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Digital Government a Pathway to Sustainable Development†

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Abstract

This paper aims to investigate the impact of e-governments on promoting sustainable development and a more inclusive society. Enhancing transparency, accountability, and effective performance, including public services and integrated policies, that promote sustainable development and growth for governments and how to manage everything related to them, especially managing resources efficiently to achieve the future and current well-being of generations, is one of the main drivers for advancing the performance of governments. We applied two methods in our research: i) Bibliographic, descriptive and analytical study through specialised software tools, we have highlighted the relationships and correlations between different concepts. ii) Analysis of the e-government effect on sustainable development by Introducing a novel logistical model to study research 103 nations as a sample from 2003 to 2018. Positive results from the first technique have suggested prospective action directions, including theoretical approaches and the sharing of best practices. The second method shows how e-government, especially in emerging and transitioning countries, boosts the likelihood of achieving sustainable development. The results also show that economic growth with per capita GDP both significantly and positively influences sustainability in general and that sustainable development is more likely to occur in countries with lower rates of age interdependence with natural resource rents.

Keywords: Sustainable Development, Digital Government, Bibliographic Study, Natural Resource, E-Government

JEL-Classification: C32; L70; D73; O01, Q01

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1. Introduction

Since the turn of the century, economies have grown rapidly as a result of social and environmental effects, posing a threat to both present and future generations' financial security. Digital transformation is currently seen as an important key force behind change in governments when the objectives are to increase efficiency transparency and accountability because e-government can facilitate public services and integrated policies to promote inclusive growth, social, sustainability and environmental development protection. In order to enhance the use of natural resources and prevent a future where their usage deteriorates, e-government can help manage resources effectively Castro & Lopes (2021). As a result, rather than emphasising economic growth in conjunction with environmental and social issues, policies now place more emphasis on growth balance. According to Bardi et al. (2015), sustainable development raises interest in national accounts greening by taking into account the loss of natural capital.

The European Union considers that digital public administrations are essential today to ensure fast and high-quality services to businesses and citizens in Europe. This will include increasing funding for programs and initiatives aimed at modernizing public administrations. The policy can be orchestrated to facilitate user focus and interoperability across borders. Since the fourth revolution of the industry information technologies is led this era. Information technologies such as big data, blockchain, the Internet of Things (IoT), mobile and cloud technologies, and artificial intelligence (AI) have attempted to change paradigms of economics, work, social culture, politics, and even public services Seo & Myeong (2020). Our goals are to highlight the mechanisms for public administration digitisation Burlacu et al. (2021) which allows sustainable development promotion and inclusively the society Profiroiu et al. (2020). The well-known definition of sustainable development is "development that addresses the needs of society members without jeopardising the ability of future generations to meet their own needs," as stated by the UN Commission on Environment and Sustainable Development (1987). This new trend has led to the evolution of a number of indicators, which has posed the issue of how to measure sustainable development. One of the most widely accepted indicators of sustainability in the literature Arrow et al. (2003); Boos (2015); Koirala & Pradhan (2019) is adjusted net savings calculated by the World Bank. The World Bank (2012) states that adjusted net savings "measure the real rate of savings in an economy after taking into account investments in human capital, resource depletion, and pollution damage." The economic axiom that savings equal investment and that this is a change measure in wealth formed the foundation for the formulation of the World Bank's indicator of development sustainability for 2020. Since a nation is not on a sustainable path

if its resources are running out, wealth changes are related to development sustainability (World Bank, 2006). Net savings that have been adjusted for changes in a nation's society, economy, and environment.

According to earlier research, the effectiveness of the institutions is essential for sustained growth. Because of this, according to Sato et al. (2018), Boos & Holm-Müller (2013), Aidt (2010), Bota-Avram et al. (2018), Uwasu & Yabar (2011), and United Nations (2018), "World Bank (2016) - a set of institutions capable of managing natural resources, collecting rents from resources, and channelling them to become profitable investments." Insufficient and poor governance, according to a number of authors, including Acemoglu and Robinson (2012), Van der Ploeg (2011), Hanley et al. (2015), and Aidt (2010), is what causes the resource curse, while Good governance helps to allocate resources properly and boosts performance in sustainable development, according to Sato et al. (2018) and Güney (2017a). The dedication of the stakeholders is essential for sustainable development success. "Sustainable development is the "ages" of electronics, software and hardware, services, and people," claims Bawzier (2006).

