Androniceanu, A., Sabie, O. M., Georgescu, I., and Drugău-Constantin, A. L. (2023). Main factors and causes that are influencing the digital competences of human resources. *Administratie si Management Public*, 41, 26-53. https://doi.org/10.24818/amp/2023.41-02

Main factors and causes that are influencing the digital competences of human resources

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***Abstract*:** The integration of digital technologies in public administration is influenced by the digital competences of human resources. The objectives of this research are to identify the main factors and causes that influence human resources' level of digital competences and to find out the correlations between factors, causes, and digital competences. The survey was conducted within the National Agency of Civil Servants (NACS) responsible for the management of civil servants from the Romanian public administration. 25 variables were selected and grouped in three categories. The main research instruments used were: SPSS and Principal Component Analysis. According to the research results, the main factors influencing digital competences are social factors, extrinsic motivation factors, and administrative and managerial factors. The main causes with a relevant impact on digital competence development are data security and privacy risks, the dynamic of technologies, lack of continuity in ICT integration in organization activities, and excessive bureaucracy. All variables in the model have positive correlations. The results of the research are useful and interesting both for scholars and governmental institutions. The causes, factors, and correlations between them are discussed for the first time in the specialized literature and are raising up the key elements of digital competences that should be taken into account for an efficient digital transformation of public administration.

Keywords: digital competeneces, factors, causes, public administration, human resources.

JEL: C38, H38, J24

DOI: https://doi.org/10.24818/amp/2023.41-02

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Introduction

The phenomenon of digital transformation exerts a substantial influence on multiple facets of human existence (Małkowska et al., 2021; Kolupaieva & Tiesheva, 2023). The impact of technology on various aspects of society, including social relationships, communication, education, new products and innovations (Machova et al., 2023) consumer behaviour, health and leisure, has been significant (Bartók et al., 2021; Lazaroiu &Rogalska, 2023; Dávid & Dadkhah, 2023; Waliszewski et al., 2023) and represents an important factor of sustainability (Khan et al., 2023). To thrive in today's professional world, possessing digital competences has become a necessity and should be regarded as an essential requirement across all professional domains (Wach et al., 2023; Peláez et al., 2020; Afonsova et al., 2019; Fakunle & Ajani, 2021). In this regard, digital competency has become a prerequisite for public administration professionals in modern society (Budai et al., 2023; Shava & Vyas-Doorgapersad, 2023).

In recent years, there has been an increasing interest in studying the integration of digital technologies into administrative processes that have not only revolutionized the way public organizations interact with their employees but have also significantly enhanced their capacity to deliver efficient and transparent services (Mamokhere, 2023). What is known about digital competences is largely based upon empirical studies that investigate e-government adoption and the effect of digitalization in public areas, but less concrete information about digital competences in public administration. Several attempts have been made to critically examine the competences required to manage and deliver transparent digital services effectively and discuss the concept of transparency in e-government (Marino et al., 2023; Burhanudddin, et al., 2019). What is not yet clear is whether a relationship between factors, causes, and digital competences can be identified (Paulikas & Paulikienė, 2022). The development of public administration human resources' digital competencies has become a necessity to operate effectively in the increasingly digitalized world we live in. Discovering the main factors and causes that affect the level of public administration human resources' digital competence could lead to better public policies and strategies designed by public administration (PA) leaders. From this perspective, this research aims to identify and analyse the main factors and causes that influence the development of the digital competences of civil servants within the National Agency of Civil Servants (NACS) and to find out the most important correlations. The main research questions are:

RQ1: What are the main factors that influence the level of digital competences of NACS human resources?

RQ2: What are the main causes that influence the level of digital competences of NACS human resources?

RQ3: Is there a recognised need to develop digital competences of the NACS human resources?

The study's novelty lies in its examination of the primary factors and causes that impact the digital competences of public administration human resources (PAHR), which have received limited attention in academic literature. Additionally, the study looks at the previously unexplored case of civil servants' digital competences, which

have been developed out of necessity in recent years, particularly during the COVID-19 pandemic.
In the following, the work is structured in four parts. The first part contains some of the most important research results in which various researchers have identified and analysed the main factors and causes that can influence the level of digital competences of PAHR. Next, the research methods and process are presented, as well as the size and structure of the sample within the NACS. Then, a consistent section is reserved for the presentation and discussion of the research results obtained in the study. The last section of the paper groups the most important and interesting conclusions of the research, including limitations of it and future research.

1. Literature review

This section presents the main concepts with which the study operates in the research part, but also the main results from the specialized literature. In the beginning, the concept of digital competences is presented, as well as the difference between competences and skills, and later the main factors and causes that can influence the development of civil servants' digital competences are described.
After more than two decades of development, the term "digital competence" is frequently used interchangeably with terms like "digital skills," "information capabilities," “digital literacy” and "communication abilities" or scholarly proficiency (Linh et al., 2023; Cramarenco et al., 2023; Głodowska et al., 2023).
Digital competence is widely recognised as the most transferrable competence within the framework of eight fundamental competences for lifelong, continuous learning (European Commission, 2019; Balcar, 2011). According to the European Commission (2019), digital competence refers to a competency that impacts an individual's degree of confidence and critical thinking when it comes to working, studying, personal development, and societal engagement with digital technology, products, and services. Other researchers (Muizu & Budiarti, 2017; Jarad & Shaalan, 2020; Ślusarczyk et al., 2021) describe digital competence as a set of skills, behaviours, and attitudes that pertain to the effective utilisation of digital technologies. The emphasis on digital usage lies in the practical application of these technologies. Maximising digital competence is a crucial factor in service processes, as it has a substantial impact on the quality of services and human resource performance. International conceptual frameworks have arisen as a result of efforts to specify the particular competencies that human resources from public administration should acquire to properly integrate digital technologies into their daily tasks.
The terms "skills" and "competencies" are sometimes used interchangeably, but there are distinct variations in their meanings within the context of the workplace. While a skill usually refers to a singular proficiency, competencies tend to contain a collection of interconnected strengths. Skills refer to the aptitudes that individuals acquire via deliberate practice and knowledge. Professionals utilise their expertise to accomplish desired outcomes within the workplace. On the other hand, competencies refer to a collection of observable skills and capabilities that individuals use to accomplish a specific objective or finish a given assignment. Typically, they

integrate skills, abilities, and knowledge, including the precise behaviours necessary for an individual to perform in their job (Indeed, 2023).

