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THE LINK BETWEEN E-GOVERNMENT AND RESEARCH AND DEVELOPMENT IN THE FIELD OF ICT

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Abstract
The research presented in this article had as objectives carrying out a review of the specialized literature in the field of E-government and the research and development in the field of ICT. To highlight the relationship between E-government and the ICT upsurge opportunities offered by frequent technological breakthroughs, correlation analyzes were carried out using the secondary data made available by the Eurostat databases. Three research hypotheses were formulated and the second research hypothesis, the one regarding the readiness of public sector to upgrade to Digital Transformation (DX) in terms of monetization of digital assets, a weak positive or strongly negative relationship between e-governance activities and companies' IT research and development expenditures is validated in the case of most European countries. At the opposite pole it was revealed that there are also countries where investments in the development of IT infrastructure led to the upsurge of e-government

infrastructure, as a starting point in promoting the increase in expenses with acquiring new IT terminals and services upgrading, as a leading example for countries with lower expenditures on ICT sector development. The other two research hypotheses regarding leveraging the strategic advantages of digitization in terms of state of knowledge and research staff, have been revealed that most European countries, including Romania, have a strongly negative relationship to present e-government services development, requiring future analysis of upstream and downstream use of advanced ICT techniques implemented in e-government development feedback based on reliable data.
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1. INTRODUCTION

The evolution of the ICT sector globally is strongly influenced by the pace of research and development in the field. Both large companies in the field and the government sector have invested heavily in IT research, being aware of the benefits of assimilating digitization tools at the public and private level. The scale of innovative processes in the field of ICT has a significant impact on digitization in the public sector and in general on E-Government.

This scientific introduction sets the stage for a detailed exploration of the relationship between e-government and IT research, emphasizing the importance of this interplay in advancing both fields.

The introduction of e-government has transformed public sector operations in recent decades, improving the effectiveness, accessibility, and transparency governmental services. The use of digital tools and systems to distribute public services and promote participatory governance, or e-government, is supported by ongoing developments in information technology (IT) research. The dynamic interaction between IT research and e-government not only spurs the creation of novel technological solutions but also advances the advancement of digital governance frameworks.

With an emphasis on four crucial areas—digital infrastructure, cybersecurity, data analytics, and user-centered design—this article aims to investigate the synergistic relationship between e-government projects and IT research. This study seeks to provide a thorough understanding of how IT research propels e-government breakthroughs and how e-government projects, in turn, motivate more IT research and innovation by analyzing the reciprocal influences and advantages within both fields.

The foundation of successful e-government initiatives is the creation of a strong digital infrastructure. Research in fields including mobile technologies, broadband networks, and cloud computing directly supports the development of dependable and scalable digital environments that serve a variety of public services (Dawes, 2008; Janssen & Estevez, 2013). Furthermore, the real-world use of e-government projects provides priceless information and testing grounds for continuing IT research, encouraging an iterative cycle of adaptation and improvement (Gil-García, Helbig, & Ojo, 2014).

Because the data and services involved in e-government are sensitive, cybersecurity becomes a critical concern. To secure these digital platforms, IT research focusing on risk management, threat detection, and encryption is essential (Bertot, Jaeger, & Grimes, 2010; Scholl & Luna-Reyes, 2011). Modern cybersecurity research and innovation are driven by the need to defend e-government systems from ever-evolving cyber threats, underscoring the need of cooperation between governmental agencies and academic institutions (Luna-Reyes & Gil-García, 2011).

Artificial intelligence (AI) and data analytics are essential components for improving e-government services. The vast amount of data produced by digital government initiatives serves as a rich environment for big data and artificial intelligence research, allowing for the extraction of insights that influence public policy and service delivery (Srivastava & Teo, 2007; Zuiderwijk, Janssen, & Dwivedi, 2015). On the other hand, the difficulties in managing massive amounts of government data spur improvements in analytical techniques and tools, illustrating the mutual impact between both fields.