Governments in developing countries and developed nations may now more easily provide public services and implement integrated policies thanks to the digital revolution and the use of ICT (information and communication technology). Similar to the UN (2016), Adjei-Bamfo et al. (2019) advocate for the institutions that support sustainable development to be transparent. Information and communication technology advancements have created new opportunities for individuals and the government to work together more effectively to achieve improved government goals, which are essential to achieving sustainable development. E-government, or digital government, shares excellent resource management and may thus contribute to bettering the use of natural resources now in order to prevent damaging the use of natural resources in the future.

The e-government importance in fostering accountability, openness, and participation is frequently emphasised in the literature. Benefits for economic growth have been documented by Dwivedi et al. (2009), Gautam et al. (2017), Corojan & Criado (2012), Elbahnasawy (2014), Klitgaard (1988), Sunday (2014), and Srivastava et al. (2016). Majeed & Malik (2016) and Khan & Majeed (2019). To the authors' knowledge, however, no previous study has examined the effect of e-government on sustainable development, as determined by net savings adjusted, using panel data. This study intends to evaluate how e-government growth influences sustainable development to address this gap in the economic literature.

2. Literature Review

2.1 Sustainable growth and net savings that have been modified

In order to reconcile the growth of economic and social with environmental concerns, it is vital to measure economic growth using criteria other than GDP growth. Bota-Avram et al. (2018) contend that this is insufficient to assess the progress of both economic well-being and sustainable development, despite the core premise that economic growth would be focused on enhancing well-being and life quality. The social, economic, and environmental perspectives are the most important ones to take into account while studying sustainability. Rutherford in 1997. Furthermore, Hardy et al. (1997) argued that human well-being should be taken into account in addition to economic and environmental factors when defining sustainability. The problem of sustainability from an economic standpoint relates to humanity's need to safeguard capital in all of its forms for future generations. In 2010, Van Bellen. Natural capital is seen as "a set of complex systems made up of evolving biotic and abiotic components that interact in ways that determine the ability of an ecosystem to directly and/or indirectly provide for human society with a wide range of functions and services" by Belink et al. (2015, 1). As a result, natural capital is not just considered to be a stock of resources. As a result, there is a crucial natural resource that cannot be replaced Pierce et al (1989). Accordingly, for sustainable development to continue delivering essential services for wellbeing, it is necessary to safeguard this important natural capital. This cannot be accomplished by reinvesting the profits from the exploitation of natural resources in both physical and human capital, according to Brand (2009), De Groot et al. (2003), Dietz & Neumayer (2007), Ekins et al. (2003), Noel & O'Connor (1998), Chiesura & De Groot (2003), and Boos (2015). If net investment in all forms of capital is positive, the economy can meet future needs even when sustainability is poor. Boos (2015). Natural capital must be kept at a level that is essential to the wellbeing of future generations in order to ensure robust sustainability.

Metrics that take into consideration the economic, social, and environmental factors were crucial. Van Bellen in 2010. Due to the complexity and diversity of the idea of sustainable development, several indicators have been developed; however, not all of them correctly reflect all of its elements. Witulski and Dias (2020). The adjusted net savings (or real savings) from Arrow et al. (2003), Boo (2015), Bota-Avram et al. (2018), Everett & Wilks (1999), Kasim and Grimes (2018), and Koirala & Pradhan (2019) are some of the most commonly used indicators in the literature for the capital approach, which measures the change in the value of a group of assets without taking into account capital gains. It is a symptom of insufficient sustainability and covers the economic, social, and environmental elements of

