposed objectives has been drawn up. These indicators represent fundamental tools of analysis necessary to evaluate a certain activity or to compare similar activities within some distinct entities.



Indicators - distribution on each SNADR action domain

The indicators associated with the information society measure the degree of development of society as a whole.



Indicators - distribution of information society domains

These indicators can be seen as qualitative or quantitative variables, intended to evaluate the results of public policies (Tudora, Gheorghe-Moisii, & Tîrziu, 2020), evaluations that can highlight the impact of policy implementation. The list of necessary indicators was developed collaboratively by the relevant Ministries, agencies, and competent authorities in testing the validity of each indicator and their compliance with the objectives proposed in each field.

Although the subject of e-government is addressed separately in SNADR, in practice, the success of initiatives in the field is closely correlated with the strategic directions established in the fields of governmental Cloud Computing, cyber security, Open data, and Big data.

The **Manual for Monitoring and Evaluation of the National Strategy regarding the Digital Agenda for Romania 2020** (MCSI, 2016), was developed for the first time in 2016, and centralizes values for some of the indicators as well as institutional roles and positioning necessary to follow the progress in the implementation of the SNADR.

The **National Interoperability Framework (NIF)**, approved by Government Decision no. 908/2017 has as its central objective the promotion and support of the provision of public services in Romania through the development of inter-institutional,

inter-sectoral, and cross-border interoperability. The framework also introduced a set of interoperability principles relevant to the establishment of digital public services in Romania. It is an extension of the European Interoperability Framework (European Commission, 2017), which stipulates that public administrations require "more specific guidelines on how to improve interoperability activities, establish inter-organizational relationships, simplify the processes of supporting complete digital services, and ensure that existing and new legislation do not compromise efforts towards interoperability". Those specific guidelines are concentrated in an updated set of recommendations in the field of interoperability that must support the public administration:

- to optimize national governance to ensure the interoperability framework;
- to use common operational models when initiating the development of digital public services, also considering the inclusion of the needs of citizens and companies from other EU states;
- to store, manage and publish (where appropriate) the data they have in custody only in common semantic and syntactic formats, so that they can be easily reused and aggregated.

The Digital Economy and Society Index (DESI) is a composite index that analyzes relevant indicators regarding digital performance in the EU and monitors the evolution of states regarding digital competitiveness (DESI, 2021). This index is the main analytical tool for monitoring the progress made by member states toward the digital economy and society. The major aim of DESI is to assist EU states in identifying areas that require investment and priority actions, to achieve a truly single market.

The main components of DESI are (DESI, 2021): Connectivity, Human Capital, Internet Use, Digital Technology Integration, and Digital Public Services.

Case study – Digital competencies and their evolution in the context of the information society

The rapid technological development of society is mainly reflected in the case of jobs of "elementary nature", the number of which has been considerably reduced. Similarly, jobs that, until recently, did not require specific training or positions that required only basic training are subject to a review process from the perspective of the competencies that employees are required to perform.

Do societal demands give rise to technological advances? Or is the increasingly available technology shaping society? Regardless of perception, in a time when everything around is changing rapidly, modern man, both from the position of creator and consumer of new technological and communication applications, faces great challenges to adapt to society on the rise. Although information seeking is innate to human beings (Large, 1999), never before have humans had to manage so much stored information.

In today's society - automated, globalized, and dynamic - citizens are put in new situations, often out of the ordinary, which they have to solve efficiently and quickly. Moreover, citizens must not only be able to handle new information but frequently must also generate new knowledge.

As the paradigm of how society is viewed has shifted more often in recent human history than in its entire history, modern society now benefits greatly from technological breakthroughs. The pace of technological progress is very fast, but unfortunately so is

the gap between citizens in terms of access and knowledge (Banciu, Petre, & Boncea, 2019). Citizens are obliged, mainly due to the decrease in the number of jobs based on routine, to always learn, to acquire new knowledge and competencies, sometimes even raising the question of changing specialization. Working citizens must prove their skills/competencies, and also improve them.

In recent decades, Romania is facing a decrease in the number of citizens in the labor field. This phenomenon can be explained considering the high level of inactivity among the working-age population (15 years - 64 years), the high number of people working in subsistence agriculture and the external migration of the active workforce, an aspect that generated a loss of human capital. The phenomenon of migration has been enhanced by significant changes, including in the profile of migrants, especially in terms of educational level. The migration of specialists with advanced competencies has strongly affected key sectors of the Romanian economy. The loss of the labor force, especially the highly qualified one, is a subject that is constantly on the public agenda, especially after Romania's integration into the EU in 2007 and after the recent financial crisis of 2008.

As a result, it is necessary to increase the level of digitization of the activity to try to reduce the negative effects of the existing gaps but also to create a resilient economy and an inclusive digital society. Lifelong education, whether for upgrading or retraining, has become essential for citizens so that they can realize the new opportunities that have arisen in the labor market.