PAHR have the professional expertise to develop public policies and strategies, work with citizens, collaborate with other organizations from different sectors of activity and networks, etc. (Pilat & Lasher, 2018). Digital transformation of public administration organizations influences the way public services outreach communities.

The digitization of public administration encompasses more than just the technological remodeling or online migration of services (Skare et al. 2023). It entails a comprehensive digital transformation of all work environments, necessitating the early adoption of new technologies into services and decision-making processes (Gavurova et al. 2022; Ślusarczyk & Haque, 2019). Therefore, public administration organisations at both the national and local levels need more highly skilled and competent personnel (Androniceanu et al., 2022). The COVID-19 issue has brought considerable challenges, leading to a notable increase in the development and use of digital tools and, simultaneously, the development of digital competencies of PAHR. The research interest was especially high regarding certain groups of skilled employees whose working duties required immediate digital transformation (Mishchuk et al., 2023; (Belas et al. 2022; Raišienė et al., 2021; Kinnunen et al., 2021).

UNESCO (2022) identified in the first phase a set of competences that civil servants need to help them face the digital transformation of public administration. Since PAHR use data for more efficient governance, they should develop competences and demonstrate proficiency in areas such as digital literacy, data-driven decision-making, privacy and security, open data and open government, legal, regulatory, and ethical structures, or artificial intelligence fundamentals.

The European Commission (2019) defines digital competency as the ability to apply digital technologies responsibly, critically, and with confidence for study, work, and social interaction. It is described as a blend of attitudes, abilities, and knowledge. The Digital Competence Framework for Citizen (DigComp) highlights the essential elements of digital competency across five domains. These five areas are: *information and data literacy* (to identify and obtain digital data, information, and content; to express information demands; to evaluate the source's content and accuracy; to keep digital data, information, and material well-organized, managed, and stored); *communication and collaboration* (to use digital technology for interaction, communication, and collaboration while keeping in mind the diversity of cultures and generations; to engage in community activities, in both public and private online services in order to contribute to society; to control one's reputation, identity, and online presence); *digital content creation* (to produce and modify digital media to enhance and incorporate data and materials into the corpus of current knowledge while being aware of the proper use of copyright and licencing; to be able to provide computer systems with instructions that are easy to comprehend); *safety* (to secure digital environments' equipment, content, private information, and personal data; to keep individuals' mental and physical health and to be informed about digital tools that promote social participation and well-being; to understand how using digital technologies affects the environment); and *problem solving* (to

understand requirements and issues, as well as to address fundamental problems and challenging circumstances in digital contexts; rethinking processes and products through the use of digital tools; to stay updated with the development of digital). DigComp 2.2 is a cohesive framework, that includes 5 dimensions and 21 competences (Vuorikari et al., 2022). Bilan et al. (2023) analysed different frameworks for assessing civil servants' digital competences, and concluded that the measurement of digital competences suffers from a lack of methodological consistency. They demonstrated that the present frameworks for measuring PAHR competences and readiness for e-society don't have a flexible approach. Existing methods, including the most cutting-edge version of DigComp 2.2, are too broad and do not permit assessing the digital skills deficiency of civil servants. This is a limitation in the assessment of the digital abilities of all employees, not just those working in public administration. Ulfert-Blank & Schmidt (2022) also analysed and demonstrated how other scales used for measuring digital competences are inconsistent regarding the application field, such as PA. In the context of artificial intelligence development, there is a need for constant improvement and updating of digital competences measurement frameworks, including the DigComp used by the European Union.

Next, the main factors and causes that might influence the level of civil servants' digital competences are depicted in the scientific literature.

Several factors that impact the digital competences of PAHR have been individually analyzed in academic research (Van Laar et al, 2019). Digital transformation primarily entails the process of preparing and encouraging individuals to embrace and effectively utilize digital equipment and technology (Androniceanu et al, 2020). Furthermore, according to Van Laar et al (2019) contemporary jobs require cross-cultural and cross-institutional communication skills, the capacity to collaborate effectively in remote teams, and the aptitude for interpreting information within digital environments. These skills encompass a range of abilities, from medium digital literacy to advanced competencies in utilizing technology for diverse purposes (Annunziata & Bourgeois, 2018; Jurczuk & Florea, 2022). According to the literature, a few key factors have been identified as significant influencers of digital skills and competences in public administration. These are (1) technological factors; (2) intrinsic motivation factors; (3) extrinsic motivation factors; (4) financial factors; (5) political factors; (6) managerial factors; (7) cultural factors and (8) social factors.

(1) Technological factors encompass several dimensions, including the dynamic evolution of technology, the proliferation of Information and Communication Technology (ICT) tools, the integration of artificial intelligence, and the notable challenges posed by the limited interoperability of existing digital platforms. Brynjolfsson & McAfee (2014) explore the effects of technological advancements on various aspects of society, including the workforce, the economy and innovation prompting the need for new skills and approaches to work and progress (Zsigmond & Mura, 2023).

(2) Intrinsic motivation factors, including access to training courses, flexible work schedules, the pursuit of social status, and the aspiration for social prestige, hold substantial implications for the development and enhancement of digital

competences within the context of the public administrative sector. These intrinsic motivators are fostering a conducive environment that aligns individual interests with the acquisition of essential digital competences (Mungra et al, 2023). A flexible work schedule and the pursuit of social status and prestige align with the principles of Self-Determination Theory (Ryan & Deci, 2000; Fiske, 2010; Ciobanu et al., 2019).

Within public administration, an extended empirical literature has moved beyond the question of whether financial incentives, such as (3) extrinsic motivation (salary increments, performance-based bonuses, and additional compensation for digital skill acquisition and application), constitute a motivator within the public sector. Other authors have addressed the subject of the factors that motivate public sector employees, including the role of financial incentives in achieving organizational goals (Pandey et al, 2008; Klementová et al., 2023). However, there is high dissatisfaction among Romanian civil servants regarding the remuneration system, despite some income increases (Profiroiu et al., 2021).

Also, the development of digital competences is significantly influenced by (4) financial factors. PAHR are more likely to invest in digital competences development when they perceive a direct link between their efforts and financial rewards (Pollitt & Bouckaert 2000; Moynihan & Pandey, 2008).