In conclusion, the implementation of user-centered design is crucial in guaranteeing the accessibility and usability of e-government services. Research in accessibility, user experience (UX) design, and human-computer interaction (HCI) is essential to creating digital platforms that meet the wide range of demands of the general public (Medaglia, 2012). Research is further informed by feedback and usage statistics from these platforms, which leads to iterative improvements that increase the accessibility and inclusiveness of e-government services (United Nations Department of Economic and Social Affairs, 2020).

This essay aims to clarify the reciprocal advantages and future directions of the interaction between e-government and IT research by exploring these interrelated fields. The debate will identify important problems and areas for future research while highlighting successful implementations through a review of the literature and case studies. In order to fully realize the potential of e-government and promote innovation in IT research, our investigation highlights the vital necessity for continued interdisciplinary collaboration in terms of upgrading to Digital Transformation (DX) both in private and in public sector.

In the research presented in this article, we aim to highlight the possible connection between E-Government and IT research. For this, in the research carried out, we aimed to answer the following research questions:

- What is the state of knowledge regarding the link between E-government and IT research?
- What is the relationship between E-Government and the expenditure allocated to ITC research?
- What is the relationship between research staff in the information and communication technology sector and E-Government?

The answers to these questions, revealed by the research results, help to create a clearer view of the importance of the IT research sector for the E-government effort throughout the European Union (including the EAA countries).

2. LITERATURE REVIEW

The body of research on the interaction between IT research and e-government demonstrates a complex dynamic marked by reciprocal influence and progress. A sustainable e-government - ICT sector connection requires a bidirectional relationship based on feedback supported by reliable data.

Feedback of usage is as important as the discovery of new technologies and the rediscovery of old technologies enhanced by new IT terminals. As a central pillar, we also consider the readiness to unroll implementation of newly discovered IT technologies on terminals already purchased by public institutions.

This article took into account in the analysis the link between e-government and ICT development and the fact that national macro-economic development policies are based on each country's ability to acquire new IT techniques and equipment in relation to the frequent IT breakthroughs.

That is precisely why the macro-economic policies of each nation aim at the economic security of the nation itself. User feedback of the implementation on test areas in a strongly controlled environment is required for prediction and prevention of new high risk of economic crises (Iordache, Zamfir & Ionescu, 2022).

This review, which focuses on the fields of digital infrastructure, cybersecurity, data analytics, and user-centered design, highlights the most important conclusions and revelations from previous research.

1. Digital Infrastructure: For e-government projects to be implemented successfully, a strong digital infrastructure must be established (Dawes, 2008; Janssen & Estevez, 2013). Studies have underscored the significance of cloud computing, mobile technologies, and broadband networks in establishing dependable and scalable systems. Research shows that spending on digital infrastructure supports present e-government services and lays the groundwork for new ones in the future (Gil-García, Helbig, & Ojo, 2014). Real-world e-government project implementations promote a cycle of continuous development by providing insightful case studies and datasets for further IT research (Gil-García, Helbig, & Ojo, 2014).

2. Cybersecurity: Because the data and services used in e-government systems are sensitive, the security of these systems is a major worry. Advances in risk management, threat detection, and encryption are highlighted in the literature as crucial elements of safe e-government systems. (Bertot, Jaeger, & Grimes, 2010; Scholl & Luna-Reyes, 2011). Studies have indicated that cooperation between government agencies and information technology researchers is essential for creating and implementing efficient cybersecurity protocols (Luna-Reyes & Gil-García, 2011). Innovation in cybersecurity research is driven by the need to defend e-government systems from more complex cyber threats, highlighting the mutually reinforcing relationship between both domains (Bertot, Jaeger, & Grimes, 2010).

3. Data Analytics: Public service delivery is changing as a result of the incorporation of artificial intelligence (AI) and data analytics into e-government platforms. Research has indicated that sophisticated analytical

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instruments and algorithms empower governments to comprehend the requirements of the populace, enhance the delivery of services, and anticipate forthcoming patterns (Srivastava & Teo, 2007; Zuiderwijk, Janssen, & Dwivedi, 2015). Large-scale government data processing and analysis presents a number of difficulties, which have sparked a lot of big data and artificial intelligence research (Srivastava & Teo, 2007). This work advances data science more broadly while simultaneously improving the functionality of e-government platforms (Zuiderwijk, Janssen, & Dwivedi, 2015).