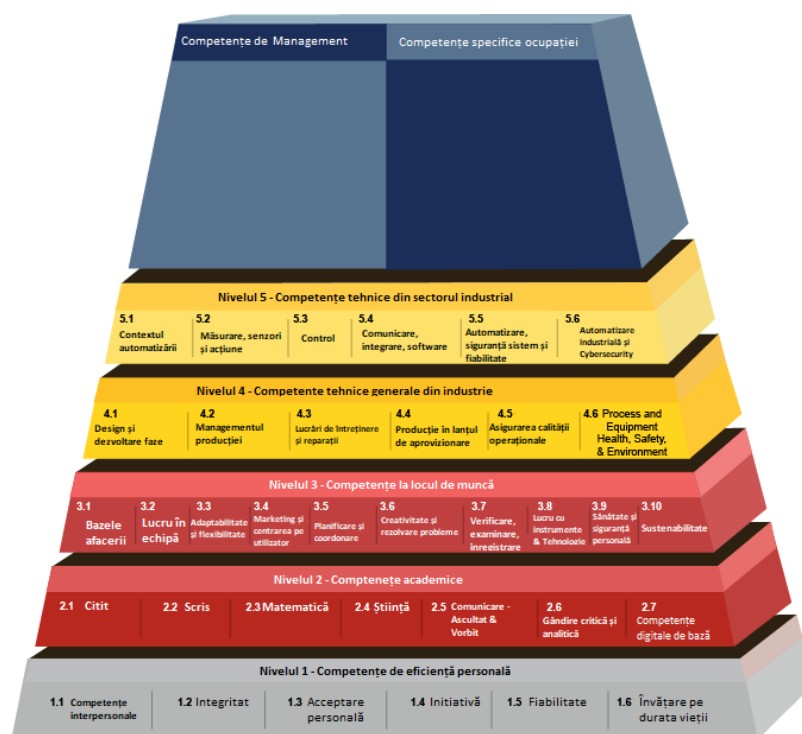
The whole of the European Union faces a significant shortage of skilled people needed to fill existing or newly created jobs that require existing digital competencies. Qualified personnel are indisputably the foundation of the functioning of successful companies. Moreover, the surveys carried out at the European level indicated the fact that for the achievement of a sustainable economic value, human resources prevail over the rest of the factors. According to European Commission estimates, more than 150,000 IT experts are needed in Europe every year. It should also be noted that the number of recent IT graduates does not keep pace with the demand in the labor market.

Many non-IT positions in finance, project management, sales, consulting, or the legal field require an understanding of new technologies. In the near future, more than 90% of jobs will require some level of digital competencies, and innovative leaders are needed to transform organizations and organizational culture. In the fiercely competitive business environment, technology is an essential factor for innovation, communication, and efficiency, and while this is an important factor, there is a high demand globally for staff with digital competencies. The offer, however, cannot respond to such a request.

Digital competence involves the confident and critical use of information society technology (IST) for work, leisure, and communication. It is supported by basic ICT competencies: using computers to retrieve, evaluate, store, produce, present, and exchange information and communicate and participate in collaborative networks via the Internet (European Commission - Key Competencies, 2019). Consequently, digital competencies involve the ability to search, collect and process information and use it critically and systematically, assessing the relevance and distinguishing the real from the virtual, 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, the use of IST to support critical thinking, creativity, and innovation.

The *Information Technology Competency Model* identifies the knowledge, competencies, and abilities needed for employees to successfully manage information technology (Petre & Cristescu, 2019).

The model is represented as a pyramid consisting of several levels. The arrangement of the levels in this form is not intended to be hierarchical or to assume a higher level of proficiency in the top competencies. On the contrary, the conical shape of the model represents the increasing specialization and specificity of the competencies covered. The levels of the pyramid are further divided into blocks that represent competency areas (i.e. groups of knowledge, skills, and competencies), which are defined using critical job functions and technical content areas:



The Model of Competence in Information Technology (Petre & Cristescu, 2019)

Fundamental competencies

- Levels 1 to 3 represent the soft-skills and professional training required by most employers. Each level covers a different group of competencies:
- Level 1 - Personal efficiency: for all roles performed. Often referred to as soft-skills, self-efficacy competencies are generally learned in the family or community and honed in school and work.
- Level 2 - Academic competencies: they are initially learned in the school environment. These include cognitive functions and thinking styles. Academic competencies can be applied to all industries and occupations.
- Level 3 - Workplace Competencies: represents motives and traits, as well as interpersonal and self-management styles. They are generally applicable to a large number of occupations and industries.

Industry-specific competencies

Levels 4 and 5 present industry-level technical competencies needed to create career networks within an industry. These competencies are considered transversal because they allow an employee to move easily between industry subsectors. This

model supports the development of an agile workforce. As with foundation levels, grades 4 and 5 deal with distinct types of competencies:

- **Level 4** - Industry-wide general technical competencies: covers the knowledge, competencies, and abilities that can benefit employees across the industry, regardless of the sector in which they operate. Because of this, many of the critical work functions at this level involve awareness or understanding.
- **Level 5** - Industrial sector technical competencies: represents a subset of industry technical competencies specific to the industrial sector. As a result, critical job functions deal more with execution tasks than those at level 4. The Employment and Training Administration's IT model does not include level 5 competencies.

Higher levels represent the specialization that occurs within certain occupations within an industry. Occupation-specific requirements and managerial competencies are included in this category. The Employment and Training Administration's IT model does not include higher-level competencies.

According to the Employment and Training Administration United States Department of Labor (2012), the basic IT competencies of users include the use of computer, communication devices, and related applications to enter, retrieve and communicate information.

