

## Unraveling the link between E-Government and sustainable development indicators in Europe with the PLS path model

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### Abstract

*As we see around us, technology is part of our lives and will gain more and more ground, leading to technology in all areas of life. In this context, digitalization plays a crucial role for the public sector and the citizens, especially young people who are the most connected generation in online communication. Very often, when discussing state institutions, it comes to light the need for more efficient changes since the interaction with public administration is very complex. The purpose of this study is to make a significant contribution to the digitalization literature by exploring how sustainable development indicators influence governance digitalization performance. The conceptual framework of this study combines the 2022 United Nations E-Government predictors with several 2022 World Bank world development indicators. The partial least squares path modeling method was used to explore 2022 secondary data for thirty-six European countries. The findings of this study reveal that technology usage, trust in the public sector, decent work and economic growth and education duration have a significant impact on the digital government performance. Therefore, these insights offer valuable practical implications for optimizing E-Government functioning in the European countries.*

**Keywords:** E-Government, digitalization, world development, government, public sector

**JEL Classification:** H83, O38, O47.

### 1. Introduction

E-government is a powerful tool in the process of globalization of the world's economies, that can beneficially influence the existing gaps between countries. A strong e-government can have direct effects by making public spending more efficient, making optimal public procurement, paying taxes and fees electronically, and improving relations with citizens in all parts of the country. E-government can also have indirect effects on society, such as transparency of public decisions, reduction of corruption, a strong democracy, and encouraging the use of IT applications developed by public administration structures (World Bank, 2002).

In today's global context, only a government based on advanced digital technologies can be a driver of strategic and efficient public sector development if it is aligned with transparent, participatory principles

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and manages to attract trust and innovation from stakeholders involved in the implementation of strategies. However, the implementation of digital transformation in the public sector also brings challenges and opportunities, and to manage the challenges the transformation must be based on a strong governance policy that takes into account all contextual, institutional, and policy factors in the system (OECD, 2021).

The IT platforms used by the government in its relations with citizens are influenced by human factors such as behavior, attitudes, and subjective beliefs of users related to trust in data security and the accuracy of the information used. There are also cultural, religious, and social influences that can modify users' behavior in e-government, related to their expectations of the system (Aleisa, 2024).

E-government can be successful only if citizens trust electronic public services, and their trust can be gained if these services deliver visibly improved results without errors and interruptions in their use. However, there may also be influences related to the value system, culture, level of education, experience, and personality of each user in the system, which should be studied to understand the full and multilateral framework of e-government policy (Alzahrani et al., 2017).

The main objective of our research is to study the link between a country's sustainable development indicators (quantified using World Bank indicators) and E-government (measured using the E-Government index) to reveal the drivers of improving e-governance, given its essential role in the economy and society.

Against this background, we address the following research questions:

1. How do external factors, including online services and e-participation, influence the E-Government index, which is explained through internal factors like human capital and telecommunication infrastructure?
2. How do world development indicators, including online access, peace justice institutions, quality of education, decent work economic growth, secure internet servers, and compulsory education duration, impact the formation of the E-Government index?
3. What may shape the quality of education and the security of internet servers, and how do they influence the formation of the E-Government index?

We use secondary data from the 2022 United Nations E-Government Survey and 2022 World Bank world development indicators for thirty-six European countries selected for the survey: Albania, Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom of Great Britain and Northern Ireland. Embracing the Partial Least Square (PLS) path modeling method, we look at the dependent variable, namely E-Government, comprising the human capital and telecommunication infrastructure indexes.

Our findings enrich the E-Government literature by highlighting the importance of external factors (factors outside the E-Government index that can have an impact on it) in determining the performance of the E-Government. Also, we accentuate the importance of quality of education and security of internet servers in the process of understanding E-Government index formation and suggest practical implications for supporting more efficient public administration services.

The paper is structured as follows: we begin with a review of essential literature on the digitalization of the public sector, or E-Government, and identify the research gap. Here we develop the hypotheses and introduce our research model. Afterward, we detail our methodology and present the results. The final



The use of public e-services in 2020-2021 was higher than before, suggesting an acceleration of digitalization in the EU during the COVID-19 pandemic (Savchenko et al., 2024). Analyzing from the point of view of citizens, digitalization reduces their efforts by simplifying access to digital services (Vigoda-Gadot & Mizrahi, 2024).

Sihombing and Lumbantobing (2024), develops interesting research about the integration of digital technology in public services at different levels. Being conducted on 315 officials from 167 villages in 16 sub-districts in Toba District, North Sumatera Province, the study showed that many village officials need to acquire the necessary knowledge and skills to solve administrative tasks digitally. Increased support and assistance from the Government are recommended to acquaint village officials with advances in information technology, but digital transformation remains a challenge that could be overlooked, requiring additional training and improved infrastructure (Sihombing & Lumbantobing, 2024).

In the study "Degree of Digitalization and Citizen Satisfaction: A Study of the Role of Local E-Government in Swede" Benrhard et al. (2018) confirmed that the degree of digitalization is related to citizen satisfaction. Citizens appreciate to the greatest extent a digitalized administration and prefer to give evaluations on digitalized platforms. Compared to traditional communication channels through which citizens could submit evaluations on the activity of public institutions, other online interfaces, such as QR codes, government websites, and SMS, are preferred by citizens and bring better evaluations in terms of concerns about the activity of these digitized public institutions (Wang & Ma, 2022).