4. User-Centered Design: Services provided by e-government must be easy to use and available to a wide range of users. For platforms to be developed that satisfy the demands of all users, research in accessibility, user experience (UX) design, and human-computer interface (HCI) is essential (Medaglia, 2012). The literature emphasizes how crucial iterative design procedures and user feedback are to the development of inclusive and user-friendly e-government services (United Nations Department of Economic and Social Affairs, 2020). Research is further informed by the data created by user interactions with these platforms, which results in ongoing improvements to design and usability (Medaglia, 2012).

The literature study demonstrates how e-government and IT research are complementary fields, with advances in one influencing development in the other. The ongoing development and improvement of IT innovations and digital government services demonstrate the mutual benefits of this interaction. To further enhance this dynamic link, future research should keep investigating cutting-edge technologies like blockchain, quantum computing, and the Internet of Things (IoT). To effectively address the multifaceted difficulties and opportunities found in the fields of IT research and e-government, interdisciplinary collaboration is still important.

On the same level of upstream and downstream usage feedback, the testing experiments of the new ICT tools and the case studies must also include the description of the environment in which the new IT techniques were implemented - how technologically equipped the environment was at the time of implementation and how digitally skilled were the employees to maintain the long-term upgrade level in terms of sustainability.

The importance of e-government is worldwide acknowledged (Arshad et al, 2024) and it received more attention while global issues force governmental institutions to reconsider their way of working and effectively serve (Racis & Spano, 2024) the demands of the population.

The analysis of macro-economic policies in the medium and long term should be aligned with the research strategies in IT in the medium and long term so that the gap between what is discovered in IT and what can be implemented in the public sector in the general interest of the population is narrowed in place to go deeper.

Taking into account the generations that grow mentally and physically with unlimited and unconditional access to digital resources opens the horizons to the vital necessity of overcoming the current incompatibility of full use of digital resources. The generations that grow up on phones and tablets become

adults who do not find the use of paper-based media useful and ecological. The world is heading in this direction. Digitization is no longer a wish as a source of pride in the technological endowment of a nation, it is a reality that incorporates our daily life, the old human skills tend to downgrade meanwhile the digital skills take over and erase old ways of doing and living.

The reality that we are facing, is that the new generation of population has no clue of the old politics and working skills and has less to none percent of interest in going back to paper and pen within the working environment as well as in the interaction with public institutions. The new generation of population opens the laptop or smartphone and communicates with public institutions offering their transparent data and transactions. From this perspective, the aim is that the public institution has to be ready to process this large number of requests and data in the fastest reaction time as the ICT sector can offer.

In order to achieve a complete digital transformation, the OECD supports the creative and inclusive e-government through the 6 aspects, respectively: government as a platform, data driven, user driven, digital by design, proactiveness and open by default (Hujran et al, 2023). ICT infrastructure plays a crucial role in creating efficient e-government frameworks (Kibria & Hong, 2024), together with relevant administrative reforms for strengthening the structure and operations part (Bisogno et al, 2024). Researchers demonstrate that the development of ICT enhanced economic protection (Chen et al, 2024) in time of Covid 19 pandemic, but also this kind of disruptive events have the potential to speed socioeconomic improvements (Roztocki et al, 2024), including services offered by the electronic government (Suhanyi et al, 2024).

Sustainability is promoted by e-government policy (Alofaysan, 2024) through taking into consideration the SDG agenda (Silal & Sharma, 2024), enabling transparency and democracy (Kibria & Hong, 2024). Researchers identified e-governance difficulties such as lack of expertise, poor strategy and management, incapacity, mediocre technological framework, among others (Arshad et al, 2024), key inhibiting factors of e-governance such as personal, institutional, operational and technical restrictions (Gupta et al, 2023). The level of education, average age of the population and income have an impact on the degree of online interaction with governmental institutions (Suhanyi et al, 2024).