DigComp - Online survey platform in SNADR fields

<https://digcomp.ici.ro>

To facilitate the collection of statistical data for the indicators provided for in the SNADR, we have selected one of the subjects that has a strong impact on Romanian society - digital competencies.

To assess the dimension of ICT competencies in public administration in Romania, we designed, coordinated, and developed an online tool for collecting information. At the international level, the digital competencies of central public administration staff are acquired through schooling in the field of public administration, conducted through courses in higher education units, through separate dedicated modules, and certified by a diploma certifying digital competencies for public administration. The relevance of digital competencies is correlated with the specificity of the considered public administration sector.

The developed study tool is administered and applied online, and the collection and centralization of data are done automatically, also ensuring the security of the collected information.

The web application can be extended; depending on the type of users, different questionnaires can be created according to the needs identified at the level of the institutions involved in digitization strategies, without limiting ourselves to the field of public administration digital competencies, offering scalability and expanding the applicability of the platform.

In essence, considering the rules and norms of making a questionnaire, the following general requirements were considered for the development of an applied questionnaire for digital competencies in public administration:

- The working tool must be defined by considering the theme of the project and the entities to be evaluated.

- The work tool must be developed in relation to the project's objectives.
- The work tool must be developed based on preliminary documentation.
- The work tool must consider the delimitation of the research universe, basically the population to which the project is addressed.
- The development of the work tool is based on the development of the theoretical framework of the study (problem theory).
- Requirements regarding the specification of the study population – meeting the requirements that claim compatibility between the strategy used and the population under investigation.
- Quantification requirements (quantitative description) – meeting the requirements aimed at the quantitative determination of the manifestation of the phenomenon/subject studied.
- Establishing work techniques – meeting the requirements regarding the suitability of each work technique to the specifics of the field and the objectives pursued.
- Data collection requirements
- Identification of the studied persons
- Application of the research tool
- Data collection control
- Data collection and processing requirements
- Fulfilling the requirements regarding the verification of the resulting information: completeness, accuracy, and uniformity.
- Fulfilling the requirements related to the methods of data processing
- Interpretation of the results (theorizing)
- Formulation of proposals for solving the targeted problems

Starting from the unanimously recognized requirements for the establishment/evaluation of digital competencies, a questionnaire was designed to allow both the identification of the level of competencies and the development of statistics. Following the processing of the questionnaire by means of a dedicated platform, it is possible to obtain different types of statistics necessary for the management of the institutions where the DigComp platform was used.

The developed platform aimed to have an easy interface with users so that the questionnaire can be easily completed, and the processing of the obtained data allows generating basic statistics, as a support element for decision-makers.

Three types of actions are implemented, in fact, functionalities provided by the platform:

- a) Definition of questionnaires, interpretation of data, development of statistics - actions dedicated to management;
- b) Completing questionnaires - user actions and viewing statistics, as appropriate;
- c) Administration/supervision of the process – technical actions.

Function (a), in fact, a complex of software routines, has the role of supporting managerial activities for decisions. In essence, the Digcomp platform represents a managerial decision support system for defining strategies, action plans, and

measures dedicated to improving digital performance/competencies in administration or other fields of activity.

The online system for evaluating Digital Competencies in Public Administration is available at the web address <https://digcomp.ici.ro>:

SISTEM ON-LINE PENTRU EVALUAREA COMPETENȚELOR DIGITALE ÎN ADMINISTRAȚIA PUBLICĂ Acasă Chestionar Statistici Contact

Competențe digitale în Administrația publică

Având în vedere situația existentă și problemele la nivelul administrației publice din România, lucrarea își propune crearea unui instrument on-line pentru evaluarea necesarului de competențe digitale în administrația publică. Obiectivele specifice urmărite la realizarea lucrării sunt:

- ✓ Evaluarea necesarului de competențe digitale în administrația publică - Studiu privind problematica competențelor TIC cu particularizare în administrația publică.
- ✓ Dezvoltarea și utilizarea unui instrument on-line pentru colectarea informațiilor privind competențele TIC
- ✓ Identificarea deficitelor tematice de competențe digitale în administrația publică.

Chestionar
Secțiune chestionare - în cadrul acestei secțiuni utilizatorul va putea vizualiza și completa toate

Statistici
Secțiune statistici - în cadrul acestei secțiuni utilizatorul va putea interpreta și va putea elabora

Contact
Secțiunea contact - în cadrul acestei secțiuni utilizatorul va putea vizualiza detaliile de contact.

DigComp – public interface – Home page

This page displays the most important information related to the competencies assessment and the platform. The page contains different access options for the user. A context menu where you can find the survey, survey statistics, or contact page. In addition to these, the context of the creation of this online platform is described, along with the objectives of the work.

The user also has three explicit areas available, in which each section and its role is briefly explained:

- Questionnaire - The section where the user will be able to complete the questionnaire related to the evaluation platform.
- Statistics - The section where the user will be able to observe the different responses of other users, and people who have the necessary knowledge can interpret these results to improve the services offered by those in the public administration.
- Contact

Collection of information by online questionnaire:

The collection of information, the data that will be used for the elaboration of statistics, is carried out entirely online. The software system is designed so that each type of response can be accounted for in real-time in the specific associated structure.