(5) Political factors influence the development of digital competences within the Romanian public administration in specific directions. Regular transitions in political leadership and government administrations can influence the direction and sustainability of initiatives aimed at enhancing digital competencies (Androniceanu, 2023).

(6) Managerial factors are another category of factors influencing the digital competencies of PAHR. Leadership styles and particularly transformational leadership produce openness to technological change. Transformational leaders inspire and motivate employees to embrace innovation and change based on their digital competences. (Nica, 2013; Mura et al., 2023).

(7) Cultural factors within PA, including habits at the workplace, mentality, bureaucratic skills, organizational culture and transparency, significantly influence the development and integration of digital competencies. Bureaucracies may have detrimental impacts on human personality, infantilizing people, and not allowing them to develop to their true potential (Argyris, 1957).

Digital competencies are not only shaped by individual efforts but are also profoundly influenced by (8) social factors. An aging workforce may face challenges in adapting to rapidly evolving digital technologies, emphasizing the importance of ongoing training and upskilling. There is a large volume of literature about separate factors that influence the development of digital competences, but there is a lack of empirical evidence.

Several key causes were identified for analysing digital skills and competences in public administration. They are: (1) morally used equipment, programs and platforms (2) relative knowledge, competences and skills for using digital tools, (3) data security and privacy risks,(4) the speed of technological change, (5) excessive bureaucracy and rigid procedures, (6) budgetary constraints, (7) low interest for digitization, (8) lack of continuity in ICT integration, (9) less openness of PAHR for

the integration of ICT tools in professional activity, and all of them can limit or improve the professional activity and impact public service delivery.
In a world where scientists are trying to teach robots what is good and bad (Wallach & Allen, 2008), (1) morally used equipment should be history. The literature shows that (2) knowledge, competences and skills for the use of digital tools drive organizations' competitiveness, and innovation capacity (Van Laar et.al., 2017) and also can be a cause that influences digital competences in PA. Over the past three decades, there has been extensive exploration and study of data (3) security and privacy. There is also (4) the speed of technological change and a diversity of innovation between different parallel processes, which can be a cause that impacts PAHR digital competences (Pollitt, 2011).
Another important cause for digital competences in PA is (5) excessive bureaucracy and rigid procedures. The relationship between bureaucratic structure and human personality generates bureaucratic inefficiency in some cases, rigid procedures, people becoming "ritualists", having repetitive activities based on complicated procedures, with a difficult information circuit and many authorizations, notices, or signatures (Mori, 2017; Van Deursen & Van Dijk, 2009).
The impact of (6) budgetary constraints in central public administration regarding 40 HR issues and HR instruments was analysed and reveals a strong correlation between budgetary constraints and cost-cutting measures (Demmke, 2017). (7) Reduced interest of the organization's management in digitization is a factor that negatively influences the success of digitalization (Azizan et al, 2021; Tidd & Bessant, 2020) and a cause for digital competences development in PA too.
Research during the pandemic concluded that there was a positive and high relationship between ICT integration and digital competences (Manco-Chavez et al, 2020), so (8) the lack of continuity in ICT integration can bring significant changes to digital competences (Schwester, 2009). (9) Openness of PAHR for the integration of ICT tools in professional activity is analysed for modernizing government services and improving efficiency in an increasingly digital public administration (Mutiarin et. al., 2019).

2. Research methodology

The research was conducted within the National Agency of Civil Servants (NACS) in Romania. NACS is the public institution of the central public administration that ensures the records and management of the public function and civil servants, elaborating the frameworks of competence, policies and strategies, as well as drafting normative acts in the field (ANFP, 2023). This institution was selected and considered relevant for our pilot study since it supports the development of a professional civil servants' corpus, well-trained, politically neutral and capable of achieving performance standards established at the European Union level, to make public administration more efficient. The NACS also plays a significant role in effectively implementing public policies and strategies related to the management of civil servants, in the context of the digital transformation of public administration worldwide. The Agency is also responsible for developing competence frameworks that define the standards, indicators, and descriptors used to assess a civil servant's ability to effectively and efficiently solve tasks. These frameworks also guide the

selection and application of knowledge, skills and competences for professional and personal development (The Government of Romania, 2019). Additionally, the new public recruitment model requires all candidates to take an initial test of their IT knowledge as a mandatory step.

In this context, the main research objectives (O) for this study are presented below:

O1. Identifying the main factors and causes in NACS that positively influence the digital competences of human resources.

Obv. 2 Identifying the causal relationships between factors, causes and digital competences of the human resources from NACS.

The research hypothesis were the following:

H1. There is a significant relationship between the level of PAHR digital competences and the factors that influence them.

H 2. There is a significant relationship between the level of PAHR digital competences and causes that influence them.

H3. There is a simultaneous influence of factors and causes on developing PAHR digital competences.

The 25 research variables are grouped into three categories, as can be seen in Table 1 from Annex no. 1. The variables presented in Table 1 were identified to allow the researchers to analyse the internal environment of the NACS.

2.1. The research methods

A mixed methodology was applied to analyse data, test the hypotheses and accomplish the research objectives. An online survey has been developed to find out the perceptions of the NACS' human resources regarding the main factors and causes that could impact their digital competences. Data collection was carried out as part of the institutional research project titled "Digitization, digital transformation, and artificial intelligence in public administration". The questionnaire's items were created by the authors, and the majority of them were closed-ended, single- or multiple-choice, or Likert-type questions with a scale from 1 to 5. To allow the respondents to provide more information there were also several open-ended questions. Descriptive analysis, in which the responses are evaluated primarily through frequency analysis, is the first step in quantitative data analysis, followed by inferential statistics like Principal Component Analysis (PCA), as well as nonparametric tests. IBM SPSS 23.0 was used for data analysis, and an appropriate graphic representation was also generated using the software.