sustainability. Other measures, like the Human Development Index (HDI), which takes human development traits like education, longevity, and standard of living into account, focus on the economic and social aspects of sustainable development while ignoring environmental degradation. The Environmental Performance Index only considers environmental problems. The Sustainable Society Index covers the three aspects of sustainability, but it does not combine them into a single index as recommended by the Joint Research Centre (JRC) of the European Commission due to the unfavourable correlation between human and environmental well-being. It is only released every two years and is titled Dimensions of Existence. Others, like the Adherence to Development Index and the Index of Sustainable Economic Welfare, are only measured in a select few countries. The World Bank-adjusted net savings are commonly employed as a broad indicator of long-term sustainability (Arrow et al., 2003; Hanley et al., 2015; Qasim & Grimes, 2018). Adjusted net savings (ANS) are created by changing the gross national saving (GNS) in the following ways: (i) The government's current operating expenditure on education has been added to account for investment in human capital (GEE); (ii) the consumption of productive capital has been discounted to obtain net national savings (D_K); (iii) natural capital depletion (energy, minerals, net forests) has been subtracted to express the decline in asset values related to extraction and depletion (D_{NC}). (iv) divided by Gross National Income (GNI); (v) damages are subtracted from carbon dioxide and particulate matter (CO_2) emissions;

The following phrase neatly expresses this:

$$ANS = (GNS + GEE - D_K - CO_2)/GNI \quad (1)$$

GNS is GNI minus gross consumption, plus net remittances. If a country's adjusted net savings become positive, it means the present social welfare value increasing. On the contrary, negative adjusted net savings consistently indicates that the economy is on an unsustainable path.

2.2 The Sustainable Development Determinants (E-Government and The Institutions Role)

Institutions' quality commonly affects the growth in the long-term Aidt (2010), Boos and Holm-Müller (201impacts3), Sato et al. (2018), Sharma (2007), United Nations (2018), and Venard (2013) are some of the authors. A better government may manage resources more effectively to foster long-term growth. Sato et al. (2018); Bota-Avram et al. (2018); Kaufmann et al. (2005). Member States reiterated in UN General Assembly Resolution 66/2888 - "The Future We Want" that strong governance, democracy, the rule of law, and an enabling environment are critical to sustainable development, which includes inclusive

economic growth, social development, and environmental protection. Nowadays, digital technologies can disrupt established business practices, and ICTs "provide governments with an unprecedented opportunity to achieve sustainable development and improve the well-being of their citizens." United Nations (2018, xxvii). According to the World Bank (2013), "e-government refers to the use of information technologies (such as wide area networks, the Internet, and mobile computing) by government agencies that have the potential to transform relationships with citizens, businesses, and other government weapons." According to the United Nations (2016, 6), e-government has become a development indicator and "an aspiration in itself." E-government is a tool for improving government (UNDESA 2001 and the Organisation for Economic Cooperation and Development (OECD) in the United Nations (2016, 165) and positively impacting good governance, both of which are required for attaining sustainable development. UN (2016); Alaaraj and Ibrahim (2014). According to Von Haldenwang (2004), e-government is not governance neutral and can increase administrative capability and democratic governance in underdeveloped nations.

E-government has many benefits, including bettering the delivery of public services, reducing costs, saving time, empowering citizens through knowledge sharing with the government, enhancing interactions with business and industry, enhancing effectiveness and efficiency in all areas of government, and boosting revenue growth. Political and societal repercussions including increased openness, transparency, and a decrease in corruption have been discussed by Al-Khatib et al. (2015), the World Bank (2013), and others. Stanimirovich and Vintar (2013); World Bank (2013). According to Stanimirovic and Vintar (2013), the growth of e-government has a significant impact on sustainable development through its effects on the economic, social, and environmental facets of development. Corsi et al. (2006), in a study prepared for the European Commission's E-Government Unit, considered that due to the importance of the public sector. Economic growth in European nations may be boosted through e-government initiatives. The authors believe that the growth of public sector output, the effectiveness of public administration, and the increase in aggregate demand all have a positive impact on the economy because, in accordance with the prior literature, the development of e-government improves the efficiency of the public sector. As a result, the authors believe that labour productivity in this sector will rise. growth. Additionally, the social and environmental facets of sustainability may benefit from e-government. It may increase access to vital services like social welfare, employment, and the provision of health and education. Through the dissemination of information, especially through the use of open government data (United Nations, 2010), governments may inform and assist citizens in balancing the use of natural resources with the preservation of their quality and availability.