We must finally recognize that the period of crisis imposed on us by the COVID-19 pandemic had a positive impact on the degree of digitalization of the public administration and forced citizens to adapt to submit requests online and interact remotely (Mina-Raiu & Melenciuc, 2022). The differences in reaction observed at the territorial level during the pandemic were noticeable, and the importance of E-Government increased (Goschin & Dimian, 2021).

In the process of implementing digitalization in public institutions, caution must be taken regarding the fact that there may be risks and disadvantages may be created for some citizens who do not have access to the online environment or do not have the necessary training to use modern technologies. In this sense, strong legal regulations must be adopted to govern the digital transformation in an ethical framework (Latupeirissa et al., 2024). Electronic services must function correctly to encourage citizens to use them, errors and failure of computer programs in public administration could hinder citizens' desire to use digital services (Prokop & Tepe, 2022).

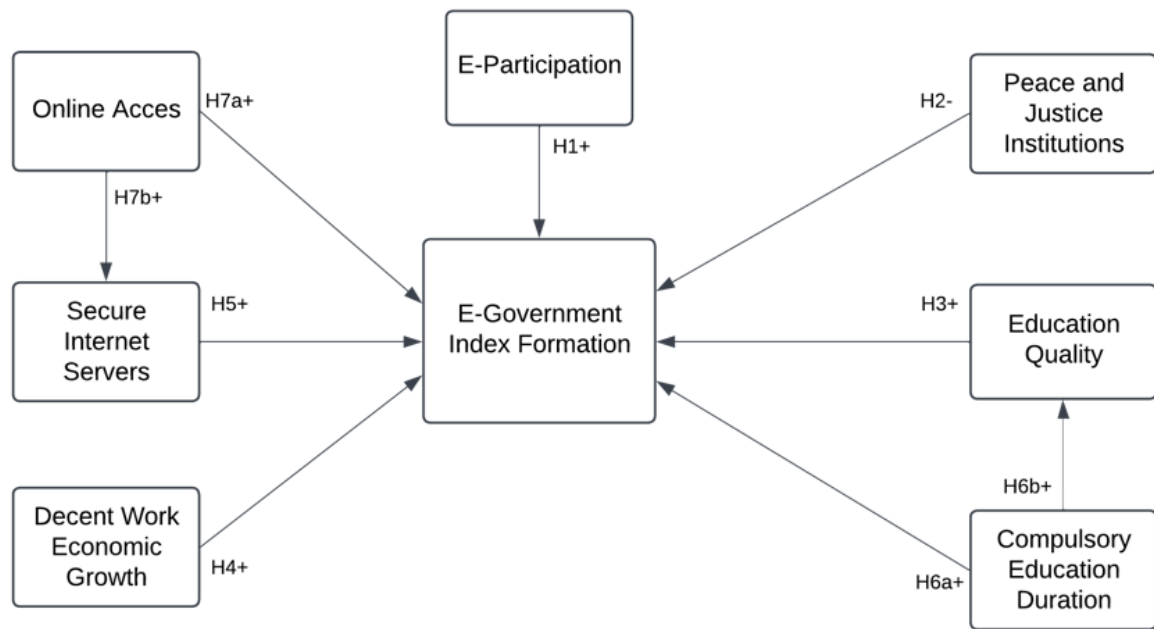
In the period of crisis brought on by the COVID-19 pandemic, many employees found themselves in the new situation of teleworkers (Dimian et al., 2023). All over the world, this was a period in which the speed of digitalization transformation accelerated, taking innovative measures and organizational adaptations that would not have existed in normal life conditions (Moser-Plautz & Schmidhuber, 2023).

Within the Ministry of Justice of Jordan, it was appreciated that there is a positive relationship between digital possibilities and organizational performance, and the fact that it has been invested in computer programs and high-performance IT infrastructure is associated with operational benefits, an efficient budget, and satisfied customers (Atobishi et al., 2024).

Governments with a high level of digitalization are less corrupt. Digitalization brings with it new forms of organization with modern management, advanced tools for carrying out reforms in administration, as well as the establishment of values in society on a real basis. Also, digitalization is a strategic objective of the EU member states and a priority in their development (Androniceanu et al., 2022).

The use of government websites is a rapidly developing activity, giving rise to E-Government, which can be seen as a tool to increase the flow of information in the citizen-public administration relationship, with benefits for public management. Research suggests that the first step in the development of E-Government is citizen pressure. Later, the existence of adequate public management is more important than citizens' demands (Rodríguez Domínguez et al., 2011).

Built upon the 2022 United Nations E-Government Survey we present our research model in Figure no. 2 and develop the following hypotheses.



**Figure no. 2: Research Model**

*Source: Authors' research.*

Electronic participation or e-participation (EP) refers to the use of ICT to facilitate citizen participation in government-related processes, encompassing areas such as administration, service delivery, decision-making, and policy-making. E-participation is essential for E-Government performance and evolves with information and communication technology (Adnan et al., 2022). Thus, we propose further investigation into finding the link between digitalization and electronic participation and formulate the following hypothesis:

*H1: E-Participation positively influences E-Government performance*

Peace, justice, and institutions (PJ) comprise trust in government, a direct factor influencing the development of a successful E-Government model. This indicator allows governments to develop their E-Government policy to boost the digital economy and society further (Nookhao & Kiattisin, 2023). Therefore, we suggest:

*H2: Peace Justice and Institutions negatively influence E-Government performance*