The current investigation is an empirical study (Chelcea, 2022) that draws upon theories from previous publications on digital competence. The research employed a sociological survey using a questionnaire. The questionnaire was structured into three main parts and summed up 33 questions. Eight socio-demographic questions about respondents' positions, education levels, genders, ages, hours worked per week, seniority in their current positions, etc., were included in the initial section of the questionnaire. The second part of the questionnaire includes fifteen questions that identify the respondent's perception of the level of training and digital competences possessed. The last section of the questionnaire includes ten questions that identify the respondent's perception regarding the new intelligent digital

technologies. The survey was disseminated online via the institution's official communication channels to the sample population from July to August 2023. The research gathers primary data from 23 respondents affiliated with the National Agency of Civil Servants, shedding light on the Romanian case.
The data gathered in this study was processed using SPSS version 23.0. The subsequent data analysis involved the use of 25 variables. To see how NASC employees' digital competences are influenced by different factors and causes, and how these variables are correlated, the authors designed three questions with 25 items per total (Q5 included 10 items, Q9 included 5 items and Q20 included 10 items).
The authors, designed question number 5 to identify which are the main causes that limit the access of NACS employees to digital technologies [To what extent do the causes listed below limit your access to digital technologies in your professional activity? (1 - Not at all; 5 - To a very large extent)]. Question number 9 identifies the perception of NACS employees regarding their level of digital competences [Please rate to what extent you are familiar with the following: (1 - Not at all familiar; 5 - To a great extent familiar)]. It includes five items, referring to the main digital competences that an employee should have (browsing the Internet, etc). Question 20 was designed to find out NACS employees' opinion regarding the main factors that could influence their digital competences [Please rate to what extent the following factors influence the level of digital competences of the NACS human resource (1 - Not at all; 5 - To a very large extent)]. Those questions can be found in Annex no. 2 and were selected to answer the research questions and objectives. The present research is part of a wider research that used a more complex tool, but for the present study, the authors used the database related to the theme of this research.
The Principal Component Analysis (PCA) was used to identify and analyse the correlations between the main causes, factors, and NACS human resources digital competences. PCA is a dimensionality reduction technique, mainly applied for simplifying complex data by transforming it into a more compact and lower-dimensional representation (Jolliffe, 2002). At the same time, most of the data's original variance is preserved. PCA can be usefully applied for analyzing questionnaire data when there are several survey questions or variables (Hair et al., 2019). In this case, the steps of PCA were: (1) data collection, ensuring that the responses are organized in rows and the questions are displayed in columns; (2) data standardization, when dealing with ordinal variables; (3) PCA calculation involves to compute the covariance matrix, the eigenvalues, and the eigenvectors; (4) selection the number of PCs, often based on the principle of cumulative variance explained. The selected PCs should explain about 80-90% of the total variance; (5) interpretation of the loadings' impact on each PC. High loadings indicate that a question dominates that PC. PCs should be named according to the questions with higher loadings. Saukani & Ismail (2019) propose a more flexible alternative of PCA, called Categorical PCA (=CATCPA) used for all types of questions.

2.2. The sampling method

The survey included public administration professionals who were affiliated with the National Agency of Civil Servants in Romania. From 135 NACS employees, only

67 tried to answer the questionnaire, and only 23 respondents completed all the questions. The main features of the sample are displayed in Table 2.
When it comes to the main field/fields of activity in which they work in NACS, it can be observed that most of them work in more than one field of activity: 10 – in organization of contests; 7 – in the management of civil servants; 4 in project management and legislation, etc. The specificity of the activities of NACS employees made it possible to include them in more than one field, thus explaining the number corresponding to their fields of activity/tasks.

Table 2. The main characteristics of the sample

Item	Categories	Number
Gender	Feminine	20
	Masculine	3
Age	20-30 years	3
	30-40 years	3
	40-50 years	13
	over 50 years	4
Education	Bachelor degree	7
	Master degree	13
	PhD	3
Tenure in the analysed public institution *(years)*	0-1 years	6
	2-7 years	8
	over 7 years	9
The main field/fields of activity in which you work in NACS	Management of public function and civil servants	7
	Record of civil servants	5
	International relations	3
	Organization of contests	10
	Information technologies	1
	Human resource	2
	Legislation	4
	Economic	1
	Project management	4
	Counseling at the Dignitary's Cabinet	0
	Administrative procedures	1
	Public procurement	1
	Internal Audit	0
	Ethics	0
Current status within NACS	Public official	0
	Civil servant	21
	Contractual staff	2
The hierarchic levels within the state's public administration	Top management level	0
	Middle management level	3
	Execution level	20

3. Research results and discussions

This section provides an overview of the study's findings about the correlations among causes, factors, and the level of digital competences among NACS human

resources. The statistical analysis tool SPSS 23.0 was used for data analysis. This involved conducting a range of parametric tests. The Principal Component Analysis was used to address the research objectives and answer the primary research questions of the study.

Questions 5, 9, and 20 and their sub-questions (items) represent 25 variables of this model. Table 3 represents the communalities, meaning the proportion of variability in each variable which can be explained by factors such as latent underlying dimensions. In the Extraction column, the values represent how much of the variance in each variable can be accounted for by the factors that were retained. Variables with higher values are well represented in the common factor space, while variables with low values are not well represented. In this case, the only variable which is not well represented is V5.10 with a coefficient of 0.91. The explanation for this coefficient value (V5.10 - 0.91) is that the respondents did not specify any other causes that could lead to an improvement of public administration human resources' (PAHR) digital competences. In Table 3, it can be observed the communalities for all 25 variables.

Table 3. Communalities by using the Principal Component Analysis

Variables	Raw		Rescaled	
	Initial	Extraction	Initial	Extraction
V 5.1 Used and old equipment, programs and platforms	1.579	1.137	1.000	.720
V 5.2. Relative knowledge and competences for using technology and digital tools	1.649	1.445	1.000	.876
V 5.3. Data security and privacy risks	1.655	1.607	1.000	.971
V 5.4. The speed of technological change	1.538	1.351	1.000	.878
V 5.5. Excessive bureaucracy and rigid procedures	.930	.764	1.000	.822
V 5.6. The budgetary constraints regarding the organization of training for the development of digital skills	1.596	1.329	1.000	.833
V 5.7. Reduced interest of the organization's management for digitization	1.029	.815	1.000	.792
V 5.8. Lack of continuity in ICT integration in NACS activities	1.480	1.385	1.000	.936
V 5.9. The degree of openness of the human resources in NACS for the integration of ICT tools in your activity and the organization	1.450	.887	1.000	.612
V 5.10. Others …	.211	.019	1.000	.091
V. 9.1. Browsing the Internet and searching for information online	.211	.154	1.000	.729
V 9.2. The concept of cyber security and measures to protect personal and professional data	1.322	1.060	1.000	.802
V 9.3 The ability/ knowledge to use the Microsoft Office package	.813	.705	1.000	.867
V 9.4 Use of online communication platforms: e-mail, Zoom, WhatsApp, Skype	1.135	1.053	1.000	.928
V 9.5. Data analysis and drawing up reports on current activity using digital tools specific to your field of activity (e.i. human resources, competition organization, public procurement, etc.)	1.596	1.182	1.000	.741