Despite the literature on the topic, studies on the effects of e-government on sustainable development as assessed by adjusted net savings are rare. In their 2007 examination of actual savings in 115 nations, Dietz et al. concentrated on identifying the qualities of high-quality institutions, such as the rule of law, effective bureaucracy, and the absence of corruption. The results demonstrate that since corruption and resource abundance interact negatively, actual savings may be enhanced by enhancing their capacity to fight corruption. Using panel data from 63 different countries, Sato et al. (2018) discovered that strengthened institutions not only enhance the quantity of real savings but also stabilise their volatility. A favourable correlation between measures of good governance and adjusted net savings has been discovered by other writers as well. Bota-Avram et al. (2018), Güney (2017a), Boos & Holm-Müller (2013), and others.

E-government is defined by the Organisation for Economic Cooperation and Development (2003, 11) as "the use of information and communication technology (ICT), especially the Internet, to achieve better government" and is seen as more about governance than the letter "e" itself. The OECD (2003) stated that "the impact of e-government at a broader level is simply better management by enabling better policy outcomes, higher quality services, greater engagement with citizens, and improved other key outputs." E-government is a key component of transformational growth in the efficacy, efficiency, and quality of resource management, and it may support good governance. Bala & Verna(2018); Heeks (1999). Although the goal of e-governance is to improve the quality and speed of services provided by public institutions via the use of information and communication technology, it also improves democratic accountability and involvement. In 2012, Subramanian. "E-government can aid in green government initiatives, support effective resource management, spur economic growth, and broaden social inclusion of underserved and privileged groups." Nica (2015, 70).

E-government increases the potential for economic progress by transmitting knowledge and information Majeed and Mali (2016). Gustova (2017) analyses the impact of e-government on social and economic progress using data from 34 European countries between the years 2003 and 2014. The results demonstrate that, in addition to promoting economic growth, e-government has positive effects on the health index and negative effects on the death rate for children under five. These findings support the hypothesis that the adoption of digital technology by the government will have a significant influence on both social and economic development. Even though numerous studies examine the impact of governance indicators on sustainable development, there is little empirical study on the impact of e-government on adjusted net savings as an indicator of progress.

2.3 Additional Factors That Affect Sustainable Development

Along with the effectiveness of institutions, several other characteristics, including economic growth, per capita income, age dependence, urbanisation, resource availability, and financial development, have been studied in the literature as predictors of sustainable development. The estimation methods (OLS, random/fixed effects, autoregressive distributed lag model, GMM, and IV approaches), sample (a collection of developed and/or developing countries, or just one country), and method of measurement (sustainable development) employed in research differ. Due to the use of several tests—including the VECM, the Johansen co-fusion test, and 2SLS, among others, results are difficult to compare.

Koirala and Pradhan (2019) found that adjusted net savings are significantly positively influenced by per capita income and financial development, but negatively impacted by natural resource rents, inflation, and time using panel data for 12 Asian (developed and developing) countries from 1990 to 2014. Dietz et al. (2007) found that real saving rates in resource-rich nations are significantly harmed by the abundance of natural resources (as shown by the proportion of fuels and mineral goods in total exports). This was based on panel data collected over an 18-year period from 115 developing and wealthy nations. Although per capita income, national income, and urbanisation did not approach statistical significance, their findings highlight the benefits of economic growth and offer some support for the negative effects of age dependence.

The increase in the labour force and the population over 65 are not taken into consideration, according to Güney (2017b), who observed that population growth and youth growth have a major negative influence on sustainable development. For the whole sample of 142 nations, this study examined how population increase affected sustainable development (adjusted net savings). One of the most important elements of sustainable development is even though the results differ across developed and underprivileged countries. Additionally, while consumption has a negative effect on sustainable development, trade openness, economic progress, and the decline in corruption have a beneficial impact on it.

When Güney (2017a) examined the connection between governance and sustainable development, he found that while population growth and economic growth have a negative effect on it, democracy and urbanisation have positive effects that are felt globally (and in both developed and developing countries). Not a lot. Population growth, money supply, inflation rate, and the exploitation of non-renewable natural resources are all damaging to Japan's and ASEAN members' ability to develop sustainably, claim Bardi et al. (2016). For Kenya between 1991 and 2014, real GDP per capita, resource productivity, and terms of trade

had no discernible effect on adjusted net savings, according to Kaimuri and Kosimbei (2017). However, per capita home consumption has a negative long-term impact on sustainable development (ANS) and a negative short-term impact on energy efficiency and unemployment.