- Avansat
 Expert

5. Modalitatea/modalitățile de dobândire a competențelor digitale:

Selecționați una sau mai multe variante, după caz.

- Mimetic, prin imitație mecanică după alții
 Studiu individual pe cont propriu
 Prin explicații de la alții și/sau din tutoriale
 În cadrul studiilor absolvite
 Prin cursuri de specializare/formare specifice
 Altele (le puteți preciza în răspunsul la ultima întrebare din chestionar)

6. Domeniul/natura postului/activității dumneavoastră:

Selecționați varianta cea mai potrivită situației dumneavoastră

- Conducere/management
 Financiar-contabil/economic
 Tehnic/TI&C
 Social/cultural/educație/turism/sport
 Legal/juridic
 Altele (agricultură, transporturi, construcții, energie, industrie etc.)

7. În activitatea dumneavoastră de până acum, ați avut nevoie de competențe digitale?

- Da
 Nu

8. În activitatea dumneavoastră curentă și viitoare în domeniul public, sunt necesare competențe digitale?

Selecționați varianta cea mai potrivită situației dumneavoastră

- Nu, activitatea mea nu necesită competențe digitale
 Posibil în viitor, momentan nu
 Da, la nivel de bază
 Da, de nivel avansat
 Da, de nivel expert

9. În ce măsură stăpâniți utilizarea unui echipament / dispozitiv digital (computer, laptop, tabletă sau alt tip)?

Selecționați varianta cea mai potrivită situației dvs.

- Deloc
 Suficient
 Bine
 Foarte bine
 Excelent

Responding to questionnaire

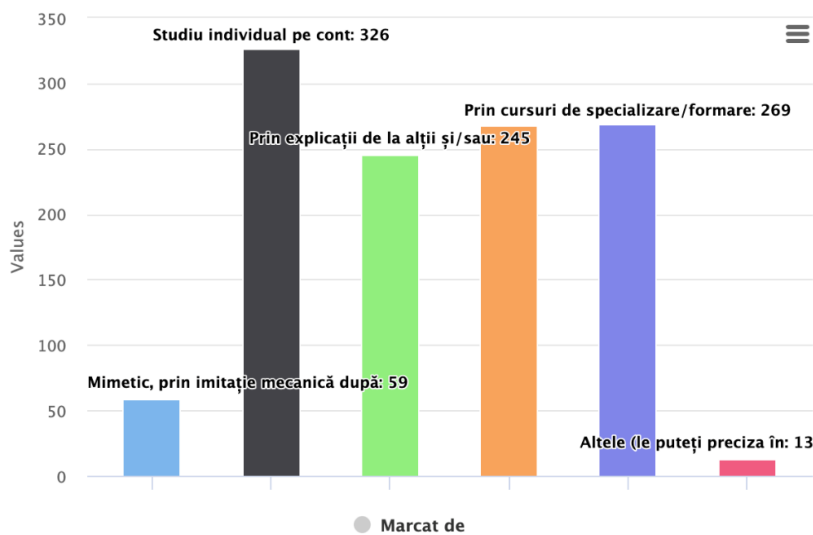
Display the results: The results were presented in real-time within the platform, with any respondent able to view the statistics.

The results obtained as a result of processing the collected data were visualized in graphic forms, easy to interpret by users. Complex data aggregation can be done afterward.

SISTEM ONLINE PENTRU EVALUAREA COMPETENȚELOR DIGITALE ÎN ADMINISTRAȚIA PUBLICĂ

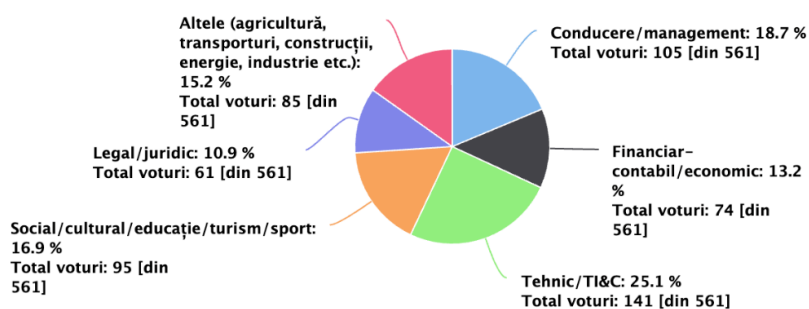
Highcharts.com

Modalitatea/modalitățile de dobândire a competențelor digitale:



Highcharts.com

Domeniul/natura postului/activității dumneavoastră:



Highcharts.com

Displaying statistics

A total of 561 people from the public administration responded to the applied questionnaire. The gender distribution showed that the proportion of females was 57% (320 people), and that of males was 43% (241 people).