Variables	Raw		Rescaled	
	Initial	Extraction	Initial	Extraction
V 20.1. Technological factors (evolution of technology, ICT tools and artificial intelligence; low degree of digital platforms interoperability, etc.)	1.830	1.645	1.000	.899
V 20.2. Intrinsic motivation factors (training courses, flexible schedule, working from other locations, social status, professional prestige, etc.)	1.655	1.585	1.000	.958
V 20.3. Extrinsic motivation factors (financial rewards, salary)	2.117	2.061	1.000	.974
V 20.4. Financial factors (internal resources allocated for training; monthly income, premiums/ salary bonuses granted based on employee performance, standard of living, etc.)	2.094	1.882	1.000	.899
V 20.5. Legislative factors (requirements on ICT and AI digital competences integrated into specific regulations)	1.924	1.734	1.000	.901
V 20.6. Political factors (frequent changes on the political scene, the vision of the political class regarding digitalization; priorities set/agreed by political factors, etc.)	2.263	1.972	1.000	.871
V 20.7. Managerial factors (openness of managers to the integration of new technological changes, relations between superiors and employees, management style, etc.)	1.924	1.781	1.000	.925
V 20.8. Cultural factors (habits at the workplace, mentality, bureaucratic skills, organizational culture, organizational values, ethics, morals, organization's image, organizational transparency; teamwork, etc.)	1.702	1.554	1.000	.913
V 20.9. Social factors (aging human resource, educational structure, resistance to change; society structure, digital platforms with wide social accessibility, etc.)	1.544	1.433	1.000	.928
V 20.10. Administrative factors (the way activities are organized; the bureaucratic administrative procedures, the methodologies and rules for applying the regulations regarding digital competences, etc.)	1.211	1.101	1.000	.910

Source: Authors' computation

The proportion of variation attributed to each variable can be explained by the principal components, which represent the underlying latent continuum. The initial value of the communality in a principal components analysis is 1, as seen in the Initial column (Table 3). The percentage of each variable's variance that the principal components can account for is indicated by the values in the Extraction column. In the common factor space, variables from Table 3 with the highest values for causes are recorded by: data security and privacy risks (.971), lack of continuity in ICT integration in NACS activities (.936), use of online communication platforms: e-mail, Zoom, WhatsApp, Skype (.928), extrinsic motivation factors (financial rewards, salary) (.974), intrinsic motivation factors (training courses, flexible schedule, working from other locations, social status, professional prestige, etc.) (.958), managerial factors (.925), cultural factors (.913) and administrative factors (.910); whereas those with low values are not.

According to the principle of cumulative variance retained, six PCs have been extracted from the 25 variables, which explain 86.791% of the initial variability. PC1 explains 17.28% of the total variability, while PC2 explains 5.128%.

A factor analysis was performed for the authors to analyze the causes and internal and factors related to the development of digital skills among public administration employees affiliated with the NACS. The aim was to get insight into the dimensions and significance of the variables derived from our questionnaire. Furthermore, factor analysis can be applied to generate a concise representation of the interrelationships among data, hence facilitating the classification of variables into appropriate groups (classes). We believe that their perception regarding the main causes and factors that influence PAHR level of digital competences will help us to identify the significant aspects for the development and adoption of public strategies and policies.

The sample size of 23 participants in this research, obtained from a public institution, is considered to be adequate for this particular research study (Solemon et al., 2010; Sison et al., 2006). The study includes variables that are measured on a six-point Likert-type scale. First, it is necessary to verify if the data are suitable and appropriate for principal component analysis (Field, 2009). In assessing the appropriateness of the data, sample size and the degree of correlation between the variables are the two primary factors to take into account. Examining the degree of inter-correlations between the variables is another way to determine if the data are appropriate for PCA.

One step in factor analysis is factor extraction. The process is figuring out how few parameters, or components, can accurately capture the relationships between the various sets of variables. The extraction approach in this study is principal component analysis. Two sets of data that can be used to determine the number of factors (components) that are retrieved are the scree plot (Field, 2009) and eigenvalues (also known as the Kaiser criterion). The factors with eigenvalues greater than 1 will be extracted and kept for additional research using the first technique, eigenvalues or Kaiser's criterion. According to the principle of cumulative variance explained and to the Kaiser principle, we retain the first six components (Table 4).

Table 4. Total variance and eigenvalues explained

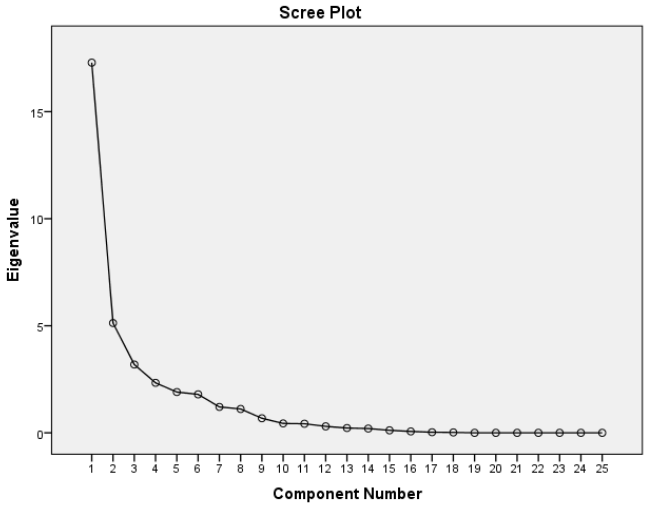
Component	Initial Eigenvalues[a]			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	17.289	47.425	47.425	17.289	47.425	47.425
2	5.128	14.067	61.492	5.128	14.067	61.492
3	3.190	8.750	70.242	3.190	8.750	70.242
4	2.333	6.400	76.642	2.333	6.400	76.642
5	1.904	5.223	81.864	1.904	5.223	81.864
6	1.796	4.926	86.791	1.796	4.926	86.791

Source*:* Authors' results

Table 4 presents the eigenvalues of the correlation matrix, which indicate the significance of each principal component. Additionally, it provides the proportion of

the overall variability accounted for by each principal component, as well as the cumulative proportion. The first four main components were selected, accounting for 76.642% of the total variability observed in the dataset.