UNICEF (2000) provides a very comprehensive definition of quality education (EQ) that includes healthy learners who are well-nourished, are ready to participate and learn, whose learning is supported by their families and communities; healthy, safe, and supportive environments; content that includes the foregoing elements and peace; inclusive child-centered processes that competent self-driven teachers facilitate; and actual outcomes that encompass life-supportive knowledge, skills, and attitudes and are linked to national

goals for education (equity) and positive participation in society. The studies confirm the centrality of the influence of education on the use of digital public services compared to the other spatial and social variables considered (Mesa, 2023). In this regard, we consider the following hypothesis:

*H3: Quality of Education positively influences E-Government performance*

Empirical findings suggest that the growth impact of E-Government is positive and significant while the direct growth impact of financial development turns out to be insignificant (Majeed & Malik, 2016). We propose a further investigation to understand how decent work and economic growth (WEG) influence the E-Government index formation and propose:

*H4: Decent work and Economic Growth positively influence the E-Government performance*

The confidence of citizens to use E-Government services is directly influenced by their trust in the Internet and the security offered by internet servers (SIS) in terms of data privacy and security (Gupta et al., 2024). Hence, we suggest:

*H5: Secure Internet Servers positively influences E-Government performance*

Education and its duration (EDUR) have a significant impact on the use of E-Government services. However, there is a possibility that the entire population may not benefit from the advantage of education (Belanger & Carter, 2006). Along these lines, we consider:

*H6a: Education duration positively influences the E-Government performance*

*H6b: Education duration positively influences the Quality of Education*

Online access and frequency of internet use (OA) have a significant impact on the use of E-Government services. Also, there may be digital gaps between citizens that influence the use of E-Government services (Belanger & Carter, 2006). Hence, we assume:

*H7a: Online access positively influences the E-Government performance*

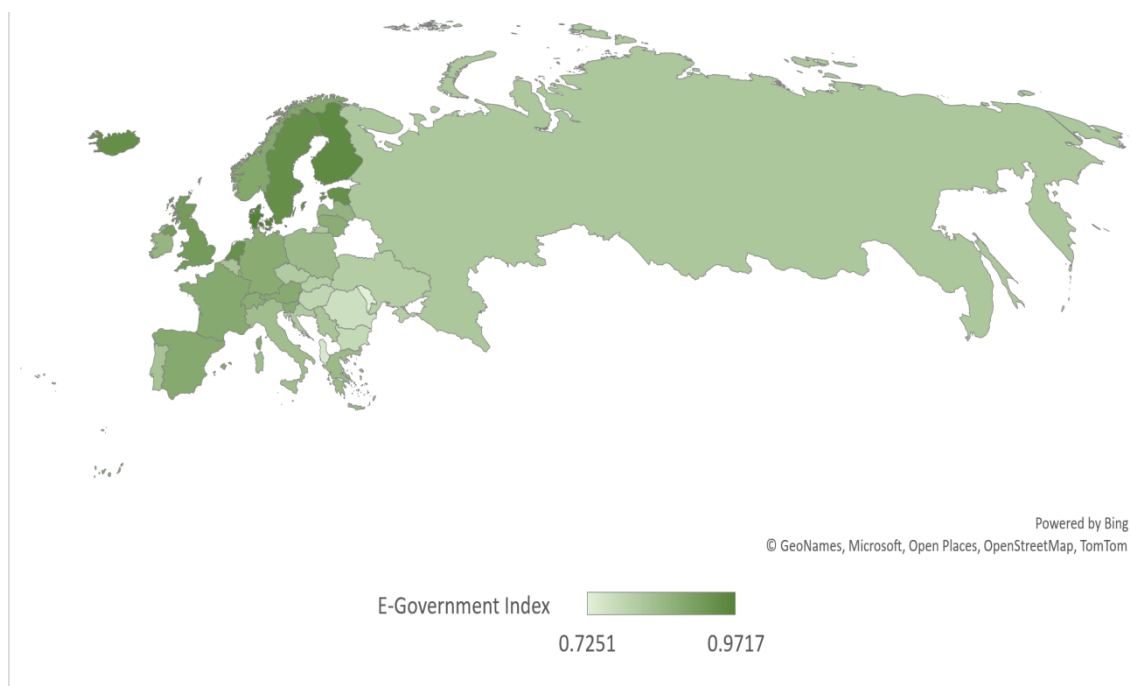
*H7b: Online access positively influences Secure Internet Servers formation*

### **3. Methodology**

#### *3.1. Data*

We collected secondary data on European countries from the official United Nations E-Government database for 2022. We chose the indicators recommended in the literature to explain the formation of the E-Government index, through the lenses of E-Participation, Online Service, Human Capital, and Telecommunication Infrastructure indexes (United Nations, 2022). We added to our conceptual framework world development indicators collected from the World Bank database (World Bank Group, 2022). like online access, peace justice institutions, quality of education, decent work and economic growth, secure internet servers, and compulsory education duration. The description of the variables and data source are presented in Appendix 1.