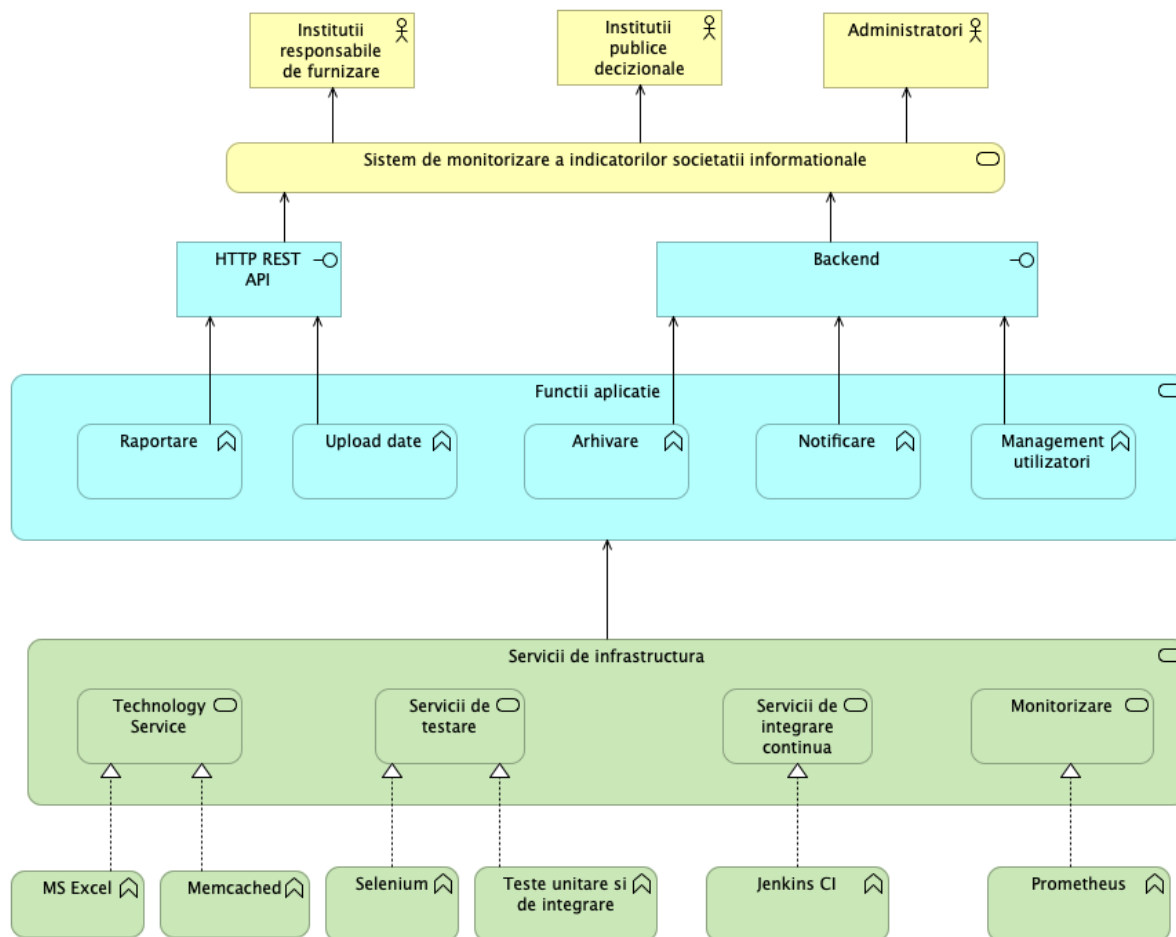
Integrated platform for monitoring the implementation of Information Society: IndMSI

<http://indicatori.comunicatii.gov.ro/>

Monitoring the information society at the level of a community, administrative-territorial area, country, etc. represents a difficult and complex process that involves the cooperation of several institutional entities. In addition to the inherent difficulties in institutional cooperation, there can be numerous factors that disrupt both the process as such and its results. The use of an IT tool implicitly leads to the simplification of the process and eliminates elements that can vitiate the result. Thus, the realization of an integrated platform for monitoring the information society becomes an essential objective in supporting managerial decisions for the digital transformation of society. On the other hand, system planning and design is itself a complex IT process.

The process of selecting the right technology stack can be difficult, but given that there is an entire class of performing solutions, the risk of making the wrong decision is reduced. The solution must best fit the specific objectives and solve the underlying problems, which is more complex than a typical price/performance evaluation (Boncea, Petre, & Smada, 2017). An important advantage in the selection of complex technologies was the high level of knowledge of the personnel involved in planning and development.

The computer system represents an information management platform intended for the collection, evaluation, and presentation of data in an intelligible format, to improve the level of correct and as complete knowledge as possible to support strategic decision-making regarding the analyzed field.



The architecture of the monitoring system

The construction of the system started from the analysis of the national strategy and the set of indicators defined to monitor the degree of implementation of the strategy. Thus, the requirements necessary to build the online system for information society indicators were identified.

Prima pagină Categori Instituții MCSI Contact Autentificare


Sistem de monitorizare a indicatorilor pentru societatea informațională

Sistem de măsurare și monitorizare a indicatorilor privind Strategia Națională Agenda Digitală pentru România 2020


Căutați indicatori după denumire sau cod

INSTITUȚII


Instituțiile care se ocupă de colectarea datelor privind indicatorii



Ministerul Sănătății




Ministerul Muncii, Familiei, Protecției Sociale și Persoanelor Vârstnice



Ministerul Afacerilor Interne


CATEGORII DE INDICATORI

Domeniile societății informaționale monitorizate prin indicatori




Bandă largă și infrastructura de servicii

Dezvoltarea infrastructurii TIC în bandă largă pentru o acoperire regională comp...




Cercetare-Dezvoltare și Inovare în TIC

Creșterea numărului de locuri de muncă în sectorul TIC.