Figure 1. Scree plot Principal Component Number



Source: Authors' computation

The scree plot illustrates how eigenvalues relate to the number of factors. Starting from the 7th factor, the scree plot curve levels off, indicating that each subsequent factor contributes progressively less to the overall variance. Table 5 presents the linear correlation coefficients between the initial items, consisting of 25 variables, and the six principal components, labeled as PC1 to PC4. These coefficients were derived following the application of a Varimax rotation. The six extracted PCs are also confirmed by the scree plot (Figure 1).

Table 5. The six Principal Components Rescaled

Items (variables)	Rescaled Component					
	1	**2**	**3**	**4**	**5**	**6**
V 20.9 Social factors	.933	-.078	-.073	-.054	.194	.075
V 20.3. Extrinsic motivation factors	.932	-.154	-.032	-.218	-.043	-.178
V 20.10. Administrative factors	.931	-.091	.140	-.006	-.005	-.118
V 20.7. Managerial factors	.903	-.150	-.225	.137	-.076	-.111
V 20.2. Intrinsic motivation factors	.898	.028	.053	-.268	.255	.109
V 20.8 Cultural factors	.872	-.133	.036	-.193	-.258	-.171
V 20.6. Political factors	.842	-.012	.106	.174	-.257	-.235
V 20.1. Technological factors	.823	.147	.031	-.167	.345	.226
V 20.4. Financial factors	.815	-.391	-.264	-.065	-.001	-.087
V 9.4 Use of online communication platforms: e-mail, Zoom, WhatsApp, Skype	.787	.030	.372	.329	.242	-.045

Items (variables)	Rescaled Component					
	1	**2**	**3**	**4**	**5**	**6**
V 9.3 The ability/ knowledge to use the Microsoft Office package	.759	.042	.368	.368	.067	-.122
V 20.5. Legislative factors	.734	-.325	-.136	-.207	.133	.422
V 9.5. Data analysis and drawing up reports on current activity using digital tools specific to your field of activity	.665	-.128	.459	.154	-.211	-.053
V. 9. 1. Browsing the Internet and searching for information online	.569	-.256	.396	.266	.258	.215
V 5. 9. The degree of openness of the human resource in NACS for the integration of ICT tools in your activity and the organization	.542	.206	-.365	.214	-.159	.267
V 5. 7. Reduced interest of the organization's management for digitization	.499	.424	.002	-.241	-.486	.261
V 5. 10. Others …	.250	-.092	.099	-.088	-.035	.038
V 5. 3. Data security and privacy risks	.396	.837	-.269	.008	.126	.157
V 5. 4. The speed of technological change	.220	.829	.030	-.365	.012	-.091
V 5. 8. Lack of continuity in ICT integration in NACS activities	.320	.815	.084	-.064	-.389	.085
V 5. 5. Excessive bureaucracy and rigid procedures	.254	.661	-.384	.407	-.083	.000
V 5. 2. Relative knowledge and competences for using technology and digital tools	.093	.299	-.570	.133	.445	-.488
V 9.2. The concept of cyber security and measures to protect personal and professional data	.212	.157	.574	.441	.266	.370
V 5.1 Used and old equipment, programs and platforms	.288	.451	.536	.142	.211	-.287
V 5. 6. The budgetary constraints regarding the organization of trainings for the development of digital skills	.351	-.112	-.447	.663	-.134	.198

Source: Authors' computation

The primary method of interpretation is mostly conducted using the pattern matrix. However, the structural matrix serves as a valuable tool for validation (Field, 2009). The data presented in Table 5 indicate a stronger correlation between the newly formed components and the initial variables (items). The initial variables have been rearranged to emphasize the correlation coefficients that indicate a stronger association for each principal component. This reordering facilitates the interpretation of the principal components. The principal components were defined based on the primary variables: PC1 – *factors* influencing digital competences, PC2 – *causes* influencing digital competences, PC3 –*ICT support*, and PC4 –*financial resources*. Even if PC6 and PC7 are retained, they are influenced to a lesser extent by the 25 variables. Certain variables have been observed to exhibit negative loadings. The presence of a negative sign in the loading does not provide any indication of the magnitude or strength of the relationship between the variable and the factor. Nevertheless, this implies that the variable exhibits an inverse relationship with the factor.

The findings of the PCA indicate that within the realm of PA, PAHR opinions are influenced by four distinct components that have the potential to impact their degree of digital competencies.

The first component (PC1) refers to the main *factors* that influence the level of PAHR' digital competences. Contrary to other studies (Casalino et al., 2020; Azizan et al. 2021), factors like social (0.933), extrinsic motivation (0.932), administrative (0.931), management (0.903) have in NACS respondents' opinion a greater impact, than the technological ones. The other factors that play a role in improving digital competences are intrinsic motivation (0.898), cultural (0.872), political (0.842), technological (0.823), and financial (0.815). Social factors, like NACS's aging human resources, point out the institution employees' opinion regarding the lack of adequate digital competences to support learning and task accomplishment. The findings presented in this study align with previous research that demonstrates that older people are less willing to improve their digital competences or to learn how to use new ICT instruments (Rasi & Kilpeläinen, 2015; Carenzio et al., 2021; Schirmer et al., 2023). Extrinsic motivation, like salary; financial rewards; organizational constraints (procedures, methodologies, internal norms), and pressures, confirm the willingness of PAHR to develop digital literacy, only if at the organizational level are established different constraints regarding their future evaluation or career. According to Bareket - Bojmel et al. (2017), the presence of external incentives has been found to result in enhanced performance, particularly in situations involving basic and standardised tasks that can be easily measured and evaluated. Conversely, previous research has indicated a correlation between extrinsic motivation and negative psychological outcomes, as well as reduced levels of overall well-being. These factors can impede task engagement and hence diminish the efficiency of employees' learning endeavours (Cerasoli et al., 2014; Kuvaas et al., 2017). If the public administration organizations are willing to pay for the training courses, then the civil servants will develop their digital competences. This is in contrast with the main scientific literature published, where intrinsic motivation dominates and has a positive impact on learning results (Vansteenkiste et al., 2009; Dweck, 2013; Zaccone & Pedrini, 2019). Also, administrative factors (administrative and bureaucratic procedures, the way activities are organized) and managerial factors (openness of managers to the integration of new technological changes, relations between superiors and employees, management style) have in our respondents' view an important impact on digital competences improvement (Wasono & Furinto, 2018; Nowacka & Rzemieniak, 2021). A good manager knows how to efficiently organize employees' tasks to grow their productivity and give them time to learn new skills or the leader with his team anticipates the professional learning needs of his team and develops a training program for each person within the organization. These results confirm hypothesis 1 - *there is a significant relationship between the level of human resources' digital competences and the factors that influence them*.