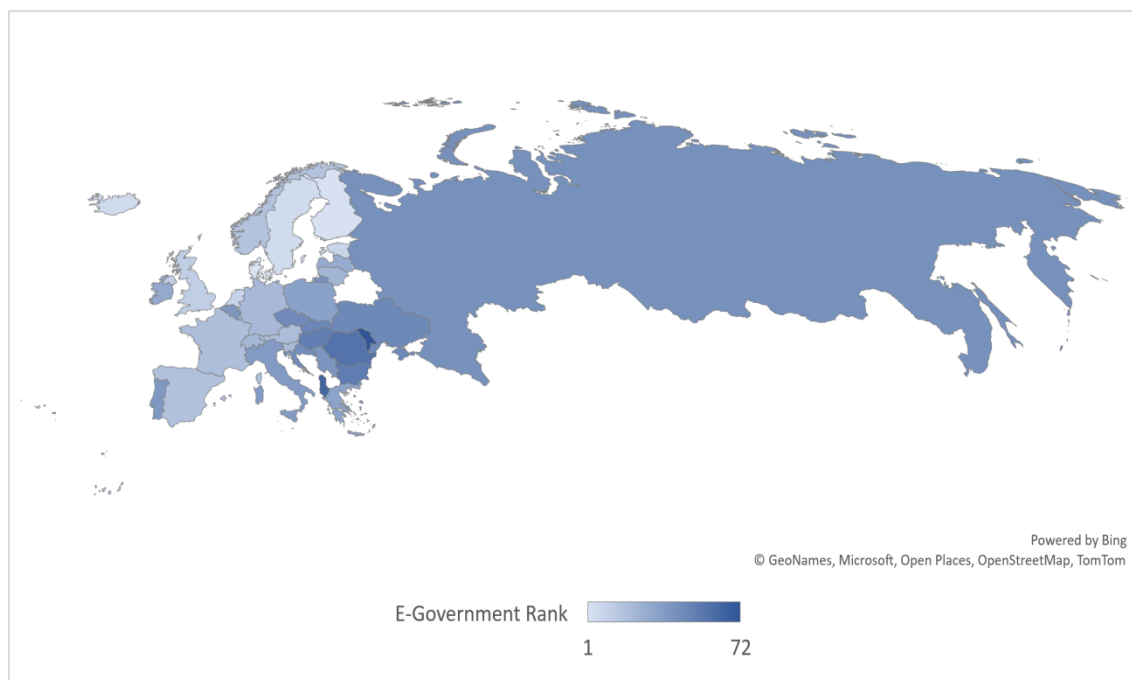
The map in Figure no. 3 shows the geographical distribution of the E-Government Index as described in the 2022 United Nations E-Government Survey. Values start from 0.7251 to 0.9717, with countries like Denmark, Finland, Sweden, and Iceland having the highest indexes in Europe and leaving the Republic of Moldova, Albania, Romania, and Bulgaria to have the lowest figures.



**Figure no. 3: E-Government Index**

*Source: 2022 United Nations E-Government Survey.*

In terms of E-Government performance, there is a clear correlation between a country's index and its ranking. Figure no. 4 highlights the geographical distribution performance for the E-Government development. Denmark, Finland, Sweden, and Iceland are ranked first, leaving the Republic of Moldova, Albania, Romania, and Bulgaria to rank the lowest performance during 2022 in Europe.



**Figure no. 4: E-Government Rank**

*Source: United Nations, 2022*

### 3.2. Method

Furthermore, we employed WarpPLS 8.0 software (Kock, 2024; ScriptWarp Systems, 2022). (ScriptWarp Systems, 2022) For implementing partial least square-path modeling (PLS-PM), a structural equation model (SEM) is used to investigate the current relationships (Joreskog, 1982). This method synthesizes a measurement (outer) model, measuring observed variables, and a structural (inner) model, representing structural relationships. The first assesses the associations between measurement latent variables and their indicators or manifest variables, while the second explores the structural relationships among latent variables (Haenlein & Kaplan, 2004; J. F. Hair et al., 2011). The measurement model relates observed manifest variables  $X_j$  to their latent variables  $\xi_k$ . In the context of this study, the model follows a reflective approach, describing each manifest variable  $x_{ij}$  as a function of the latent variable. We use the following formula, where  $\lambda_{ij}$  represents the indicator reliability and its measurement error ( $\varepsilon_{ij}$ ).

$$x_{ij} = \lambda_{ij}\xi_i + \varepsilon_{ij} \quad | \quad (1)$$

However, for efficiently assessing the reliability of the measurement model, we look for good composite reliability indices, Cronbach's  $\alpha$  and AVEs. Hair et al. considers the results acceptable for exploratory research when the result is higher than 0.70 (J. Hair et al., 2013), while Nunnally confirms acceptable reliability for further research when  $\alpha$  is above the threshold of 0.7 (Nunnally & Bernstein, 1994). Finally, AVEs short for Average Variance Extracted measures convergent validity through discovering the amount of variance captured by a latent construct to the variance of the measurement error (Fornell & Larcker, 1981). Using the following formula, where  $\lambda$  represents the standardized factor loadings, and  $n$  the number of indicators, the result returned is considered acceptable when higher than 0.50.

$$AVE = \frac{\sum \lambda_i^2}{n} \quad | \quad (2)$$

We continue with the structural (inner) model and define the relationships between latent variables through a system of linear regression, with  $\beta$  representing path coefficients and  $\zeta$  residual terms. .

$$\xi_j = \sum_i \beta_{ji}\xi_i + \zeta_i \quad | \quad (3)$$

Indices are often employed in economics and finance research to test various theoretical concepts, as well as to estimate and assess their interrelationships. The PLS-PM method serves as an effective and reliable estimator in achieving this purpose (Dirsehan & Henseler, 2023). All in all, its main objective is to maximize the explained variance of endogenous latent variables (Trinchera & Russolillo, 2010): .

$$R_j^2 = 1 - \frac{Var(\zeta_j)}{Var(\xi_j)} \quad | \quad (4)$$

The missing values were imputed with the help of a missing data imputation algorithm, the arithmetic means imputation provided by WarpPLS software, through the following mathematic formula (5).

$$\bar{X} = \frac{\sum_{i=1}^n x}{n} \quad | \quad (5)$$

The process implies replacing the missing values with  $\bar{X}$ .