E-guvernare și interoperabilitate

Creșterea transparenței actelor administrației publice prin informatizarea servi...




Cloud computing și rețele sociale

Creșterea accesului la servicii publice digitalizate și administrații publice ef...




Securitate cibernetică

Dezvoltarea și îmbunătățirea rețelelor și sistemelor de Securitate Cibernetică




TIC în Educație

Dezvoltarea competențelor TIC; dezvoltarea infrastructurii TIC în domeniile de i...




Open Data și Big Data

Creșterea accesului la servicii publice digitalizate și administrații publice ef...



TIC în Cultură

Dezvoltarea competențelor TIC; dezvoltarea infrastructurii TIC în domeniile de i...



TIC în Sănătate

Dezvoltarea competențelor TIC; dezvoltarea infrastructurii TIC în domeniile de i...

Home page of the web system

To display the indicators, a software solution is used to generate graphs based on the values recorded by the institutions. The graphs are based on the reporting period and the values reported by the institution or institutions that manage a certain indicator.

Formular încărcare indicatori

Indicatori

Satisfacția Utilizatorului în ceea ce privește utilizarea paginilor de internet e-guvernare - ușurința cu care sunt găsite informațiile (în mare parte satisfăcătoare)

Completare indicator

Cod indicator	Tip Date	Frecventa	Perioada	Unitate de masura	Valoare
115	procent	anual	2010	Procentul de utilizatori eguvernare	55.4
115	procent	anual	2011	Procentul de utilizatori eguvernare	57.2
115	procent	anual	2012	Procentul de utilizatori eguvernare	59.2
115	procent	anual	2013	Procentul de utilizatori eguvernare	64.1
115	procent	anual	2014	Procentul de utilizatori eguvernare	65.2
115	procent	anual	2015	Procentul de utilizatori eguvernare	68.2
115	procent	anual	2016	Procentul de utilizatori eguvernare	69.15
115	procent	anual	2017	Procentul de utilizatori eguvernare	73.8
115	procent	anual	2010	Procentul de utilizatori eguvernare	23
115	procent	anual	2011	Procentul de utilizatori eguvernare	24.7
115	procent	anual	2012	Procentul de utilizatori eguvernare	27.9
115	procent	anual	2013	Procentul de utilizatori eguvernare	37
115	procent	anual	-- Selectati anul --	Procentul de utilizatori eguvernare	

Logout

Editeaza

Salveaza

Form for editing the values of the indicators

The public interface was also optimized for access from mobile devices, due to the fact that the trend of using mobile devices is at a higher rate than ever before (Zamfiroiu, Boncea, & Petre, 2018), so it is necessary that in the development process considers the quality indicators for mobile application development from the users' point of view.

Project Management

The purpose of project management is to maintain effective control over the fulfillment of the implementation plan. For the successful implementation of the proposed goals, it was necessary to plan management activities specific to the development of IT systems.

Thus, a work team dedicated to the project was established. This had an organizational character with temporary functionality, to solve the platform's requirements. This team was organized because, as stated in (Burduș & Popa, 2018), such a temporary structure can be much better adapted to the specific objectives of the project compared to the classic structure of a research department.

Considering the premises of project management concepts, it is noted that a project requires planning, activation, control design, detail design, implementation, and completion of the project (Barbu, Petre, Nicolau, & Smada, 2016). This leads to the need for a data "repository" containing the raw material to be used as a basis for management decisions.

Considering the importance of the information society implementation monitoring platform, members with little experience were not co-opted into the development team. As a general rule, in an R&D project, when discussing the allocation of human resources, consideration must be given to efficiency and effectiveness and how the institute will benefit from the full capacity of each team member. In the present case,

we considered the short realization time and the non-allowance of errors, so we selected employees with extensive experience in software design and development, accustomed to Agile-based work culture, with code-review capabilities.

Agile methodology was adopted to work on the developed systems. Through this approach, software was developed in short cycles, thus ensuring reliability for timely releases. This resulted in building, testing, and releasing software components quickly and with high frequency.

As a knowledge management principle, we adopted the model described in (Tîrlea, Bădilă, & Kifor, 2020): When a programmer has the task of implementing new functionality, the first step will be to check in the internal database if that functionality has been used before by a colleague. If the information is not found in the internal database, it will look for other sources of inspiration, basically in the online environment. In this second case, after solving the assigned task, the programmer will enter the acquired knowledge in the internal database, to be used in the future by other colleagues.

Knowledge sharing is intended to restructure and increase the stock of knowledge by linking the individual level (where the knowledge resides) and the organizational levels (where the knowledge is used). Knowledge sharing is closely dependent on the willingness to share and, therefore, on interpersonal and organizational factors (Popa & Ștefan, 2019).

The benefits of implementing and using the knowledge base can be translated into saved time, because the solution is quickly identified and the risk of error decreases because the solution has already been adapted to the application requirements, becoming compatible with the rest of the developed components.

The development technique used by the team was Scrum, which is a subset of Agile and one of the most popular frameworks for implementing Agile. It is an iterative software development model for managing and developing complex software.

The iteration period was set to two weeks. Briefing sessions were held daily. At the end of each iteration, a meeting was held with all team members and we mapped out technical tasks and duties for each developer.