The second component (PC2) includes the main *causes* that influence the level of PAHR' digital competences. It can be observed that form 5 included causes, and 3 had a significant influence on NACS human resources' opinions. These causes are:

data security and privacy risks (0.837); speed of technological change (0.829) and lack of continuity in ICT integration in NACS activities (0.815). According to Bogdanovskaya et al. (2020) low digital competence in areas like information security has a big impact on online risks. Employees' safe behaviour skills in a digital environment encompass the use of protective devices, the development of knowledge regarding techniques and methods for safeguarding personal data and privacy, the aptitude to identify weaknesses in digital competence, the capacity to analyse and assess information security threats and risks, and the proficiency to implement measures to mitigate information security breaches. Additionally, various studies have justified the necessity of possessing abilities about information retrieval, processing, and systematisation, as well as skills in virtual self-presentation and identifying the risks and threats inherent in the digital environment (Ferrari & Punie, 2013; Brolpito, 2018). The second cause is forcing organizations from public administration to reassess their organizational structures due to the accelerated rate of adopting innovative technologies. As a result, each member of the top management levels must be actively involved in the organizational restructuring initiatives, enabling them to individually contribute to the digital transformation of the organization and employees' digital competences (Becker et al., 2018; Mazurchenko et al., 2020). The third cause refers to a lack of continuity in ICT integration in NACS activities. The absence of consistent application of technological tools leads to a low level of digital competence and a human resource resistant to changes, especially the ones that involve the use of ICT tools. Digital instruments could help NACS human resources to be more productive and achieve better results while completing their tasks. In this sense, other researches show that there is a positive relationship between the use of digital tools and higher performance at work (Marion & Fixson, 2021; Bawono & Setyadi, 2021; Tuoi & Thanh, 2023). Hypothesis 2 – "*There is a significant relationship between the level of human resources' digital competences and causes that influence them*" was also validated by the values obtained for the second component.

The third component (PC3) brings into discussion the *ICT support*. Within the administrative environment that affects the digital competences level, the study highlights on one hand the data security and organizational measures adopted to protect personal and professional data, and, on the other hand, on the old equipment, programs, and platforms that are used by PAHR in their daily activities. Lucas et al. (2021) present the provision of necessary physical and virtual resources, as well as the support and guidance required to effectively utilize digital technology as an important contextual factor, that contributes to individuals' digital competences improvement. It is important to keep in mind that without a modern infrastructure and secured platforms, civil servants cannot defend against cyber-attacks, or protect professional data. The current period is characterized by the integration of big data technologies into aging computer systems that support essential infrastructures. The modernization of legacy critical infrastructures raises the need to pay greater attention to the intersection of cyber security with traditional engineering needs such as safety, dependability, and resilience. This attention is essential due to the historical

disconnection of these infrastructures from the Internet, when data were not so easily accessible to cyber-attacks. Because IT infrastructures are frequently interconnected, security and privacy have to be ensured through design and regulation (Michalec et al., 2022).
The fourth component (PC4) is dominated by the *financial resources* (budgetary constraints) allocated to PAHR training courses to develop their digital competences. The impact of budgetary constraints influences the cost-cutting measures (Demmke, 2017) in PA organization in a negative manner, because one of the fastest ways to reduce costs is to diminish the number of employee training courses.
In the end, the results from all four components of the PCA confirm hypothesis 3 and show that "*there is a simultaneous influence of factors and of causes on developing human resources' digital competences*". As can be seen, hypothesis 3 has been validated as well.

4. Conclusions, limits, and future research

In this paper, we used PCA to investigate the primary causes and factors that may influence the digital competencies of human resources from NACS. Four major components, derived from the simplification of 25 variables, collectively account for 76.642.% of the variation that was initially observed. Moreover, the literature review provided the causes and contributing factors. In contrast with previous studies, the present research discovered that the main factors that influence digital skills are: social factors, extrinsic motivation factors, and administrative and managerial factors; while the main causes with an impact on digital competence development are: data security plus privacy risks, the dynamic of technologies, lack of continuity in ICT integration in organization activities, excessive bureaucracy, etc. The results of the correlation study showed that there is a positive correlation between all variables. Based on the research results, the key digital competences used by NACS human resources in their daily activities are: online communication platforms (V 9.4. – 0.787: e-mail, Zoom, WhatsApp, Skype); the ability to use the Microsoft Office package (V 9.3. – 0.750); data analysis and drawing up reports on current activity using digital tools specific to their field of activity (e.i. human resources, competition organization, public procurement, etc.) (V 9.5 – 0.665) and browsing the Internet and searching for information online (V 9.1. – 0.569).
Taking into consideration the analysis results, it is recommended to recognise that future initiatives aimed at enhancing the digital competencies of civil servants should not be generic. The management of NACS should consider both the strong impact of socio-demographic (age, educational level, gender) and contextual factors (old infrastructure, budgetary constraints) and the correlations between them and digital competences when the human resources strategy will be updated.
In the end, the development and improvement of digital competence necessitates a collaborative and interconnected approach, rather than isolated efforts. The acquisition and enhancement of digital competences requires setting up of broader

connections with soft skills, creative thinking, use of e-services, advancement of technological infrastructure, and transparency.
The main limit of this research is the reduced number of respondents, due to the restricted and unfavourable period the respondents were asked to participate in this survey. Further investigation will explore the influence of unmeasured variables on public administration human resources' digital competences within the context of central, territorial, and local public administration institutions.

Conflict of interest.
There is no conflict of interest.

Acknowledgment
The paper has been prepared under the research project named: *Digitization, Digital Transformation, and Artificial Intelligence in Public Administration*, 2023, financed by the Bucharest University of Economic Studies and is part of the research strategy of the International Centre for Public Management.