Batista (et al, 2023) findings demonstrate a positive correlation between e-government maturity and income per person, internet connection and usage, urbanization level, GDP per person. E-government maturity has an impact also on wellbeing of its citizens, as per the results of the researcher Khan (2024). Researcher Hujran (et al, 2023) identifies several models such as e-government maturity model which can be used to provide sustainable e-government services in developing states. This approach has a stage of implementation focused on the operations effectiveness of the government and a stage of adoption focused on the engagement and satisfaction of the community. E-governance can be considered a reaction to the needs and expectations of digital era (Mao et al, 2024). New models of e-governance will

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rise to answer future demands of the stakeholders, social, economic challenges and to the continuous development of ICT sector (Hujran et al, 2023).

Researchers Zang (et al, 2024) underlined the importance of artificial intelligence for the development of e-governance and the need to create reliable AI systems based on the collective ethical practices in order to improve the quality of e-governance and its efficiency. Customer experience should be taken into consideration (Liu et al, 2024) by the e-government administrators in order to enhance the citizen involvement (Li & Wang, 2024). Prior studies demonstrate that even if between e-governance and trust is an indirect relationship (Alsaad et al, 2024), the e-governance contributes to boost the citizen trust in the government (Arshad et al, 2024). Through e-participation, the citizens and government communicate directly in both ways which determines responsibility, transparency and corruption control (Mao et al, 2024). There are digital participatory tools to facilitate communication (Shin et al, 2024) between governments and their citizens, such as: FixMyStreet, PlaceSpeak, Consider.it, Growfunding, Virtual Congress, Civicpower, Polis, Commonplace. On one hand governments are seeking the latest digital tools (Crusoe et al, 2024) with the purpose to maintain their relevance and to be able to continue its operations without interruptions and on the other- the technology development gives resources for innovation of e-governance systems (Sheoran & Vij, 2024).

3. RESEARCH METHOLODOGY

For the study of the relationship between E-government and the evolution of research in the field of ICT, secondary data from the following EUROSTAT databases were used:

- E-government activities of individuals via websites, Internet use: interaction with public authorities (last 12 months);
- the expenses of the companies for IT research and development as a share of the total research and development expenses;
- research staff in the information and communication technology sector.

The data available for the last ten years for the member countries of the European Union and the EAA were taken into account (and in the case of missing data for certain countries/years, the average of the values in the analyzed interval was taken into account). The Pearson correlation coefficient was used to analyze the relationship between the variables. EUROSTAT databases were preferred due to the high level of confidence in the reliability of the data and the level of their territorial extension.

4. RESEARCH RESULTS

The relationship between E-governance (activities via websites) and companies' expenditures for IT research and development as a share of total research and development expenditures is presented in the following table. As can be seen, although there are some European countries (Czech Republic, Norway) where there is a strong and positive relationship between E-governance (activities via websites) and companies' expenses for research - development in IT as a share of total research expenses - development, in most states the relationship between the indicators is either a weak and positive one, or a strongly negative one, a situation in which they find themselves (Romania and Greece).

TABLE 1. CORRELATION BETWEEN E-GOVERNANCE (ACTIVITIES VIA WEBSITES) AND COMPANIES' EXPENSES FOR RESEARCH - DEVELOPMENT IN IT AS A SHARE OF TOTAL RESEARCH - DEVELOPMENT EXPENSES IN THE MEMBER COUNTRIES OF THE EUROPEAN UNION AND THE EEA

No.	Country	Correlation coefficient value
1.	Belgium	- 0.702
2.	Bulgaria	-0.397
3.	Czechia	0.801
4.	Denmark	-0.077
5.	Germany	-0.078
6.	Estonia	0.180
7.	Ireland	0.410
8.	Greece	-0.860
9.	Spain	-0.099
10.	France	0.319
11.	Croatia	-0.619
12.	Italy	-0.485
13.	Cyprus	-
14.	Latvia	-0.080
15.	Lithuania	0.338
16.	Luxembourg	-
17.	Hungary	-0.135
18.	Malta	-0.216
19.	Netherlands	-
20.	Austria	0.710
21.	Poland	0.163
22.	Portugal	0.529
23.	Romania	-0.797
24.	Slovenia	0.064
25.	Slovakia	-0.224
26.	Finland	0.139
27.	Sweden	-
28.	Iceland	-
29.	Norway	0.944
30.	Switzerland	-0.219
31.	United Kingdom	-0.450