Risk management was actively addressed throughout the project execution by continuously monitoring potential risks, identifying and analyzing them, and applying appropriate mitigation actions.

Technical/administrative risks for which mitigation actions have been foreseen:

- (i) The proposed functionalities do not cover all requirements of the beneficiary. The analysis documents will be discussed and approved by the beneficiary.
- (ii) The open source solutions identified in the initial phase are not fully compatible for integration. We are considering new software development.
- (iii) The format of the data taken from the beneficiary is not uniform. A data normalization solution will be created.
- (iv) The proposed technical solution has bugs in operation. Sufficient time has been provided for the testing and validation stage under real-world conditions of use to allow for the resolution of deficiencies.
- (v) An experienced specialist is no longer available. There are qualified human resources that can replace that specialist.

(vi) Failure to meet deadlines. Appropriate methodologies will be used for project management and software development (PMI, Agile, etc.);

(vii) Communication problems. Online platforms for collaboration, video conferencing and periodic meetings will be used.

The project team has adequate existing hardware equipment and well-trained staff with IT experience.

Risk identification

No./ Id.	Risk description	Impact [1 ... 10]	Probability [0 ... 1]
1.	Unavailability of essential hardware resources	7	0,10
2.	Choosing development/implementation tools that are not exactly the most suitable, using new software products	5	0,20
3.	Initial misestimation of project size / complexity	3	0,30
4.	Mismatching project team size and diversity with project size and complexity	3	0,10
5.	Inadequate allocation of resources and/or unclear definition of project roles	3	0,10
6.	Lack of experience in the field and/or at the required level	5	0,20
7.	Key experienced personnel are temporarily unavailable (sick) or leave the project before completion	7	0,10
8.	Ensuring a sufficient level of information (data access)	7	0,20
9.	Exceeding the original schedule	4	0,20
10.	Quality of documents and results	3	0,10
11.	Failure to develop	7	0,10
12.	Changes in the management of the organization, other priorities	7	0,10

The identified risks are located between low and medium exposure degrees:

Degree of risk exposure:

Risk No./Id.	Degree of exposure to risk
3, 4, 5, 9, 10	Low risk exposure
1, 7, 8, 11, 12	Medium risk exposure

Communication was appropriate, specific to the intended audience, sufficient, concise, and addressing topics, and activities at the right times. Currently, all forms of collaboration can be enabled and supported through modern ICT tools, systems, and platforms (Filip, 2022).

Means of communication that were used for the project: meetings (ICI headquarters, MCSI headquarters), email, PDF, Word and Excel documents, Powerpoint presentations, phone calls, Whatsapp group, Webex/Skype online meetings.

In this project, in addition to the role of project manager, I was responsible for maintaining the flow of communication, being the main link between the project team and the outside of the project.

Internal communication lays the foundations for the good functioning of the entire project by promoting its identity. Also, internal communication is a way to solve the project members' need to belong to a group and also a way to implement the managerial strategy (Pop & Dumitrașcu, 2013).

The presentation of the management of this project has the role of showing the complexity of the project but also of the management itself. As far as major ICT projects are concerned, it is already proven that they cannot be achieved without solid management knowledge for the project leader. The managerial elements used were adequate because the information society evaluation platform was created, is operational, and used at the decision-making level.

Conclusions

International bodies encourage the construction of the "Knowledge Society", which goes beyond the concept of the "Information Society" by recognizing the multilayered knowledge components that contribute to the realization of the new society. The concept of the Knowledge Society encourages the growth of building capacity so that information can be identified, produced, processed, transformed, disseminated, and used as new knowledge for human and social development.

In Romania, the Ministry of Communications and Information Society (MCSI) and the World Bank signed a consultancy services agreement regarding "Support for the implementation of the National Strategy of the Digital Agenda for Romania 2014-2020". For a successful implementation of the Digital Agenda for Romania, an information management platform was developed to collect, evaluate, and present data in an intelligible format, to provide correct and complete knowledge to support strategic decision-making regarding the areas analyzed (Banciu, Petre, Smada, & Sandu, 2019). For the monitoring and evaluation of the implementation of the objectives of SNADR, a set of indicators was specified that is used to measure the implementation of the national objectives of the information society. The platform features several easy-to-use visualizations such as reports, charts, and graphs. The system can be used to create advanced reports and statistics on the level of implementation of solutions related to the information society and to objectively reflect the degree to which the objectives established in the Digital Agenda for Romania are met.

Results

From the analysis carried out on the digital dimension in Romania, an unfavorable reality emerges compared to the average of the European Union states, our country being practically in a preliminary phase in fulfilling the proposed objectives, except for only a few indicators. The low pace of implementation, even in the areas established as priorities by SNADR, places Romania at the bottom of the EU ranking in almost all monitored areas. The poor results obtained in digitization, a key area established including in the PNRR, reveal the need to change the strategic approach, especially in the implementation plan and monitoring of the target objectives.

An extensive study was also carried out on the field of Human Capital and digital competencies. The analysis covers trends and policies, at the European and national level, challenges of the information society for individuals, and the results obtained through a survey application platform, with a survey dedicated to digital competencies, a survey applied at the level of public administration, to which 561 subjects responded. The analyzed area was selected because the ICT system in the national administration area is highly fragmented, often resulting in an additional administrative burden for users.