### 3.3. Measure

We considered the UN E-Government methodology for explaining the E-Government Index formation and we separated the indices from the database into two latent variables. The E-Government predictor comprises the Human Capital Index and Telecommunications Infrastructure, while the other two indexes, E-Participation and Online Services, form the E-Participation predictor. All other variables were used as given.

## 4. Results

The final sample consists of 38 observations of data collected from European countries participating in the 2022 United Nations E-Government survey. Table no. 1 summarizes all indices before conducting the analysis. The indices comprised in the formation of the E-Government index take values from 0.576 to 1, with a mean of 0.850 (SD = 0.093) for Telecommunication Infrastructure, while for Human Capital Index values start from 0.802 to 0.966, with a mean of 0.899 (SD = 0.050). We also see that compulsory education duration oscillates between 8 and 13 years, with a median of 11 years (SD = 1.39). However, it is interesting to see that in 2022 we had at least one million secure internet servers in Europe.

**Table no. 1: Descriptive statistics for the analyzed indices**

| <b>Dimension</b>                 | <b>Minimum Value</b> | <b>Maximum Value</b> | <b>Mean</b> | <b>Median</b> | <b>Standard Deviation</b> | <b>Skewness</b> | <b>Kurtosis</b> |
|----------------------------------|----------------------|----------------------|-------------|---------------|---------------------------|-----------------|-----------------|
| Human Capital Index              | 0.802                | 0.966                | 0.899       | 0.907         | 0.050                     | -0.312          | -1.162          |
| Telecommunication Infrastructure | 0.576                | 1.000                | 0.850       | 0.842         | 0.093                     | -0.935          | 1.339           |
| E-Participation Index            | 0.455                | 0.977                | 0.714       | 0.727         | 0.131                     | 0.159           | -0.088          |
| Online Service Index             | 0.669                | 1.000                | 0.819       | 0.814         | 0.083                     | 0.239           | -0.381          |
| Peace and Justice Institutions   | 0.500                | 0.900                | 0.807       | 0.867         | 0.120                     | -1.502          | 1.262           |
| Education Quality                | 0.200                | 1.000                | 0.639       | 0.600         | 0.157                     | -0.351          | 0.584           |
| Decent Work and Economic Growth  | 0.222                | 1.000                | 0.907       | 1.000         | 0.156                     | -2.628          | 8.440           |
| Secure Internet Servers          | 2608                 | 1055394              | 1024048     | 363192        | 1891013                   | 3.799           | 16.155          |
| Education Duration               | 8.000                | 13.000               | 10.667      | 11.000        | 1.394                     | 0.100           | -0.644          |
| Online Access                    | 0.567                | 0.954                | 0.771       | 0.762         | 0.119                     | -0.096          | -1.383          |

*Source: United Nations, 2022; World Bank, 2022*

The results are structured into three sections: the measurement model is addressed in the first, the structural model is detailed in the second, and the third discusses the study's findings. This approach was chosen to provide a more concise and effective summary of the data.

#### 4.1. Measurement (inner) model

Table no. 2 outlines the performance of the measurement model, focusing on the composite reliability for each latent construct. The results range between 0.868 (EGOV) and 1 (SN), satisfying the recommended threshold of 0.7 (Nunnally & Bernstein, 1994). Excluding EGOV's value that is near the inferior limit, Cronbach's Alpha values are above 0.7 (Cortina, 1993; J. Hair et al., 2013), pointing out good internal consistency. The average of variance extracted (AVE) is above the threshold of 0.5 (Fornell & Larcker, 1981). All this evidence proves the reliability of the measurement model.

**Table no. 2: The reliability of measurement model.**

| Dimension                       | Abbreviation | Composite reliability index (* > 0.7) | Cronbach's Alpha (* > 0.7) | Average of variance extracted (* > 0.5) |
|---------------------------------|--------------|---------------------------------------|----------------------------|-----------------------------------------|
| Dependent variables             |              |                                       |                            |                                         |
| E-Government Index              | EGOV         | 0.868                                 | 0.697                      | 0.768                                   |
| Independent variables           |              |                                       |                            |                                         |
| E-Participation                 | EP           | 0.946                                 | 0.886                      | 0.898                                   |
| Peace and Justice               | PJ           | 1.000                                 | 1.000                      | 1.000                                   |
| Education Quality               | EQU          | 1.000                                 | 1.000                      | 1.000                                   |
| Decent Work and Economic Growth | WEG          | 1.000                                 | 1.000                      | 1.000                                   |
| Secure Internet Servers         | SIS          | 1.000                                 | 1.000                      | 1.000                                   |
| Education Duration              | EDUR         | 1.000                                 | 1.000                      | 1.000                                   |
| Online Access                   | OA           | 1.000                                 | 1.000                      | 1.000                                   |

*Source: Authors' research results.*

Furthermore, regarding correlations among latent constructs, as shown in Table no. 3, all diagonal values are above the threshold of 0.8 and higher than the corresponding off-diagonal values (Kennedy, 2008).