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Annex no. 1

Table 1. Description of variables

Variables' category	Variables	Description
Causes	V 5.1 Used and old equipment, programs and platforms	Morally and physically used equipment and technologies
	V 5. 2. Relative knowledge and competences for using technology and digital tools	Limited knowledge and competences regarding the use of ICT tools
	V 5. 3. Data security and privacy risks	The knowledge of how to protect/ secure professional and personal data, and also how to assess the privacy risks, and adopt the adequate measures
	V 5. 4. The speed of technological change	The dynamic of technological change
	V 5. 5. Excessive bureaucracy and rigid procedures	The large number of rigid procedures, norms, methodologies that need to be applied by the book.
	V 5. 6. The budgetary constraints regarding the organization of trainings for the development of digital skills	Limited financial resources for human resources development programs
	V 5. 7. Reduced interest of the organization's management for digitization	Lack of organization's top management interest in digitalization of daily activities
	V 5. 8. Lack of continuity in ICT integration in NACS activities	Disruptive ICT integration in NACS activities
	V 5. 9. The degree of openness of the human resource in NACS for the integration of ICT tools in your activity and the organization	The human resource willingness to integrate and use the ICT tools in their activity and the organization.
	V 5. 10. Others …	The respondent will indicate, if he/ she desire, another cause.
Digital competences	V. 9. 1. Browsing the Internet and searching for information online	Searching for information on Internet.
	V 9.2. The concept of cyber security and measures to protect personal and professional data	The knowledge of how to use and protect personal and professional data.
	V 9.3 The ability/ knowledge to use the Microsoft Office package	The ability/ knowledge to use: Word, Excel, PowerPoint, OneNote, Outlook, Teams, OneDrive, Editor.
	V 9.4 Use of online communication platforms: e-mail, Zoom, WhatsApp, Skype	The ability/ knowledge to use: e-mail, Zoom, WhatsApp, Skype, Webex.
	V 9.5. Data analysis and drawing up reports on current activity using digital tools specific to your field of activity (e.i. human resources, competition organization, public procurement, etc.)	The ability/ knowledge to analyse data and draw complete reports on every current activity.
Factors	V 20.1. Technological factors	Evolution of technology, ICT tools and artificial intelligence-AI; low degree of digital platforms interoperability, etc.
	V 20.2. Intrinsic motivation factors	Training courses, flexible schedule, working from other locations, social status, professional prestige, etc.
	V 20.3. Extrinsic motivation factors	Financial rewards, salary.

Variables' category	Variables	Description
	V 20.4. Financial factors	Internal resources allocated for training; monthly income, premiums/ salary bonuses granted based on employee performance, standard of living, etc.
	V 20.5. Legislative factors	Requirements on ICT and AI digital competences integrated into specific regulations.
	V 20.6. Political factors	Frequent changes on the political scene, the vision of the political class regarding digitalization; priorities set/agreed by political factors, etc.
	V 20.7. Managerial factors	Openness of managers to the integration of new technological changes, relations between superiors and employees, management style, etc.
	V 20.8 Cultural factors	Habits at the workplace, mentality, bureaucratic skills, organizational culture, organizational values, ethics, morals, organization's image, organizational transparency; teamwork, etc.
	V 20.9 Social factors	Aging human resources, educational structure, resistance to change; society structure, digital platforms with wide social accessibility, etc.
	V 20.10. Administrative factors	The way activities are organized; the bureaucratic administrative procedures, the methodologies and rules for applying the regulations regarding digital competences, etc.

Annex no. 2

The selected questions for the survey

Q5. To what extent do the causes listed below limit your access to the use of digital technologies in your professional activity? (1 - Not at all; 5 - To a very large extent)

Item	1	2	3	4	5
5.1 Used and old equipment, programs and platforms					
5.2. Relative knowledge and competences for using technology and digital tools					
5.3. Data security and privacy risks					
5.4. The speed of technological change					
5.5. Excessive bureaucracy and rigid procedures					
5.6. The budgetary constraints regarding the organization of trainings for the development of digital skills					
5.7. Reduced interest of the organization's management for digitization					
5.8. Lack of continuity in ICT integration in NACS activities					
5.9. The degree of openness of the human resource in NACS for the integration of ICT tools in your activity and the organization					
5.10. Others …					

Q9. Please rate to what extent you are familiar with the following: (1 - Not at all familiar; 5 - To a great extent familiar)

Item	1	2	3	4	5
9.1. Browsing the Internet and searching for information online					
9.2. The concept of cyber security and measures to protect personal and professional data					
9.3 The ability/ knowledge to use the Microsoft Office package					
9.4 Use of online communication platforms: e-mail, Zoom, WhatsApp, Skype					

Item	1	2	3	4	5
9.5. Data analysis and drawing up reports on current activity using digital tools specific to your field of activity (e.i. human resources, competition organization, public procurement, etc.)					

Q20. Please rate to what extent the following factors influence the level of digital competences of the NACS human resource (1 - Not at all; 5 - To a very large extent).

Item	1	2	3	4	5
20.1. Technological factors (evolution of technology, ICT tools and artificial intelligence-AI; low degree of digital platforms interoperability, etc.)					
20.2. Intrinsic motivation factors (training courses, flexible schedule, working from other locations, social status, professional prestige, etc.)					
20.3. Extrinsic motivation factors (financial rewards, salary)					
20.4. Financial factors (internal resources allocated for training; monthly income, premiums/ salary bonuses granted based on employee performance, standard of living, etc.)					
20.5. Legislative factors (requirements on ICT and AI digital competences integrated into specific regulations)					
20.6. Political factors (frequent changes on the political scene, the vision of the political class regarding digitalization; priorities set/agreed by political factors, etc.)					
20.7. Managerial factors (openness of managers to the integration of new technological changes, relations between superiors and employees, management style, etc.)					
20.8. Cultural factors (habits at the workplace, mentality, bureaucratic skills, organizational culture, organizational values, ethics, morals, organization's image, organizational transparency; teamwork, etc.)					
20.9. Social factors (aging human resources, educational structure, resistance to change; society structure, digital platforms with wide social accessibility, etc.)					
20.10. Administrative factors (the way activities are organized; the bureaucratic administrative procedures, the methodologies and rules for applying the regulations regarding digital competences, etc.)					