Romania must invest more in the development of the digital competencies of all citizens, support the organization of promotion campaigns, and offer help for training or grant subsidies for the purchase of basic IT equipment. In addition, it is necessary to increase the number of ICT specialists and reduce the gap between supply and demand for graduates, considering the needs of the industry. In the same sense, efforts should be made to increase the number of teaching staff in the field of ICT, since the number of students in this field is increasing considerably every year, while the number of teachers has remained constant. Moreover, it should also be invested in the continuous training of teaching staff, considering the dynamics of the IT field.

The DigComp platform, one of the main results of this work, can also be extended to analyze other indicators of the information society, being an adjunct tool for the institutions responsible for collecting the data necessary for reporting the stage of implementation of the objectives proposed both by the Strategy for the Digital Agenda and for the strategic directions that will be developed in the future.

The multitude of technical possibilities for data provision leads to a very heterogeneous data offer as well as different levels of data use. To facilitate the access and use of open government data, a harmonized and standardized technical implementation is required - especially in terms of the formats and systems used.

The development of data usability and accessibility can be assisted by promoting the adoption of internationally recognized technical and security standards for data formatting, structuring, and sharing. Digital strategies in the public sector require periodic updating for society to benefit from the opportunities offered by digital technologies.

The objective of this thesis was to identify the challenges brought by the information society, with an emphasis on the situation in Romania, and to create a monitoring system for the implementation of the specific objectives of the information society, as they are provided in the national level. An analysis was carried out to identify the economically, socially, and technically significant elements that influence an information society assessment system. Reference architecture of an IT platform for collecting and reporting data from public institutions responsible for implementing the indicators proposed by the Digital Agenda for Romania was proposed. The demonstration and validation of the models were done through the IndMSI system (<https://indicatori.comunicatii.gov.ro>), carried out within a project managed by the author of this thesis. The research carried out in the framework of the thesis allowed winning through competition of a sectoral research project whose central objective was to create an online system for the evaluation of digital competencies in public administration (<https://digcomp.ici.ro>).

The main original contributions are towards achieving the proposed goal, as follows:

1. creating a ready-to-use IT platform for monitoring the implementation of the information society;
2. study regarding the existing situation at the national level in the implementation of the objectives proposed by the Digital Agenda for Romania 2014-2020;
3. study on the situation of the information society, policies, and approaches, at the level of the European Union and Romania;
4. study on digital competencies, their levels and dimensions, the challenges brought by the information society on citizens and the situation of digital competencies in the EU states, with an emphasis on Romania;

5. application of management concepts for the creation of a reference model for a system for monitoring the implementation of the objectives specific to the information society;
6. coordination of the development project of the system for monitoring the implementation of the information society in Romania;
7. the user requirements and the application requirements, the technologies necessary for the realization as well as the logical scheme of operation for the software platforms realized;
8. coordination of the project for the assessment of digital competencies in public administration;
9. creating a data collection tool related to digital competencies in public administration that can be extended to other types of institutions;
10. the instrument was applied to 561 respondents from the central public administration. The results were used within ICI Bucharest, to propose training courses in specific ICT fields;
11. development of training courses for personnel from the institutions responsible for data reporting in the IndMSI system;
12. I implemented the Agile-Scrum methodology within the development teams that I coordinated, to create the systems presented in the thesis.

From the point of view of applicability, the research results were used in practice. Both IT platforms were and are still used at the decision-making level, by authorized public institutions.

The main limitations encountered were related to the insufficient involvement of public institutions, the main causes being their lack of staff and insufficient funding to measure the indicators allocated to each institution. Another obstacle was the dissolution of the MCSI (Ministry of Communications and Information Society), the division of tasks between the Ministry of Transport and the Agency for the Development of Romania, generating syncope in the reporting of values. Moreover, the abolition of MCSI also meant the interruption of funding for the sectoral project Study and online tool for assessing the need for digital competencies in public administration, in accordance with the Monitoring and Evaluation Manual of SNADR, a project that I coordinated during 2018-2019. However, the elaborated works still allow their development and application to the new construction requirements of the information society.

Prospects for further development

Since the European Commission has launched, in 2021, an extensive program for the digital transformation of Europe, which will be financially supported by the launch of certain research programs, it is obvious that there will also be a need for tools to evaluate how member countries are achieving the launched objective by the Commission.

The resulting platform, IndMSI, is built in such a way that it has a wide degree of scalability, and the questionnaire platform as well as a series of statistics can be adapted to new requirements. In this context, a research direction can be defined by continuing the process of identifying the thematic deficits of digital competencies in the public administration, improving the questionnaire applied at a general level, but also by carrying out questionnaires dedicated to certain professional categories, within the public administration, which requires high-level digital competencies.

Given both the European strategies and the strategies that will be developed at the national level, in the field of Romania's digital transformation and based on our own experience, the main topics of interest for future research are:

- defining and implementing IT resilience strategies;
- evaluating the accessibility and usability of client IT products;
- planning and developing mechanisms to ensure the interoperability of IT systems.

Using the DigComp platform, I propose to analyze and monitor the social impact on the ICT specialist, mainly through the development and application of customized questionnaires.

Current research will be continued to obtain a parameterized digital transformation monitoring model, with weights applied to the parameters and continuous optimization through reinforcement learning techniques.

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