**Table no. 3: Correlations among latent constructs with square roots of AVE.**

| Dimension | EGOV   | EP     | PJ     | EQU   | WEG   | SIS    | EDUR   | OA     |
|-----------|--------|--------|--------|-------|-------|--------|--------|--------|
| EGOV      | 0.876  | 0.400  | -0.295 | 0.056 | 0.221 | 0.254  | 0.133  | 0.231  |
| EP        | 0.400  | 0.948  | -0.140 | 0.237 | 0.245 | 0.442  | -0.045 | 0.298  |
| PJ        | -0.259 | -0.140 | 1.000  | 0.004 | 0.364 | -0.166 | 0.126  | 0.238  |
| EQU       | 0.056  | 0.237  | 0.004  | 1.000 | 0.539 | 0.316  | 0.243  | 0.186  |
| WEG       | 0.221  | 0.245  | 0.364  | 0.539 | 1.000 | 0.150  | 0.307  | 0.218  |
| SIS       | 0.254  | 0.104  | -0.166 | 0.316 | 0.150 | 1.000  | 0.442  | 0.108  |
| EDUR      | 0.133  | -0.045 | 0.126  | 0.243 | 0.307 | 0.442  | 1.000  | -0.049 |
| OA        | 0.231  | 0.298  | 0.238  | 0.186 | 0.218 | 0.108  | -0.049 | 1.000  |

*Source: Authors' research results.*

The combined loadings and cross-loadings of our latent variables are found in Table no. 4. All loadings are higher than the 0.7 threshold, ranging between 0.876 and 1. All things considered, both convergent and discriminant validity stands.

**Table no. 4: Combined loadings and cross-loadings.**

| Dimension | EGOV   | EP     | PJ     | EQU    | WEG    | SIS    | EDUR   | OA     |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|
| EGOV1     | 0.876  | -0.152 | -0.000 | 0.273  | 0.169  | 0.052  | -0.263 | -0.059 |
| EGOV2     | 0.876  | 0.152  | 0.000  | -0.273 | 0.169  | -0.052 | 0.263  | 0.059  |
| EP1       | -0.125 | 0.948  | 0.003  | -0.057 | 0.008  | 0.151  | -0.071 | 0.023  |
| EP2       | 0.125  | 0.948  | -0.003 | 0.057  | -0.008 | -0.151 | 0.071  | -0.023 |

| Dimension | EGOV   | EP     | PJ     | EQU    | WEG    | SIS    | EDUR   | OA     |
|-----------|--------|--------|--------|--------|--------|--------|--------|--------|
| PJ        | -0.000 | -0.000 | 1.000  | -0.000 | 0.000  | -0.000 | 0.000  | 0.000  |
| EQU       | -0.000 | 0.000  | 0.000  | 1.000  | -0.000 | -0.000 | 0.000  | -0.000 |
| WEG       | 0.000  | 0.000  | 0.000  | 0.000  | 1.000  | -0.000 | 0.000  | -0.000 |
| SIS       | -0.000 | 0.000  | -0.000 | -0.000 | 0.000  | 1.000  | -0.000 | -0.000 |
| EDUR      | 0.005  | -0.000 | -0.000 | 0.000  | -0.000 | -0.000 | 1.000  | 0.000  |
| OA        | 0.020  | -0.000 | 0.000  | 0.000  | -0.000 | -0.000 | -0.000 | 1.000  |

Source: Authors' research results.

#### 4.2. Structural (outer) model

The PLS model results are summarized in Table no. 5. The total amount of variance in the formation of the E-Government index explained by the model is 54.4% (adjusted R2 = 44.3%), while the quality of education towards the formation of the E-Government index is 10.4% (adjusted R2 = 7.8%) and the security of internet servers influencing the dependent variable is 7.3% (adjusted R2 = 4.6%). We have found no endogeneity, statistical suppression, or Simpson's paradox. The average block VIF (AVIF) is 1.612, below the theoretical threshold of 3.3. The Tenenhaus goodness-of-fit result is 0.483, ranked as a large value.

Table no. 5: Correlations among latent constructs with square roots of AVE

|                                     | Direct effects            |                          |                          | Direct effect sizes (f2) |       |       | Indirect effects | Total effects (via EGOV)  |
|-------------------------------------|---------------------------|--------------------------|--------------------------|--------------------------|-------|-------|------------------|---------------------------|
| Estimated coefficients              | EGOV                      | EQU                      | SIS                      | EGOV                     | EQU   | SIS   |                  |                           |
| EGOV                                | -                         | -                        | -                        | -                        | -     | -     | -                | -                         |
| EP                                  | <b>0.396**</b><br>(0.004) | -                        | -                        | 0.189                    | -     | -     | -                | <b>0.396**</b><br>(0.004) |
| PJ                                  | <b>-0.261*</b><br>(0.043) | -                        | -                        | 0.098                    | -     | -     | -                | <b>-0.261*</b><br>(0.043) |
| EQU                                 | 0.135<br>(0.198)          | -                        | -                        | 0.011                    | -     | -     | -                | 0.135<br>(0.198)          |
| WEG                                 | <b>0.271*</b><br>(0.037)  | -                        | -                        | 0.129                    | -     | -     | -                | <b>0.271*</b><br>(0.037)  |
| SIS                                 | 0.128<br>(0.211)          | -                        | -                        | 0.041                    | -     | -     | -                | 0.128<br>(0.211)          |
| EDUR                                | <b>0.212.</b><br>(0.085)  | <b>0.323*</b><br>(0.016) | -                        | 0.069                    | 0.104 | -     | 0.044<br>(0.354) | <b>0.256*</b><br>(0.047)  |
| OA                                  | 0.062<br>(0.352)          | -                        | <b>0.270*</b><br>(0.038) | 0.016                    | -     | 0.073 | 0.034<br>(0.384) | 0.097<br>(0.274)          |
| <b>The goodness of fit measures</b> |                           |                          |                          |                          |       |       |                  |                           |
| R2 /<br>R2 Adjusted                 | 54.4% /<br>44.3%          | 10.4% /<br>7.8%          | 7.3% /<br>4.6%           | -                        | -     |       | -                | -                         |
| AVIF                                | 1.612                     | -                        | -                        | -                        | -     | -     | -                | -                         |
| TenehausGoF                         | 0.483<br>(large)          | -                        | -                        | -                        | -     | -     | -                | -                         |
| SRMR                                | 0.102                     | -                        | -                        | -                        | -     | -     | -                | -                         |
| SMAR                                | 0.061                     | -                        | -                        | -                        | -     | -     | -                | -                         |

Source: Authors' research results.