Source: own processing of information from the EUROSTAT databases

The data from the previous table reveal the fact that for most European countries - and especially in Romania - the expenses of companies for research - development in IT as a share of the total research -

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development expenses do not constitute (at least from a statistical point of view) an opportunity for digitization public institutions and for E-government. Although many important companies in the field of information and communication technology are present in Romania and a good part of the highly qualified workforce is active in the IT sector, the contribution of IT research and development activities to the digitization of the public sector remains a relatively small one.

The results of the correlation analysis between E-governance (activities via websites) and ICT research-development staff are presented in the following table. As in the case of companies' expenditures for IT research and development as a share of total research and development expenditures, the correlation between E-governance (activities via websites) and ICT research and development personnel is, for most European countries, either strong and negative, either weak and positive.

TABLE 2. CORRELATION BETWEEN E-GOVERNANCE (ACTIVITIES VIA WEBSITES) AND ICT RESEARCH-DEVELOPMENT STAFF IN EU AND EEA MEMBER COUNTRIES

No.	Country	Correlation coefficient value
1.	Belgium	-0.672
2.	Bulgaria	-0.719
3.	Czechia	0.754
4.	Denmark	0.498
5.	Germany	-0.332
6.	Estonia	-0.027
7.	Ireland	-0.828
8.	Greece	-0.605
9.	Spain	0.263
10.	France	-0.411
11.	Croatia	-0.713
12.	Italy	-0.658
13.	Cyprus	-
14.	Latvia	-0.079
15.	Lithuania	-0.392
16.	Luxembourg	-
17.	Hungary	-0.897
18.	Malta	-0.243
19.	Netherlands	-
20.	Austria	0.715
21.	Poland	-0.273
22.	Portugal	0.299
23.	Romania	-0.705
24.	Slovenia	-0.546
25.	Slovakia	-0.252
26.	Finland	0.182
27.	Sweden	-
28.	Iceland	-
29.	Norway	0.819
30.	Switzerland	-0.236
31.	United Kingdom	-0.355

Source: own processing of information from the EUROSTAT databases

As can be seen from the previous table, Romania is not an exception to the situation existing in most European countries, having an important negative relationship between -government (activities via websites) and ICT research - development personnel. This situation denotes the fact that the number of scientific researchers is not one of the opportunities that will essentially favor E-Government and the digitalization process of public institutions.

5. CONCLUSIONS

The analysis of the relationship between e-governance and the evolution of research in the field of information and communication technology (ICT) in the member states of the European Union and EEA has revealed several key aspects:

5.1 The relationship between e-governance and companies' IT research and development expenditures

The study results showed that, in most of the analyzed states, there is a weak positive or strongly negative relationship between e-governance activities and companies' IT research and development expenditures as a share of total research and development expenditures. For example, in Romania and Greece, this relationship is strongly negative, indicating that although there is a significant presence of IT companies and a highly skilled workforce in the IT sector, their contribution to the digitalization of public institutions remains low. On the other hand, countries like the Czech Republic and Norway demonstrate a strong positive relationship, suggesting that investments in IT research and development are positively correlated with e-governance activities.

5.2 The relationship between e-governance and ICT research and development personnel

Regarding the correlation between e-governance activities and ICT research and development personnel, the study revealed that most European countries, including Romania, have a strongly negative relationship. This suggests that the number of scientific researchers in the ICT field is not a determining factor in promoting e-governance and the digitalization process of public institutions. Despite the presence of a significant number of researchers in the ICT field, these human resources do not automatically translate into effective opportunities for the implementation and development of e-governance services.

In conclusion, the study highlights the need for personalized and integrated approaches to fully harness the potential of ICT research and development to support e-governance in European countries. Adapting

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investment strategies and improving collaboration between sectors will be essential to achieve an efficient digital transformation of public institutions.

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