Note: \*\*\*-p value <0.001; \*\*-p value <0.01; \*-p value <0.05; -p value <0.10;

Note: TeenehausGoF: small  $\geq 0.1$ , medium  $\geq 0.25$ , large  $\geq 0.36$ ;

When predicting E-Government performance we found EP ( $\beta = 0.396$ ,  $p = 0.004$ ), WEG ( $\beta = 0.271$ ,  $p = 0.037$ ) and EDUR ( $\beta = 0.212$ ,  $p = 0.085$ ) to positively influence the dependent variable, confirming H1, H4 and H6a. We expected PJ ( $\beta = -0.261$ ,  $p = 0.043$ ) to negatively impact PI, thus we accept H2. When it comes to predictors EQU, SIS, and OA we discovered no statistically significant relationship towards E-Government, therefore we fail to accept hypotheses H3, H5, and H7a. Cohen (2013) states that effect sizes above 0.02 could be considered for practical interventions and informing policies (Cohen, 2013). EP (0.189) and WEG (0.129) have moderate effect sizes when predicting the E-Government performance, while PJ (0.098) and EDUR (0.069) are considered to have small effect sizes.

Regarding the quality of education formation, we have enough evidence to accept H6a, since EDUR ( $\beta = 0.323$ ,  $p = 0.016$ ) positively influences EQU, showing a moderate indirect effect size of 0.104. We also accept H7a, with OA ( $\beta = 0.270$ ,  $p = 0.038$ ) having a positive impact on SIS, evidence sustained by the indirect effect of the relationship (0.073), that points to a total mediation between SIS and EGOV. Despite having no statistically significant influence on the dependent variable, OA has a significant role in controlling for the mediator.

A summary of how the hypotheses were validated, the implications of accepting or rejecting the hypotheses, and the literature confirming the results obtained are presented in Table no. 6.

**Table no. 6: Hypotheses, implications and related literature confirmation**

| Hypotheses                                                                                                                               | Validation | Implications                                                                                                                                                                                                                                                  | Related literature confirmation                    |
|------------------------------------------------------------------------------------------------------------------------------------------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| H1: E-Participation positively influences E-Government                                                                                   |            | EP is an important tool to strengthen the government-citizen relationship.                                                                                                                                                                                    | (Blanc, 2020) (Adnan et al., 2022).                |
| H2: Peace Justice and Institutions negatively influence E-Government                                                                     |            | PJ is essential for ensuring a government that provides citizens with the necessary services, but negatively influences E-Government in fragile and conflict-affected countries.                                                                              | (UNDP, 2019); (Nookhao & Kiattisin, 2023)          |
| H3: Quality of Education positively influences E-Government                                                                              | X          | EQU plays a crucial role in overcoming the digital divide and in promoting citizens' digital rights in accessing digital public services. It has not proven to be a significant driver of e-governance, however.                                              | (Nimer et al., 2022), (Mesa, 2023)                 |
| H4: Decent work and Economic Growth positively influence the E-government                                                                |            | WEG foster digital transformation and they can play a significant role in government transformation.                                                                                                                                                          | (Majeed & Malik, 2016), (Castro & Lopes, 2022)     |
| H5: Secure Internet Servers positively influences E-Government                                                                           | X          | SIS has not been proven to be a significant driver of E-Government, it most likely acts as a mediator having a significant impact on E-Government trust.                                                                                                      | (Gupta et al., 2024)                               |
| H6a: Education duration positively influences the E-Government<br>H6b: Education duration positively influences the Quality of Education |            | Both the quality and the quantity of education have a positive effect on trust in E-government, but also on promoting E-Government tools.                                                                                                                     | (Méndez-Rivera et al., 2023)                       |
| H7a: Online access positively influences the E-Government<br>H7b: Online access positively influences Secure Internet Servers formation  | X          | There are more important factors besides online accessibility that are barriers in adopting and using E-Government, such as: digital divide, lack of awareness or lack of trust. Greater online accessibility has also brought an increase in risk awareness. | (Tahiru et al., 2020), (Pérez-Morote et al., 2020) |

Source: Authors' research results.

This research addresses the quantitative research gap in digitalization. We contribute to the literature by extending the 2022 United Nations E-Government Survey with new determinants, thus improving the theoretical frame. Our main results confirm the findings of the UN survey, which we consider one of the paper's theoretical implications.

This study aligns with previous research. We found E-participation to have a positive influence on the formation of the E-Government index(Adnan et al., 2022), and peace, justice, and institutions or the trust citizens have in the government to negatively impact the formation process, proving Nookhao and Kiattisin results (2023). In terms of decent work and economic growth, we also found a positive link between the two variables(Majeed & Malik, 2016). The same goes for education duration which has a positive impact on the E-Government index formation(Belanger & Carter, 2006).

The findings of this study lay the groundwork for formulating policies that can benefit both citizens, stakeholders, and the government. For boosting the E-Government index formation we must look at the dimensions that were found with an effect size higher than the 0.02 threshold. Hence, policymakers should consider increasing the degree of citizen participation in public decision-making, through E-Government, and develop and secure the servers and IT systems to ensure online access for citizens in conditions of security and trust.

## **5. Conclusion**

With a sample consisting of secondary data from thirty-six European countries, the study employs the PLS-PM method for assessing the proposed framework and, eventually, contributing to the literature. Our results found E-participation as a strong factor when predicting the formation of the E-Government performance, with peace and justice in institutions, work and economic growth, and compulsory education duration joining in explaining the dependent variable. Also, compulsory education duration has a significant impact on the formation of the E-Government performance, with quality of education mediating their relationship. We identified online access to play an important role in mediating the relationship between the digitalization index and the security of internet servers.

The factors influencing the digitalization of the public sector are highly impacted by the COVID-19 pandemic since both actors (citizens and the public sector) had to find efficient ways to continue their activity, despite the present restrictions. Thus, it is no surprise to see the E-participation predictor having a strong impact on the dependent variable, since there was a need for participation in an online environment. The same goes for work and economic growth, and compulsory education duration. The link between these two and the E-Government formation stands in the digitalization performance of each country. Good performance is highly correlated with great economic growth, while for great economic growth, it takes time for the education process. In this sense, interesting to see the total mediation effect online access has on the security of internet servers. An explanation stands in the need to feel safe online when entrusting the public sector with personal data.

Moreover, this study's practical implications could provide the possibility for citizens to overview public information and improve the barriers to interacting with governmental organizations in major decision-making processes. Through innovative E-Government mechanisms, citizens can contribute much more effectively to public decision-making, with the perception of real involvement in such processes, increasing their assessment of the quality of public services. Also, strong legal regulations must be adopted to govern

the digital transformation within an ethical framework, so that there is no risk of creating unfairness to citizens who do not have access to the internet or do not have the necessary training.

Nonetheless, the study acknowledges certain limitations, including the lack of proper explanation of the dependent variable, the E-Government Index, alongside the presence of two variables potentially explaining the same element, that is education. Moreover, the imputation of missing data could have biased the reality of the given context. Future research should consider a more in-depth analysis of the UN indicators, without compromising the generality of the results. Despite these limitations, this study advances both theoretical and practical approaches to promote E-Government, laying the groundwork for future investigations into digitalization in the public sector.

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## Appendix: Variable description and data source

| Dimension                        | Abbreviation | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Data source                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Human Capital Index              | <i>EGOV</i>  | The Human Capital Index (HCI) comprises the following variables:<br>Adult literacy (%)<br>Gross enrolment ratio (%)<br>Expected years of schooling<br>Mean years of schooling<br>The Telecommunication Infrastructure Index (TII) comprises the following variables:<br>Percentage of individuals using the Internet<br>Fixed-telephone subscriptions per 100 inhabitants<br>Mobile-cellular telephone subscriptions per 100 inhabitants<br>Fixed (wired)-broadband subscriptions per 100 inhabitants<br>Wireless broadband subscriptions per 100 inhabitants | <a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a>                                                                                                                                                                                                                |
| Telecommunication Infrastructure |              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                    |
| E-Participation                  | <i>EP</i>    | The e-participation index (EPI) is the result of the UN E-Government Survey and focuses on three dimensions: e-information sharing, e-consultation, and e-decision-making.                                                                                                                                                                                                                                                                                                                                                                                    | <a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a>                                                                                                                                                                                                                |
| Online Service Index             |              | Online Service Index (OSI) is the result of the UN E-Government Survey and focuses on determining whether a site is "usable", i.e. it has content easily discovered by the destined beneficiaries.                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                    |
| Secure Internet Servers          | <i>SIS</i>   | The number of distinct, publicly trusted TLS/SSL certificates found in the Netcraft Secure Server Survey.                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Netcraft ( <a href="http://www.netcraft.com/">http://www.netcraft.com/</a> )<br><a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a>                                                                                                                                |
| Online Access                    | <i>OA</i>    | This indicator estimates the richness and openness of online access.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | International Telecommunication Union (ITU) World Telecommunication/ICT Indicators Database<br><br><a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a>                                                                                                             |
| Education Duration               | <i>EDUR</i>  | Duration of compulsory education measures the number of years that children are legally obliged to attend school.                                                                                                                                                                                                                                                                                                                                                                                                                                             | UNESCO Institute for Statistics (UIS). UIS.Stat Bulk Data Download Service. Accessed September 30, 2024.<br><a href="https://apiportal.uis.unesco.org/bdds">https://apiportal.uis.unesco.org/bdds</a> .<br><br><a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a> |
| Education Quality                | <i>EQU</i>   | GOAL 4: Quality Education (5-year moving average) (Sustainable Development Goals -SDG Indicators)                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a>                                                                                                                                                                                                                |
| Peace and Justice Institutions   | <i>PJ</i>    | GOAL 16: Peace and Justice Strong Institutions (5-year moving average) (Sustainable Development Goals -SDG Indicators)                                                                                                                                                                                                                                                                                                                                                                                                                                        | <a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a>                                                                                                                                                                                                                |
| Decent Work and Economic Growth  | <i>WEG</i>   | GOAL 8: Decent Work and Economic Growth (5-year moving average) (Sustainable Development Goals -SDG Indicators)                                                                                                                                                                                                                                                                                                                                                                                                                                               | <a href="https://databank.worldbank.org/source/world-development-indicators">https://databank.worldbank.org/source/world-development-indicators</a>                                                                                                                                                                                                                |