3. The Methodology

3.1 First Technique

The bibliometric study is the primary methodology employed in our research. Statistical evaluation of written publications, such as books or papers, is known as bibliometrics. The widespread use of bibliometric techniques is a result of the electronic transformation of publications and the growth of information and communication technology. Currently, academic literature is subjected to quantitative analyses using bibliometric metrics. According to research, the study of bibliometric networks, including co-authorship, bibliographic association, and citation networks, has a long history in the area of bibliometrics. Early articles from Perianes-Rodriguez et al. (2016) date back to the 1960s and 1970s.

According to studies, citation-based, co-citation, bibliographic linking, keyword co-occurrence, and co-authorship networks are the types of bibliometric networks that have received the most attention. Three popular graph-based and distance-based conceptual approaches have also been identified. according to chronology. There are a lot of software solutions available now for displaying bibliometric networks. However, two of these software tools have received particular attention in recent studies, namely CitNetExplorer and VOSviewer van Eck & Waltman (2014). We decided to use the first programme, VOSviewer, taking into account the discussions, the methods used by these tools to build, analyse, and visualise bibliometric networks, the tutorials that show step-by-step how these types of tools can be used, the level of limitations, and the proper use of bibliometric network views. A computer programme called VOSviewer was made to create, display, and explore bibliometric maps for science. These maps can be used to analyse various types of network bibliometric data, including relationships between publications or journals in terms of citations, or between researchers in terms of collaboration and emergence. Eck & Waltman (2016) is one of the scientific terminologies.

3.1.1 Finding

For the bibliometric study, we first looked for papers in the Web of Science database that addressed the issue of public administration digitalization in connection to sustainable development. 52 references were listed in the analysis programme, which we found. Figure 1

depicts the acquired image. We can get a general picture of the phenomena by looking at the links between the ideas. Using the programme made four galleries with various colour shadings emerge.

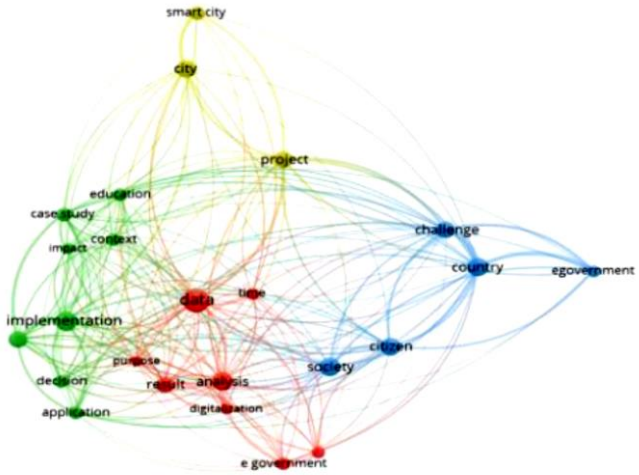

Figure 1: shows how the literature cited in Web of Science databases relates the digitization of public administration to sustainable development.

The blue group connects the idea of e-government with problems, people, and society. This notion centres around the idea of the state and may be used to refer to significant state features that have significant significance for the digitization of public administration. a distinct category of smart city ideas, initiatives, and cities. The researchers' emphasis on specific projects, successful case studies, or sound practices formed from the application of successful projects is highlighted by this association. The current research finds evidence of sustainable development that is partially tied to the digitalization of public administration.

The fact that so few papers have been found in Web of Science databases suggests that this strategy is still developing, with an emphasis on issues with a direct impact, like implementations. influence and judgement. The green cluster highlights case studies and education. We applied the same search methods to the same topics in Scopus databases to evaluate these hypotheses. The highlighting of 72 articles came from a search of the same themes in the Scopus databases on the digitization of public administration in relation to sustainable development. Figure 2 shows a study of the domains in which they were used. The distribution of research findings on the digitalization of public administration connected to sustainable development is dominated by computer science and social sciences, which is maybe not surprising, according to the plot in Figure 2.

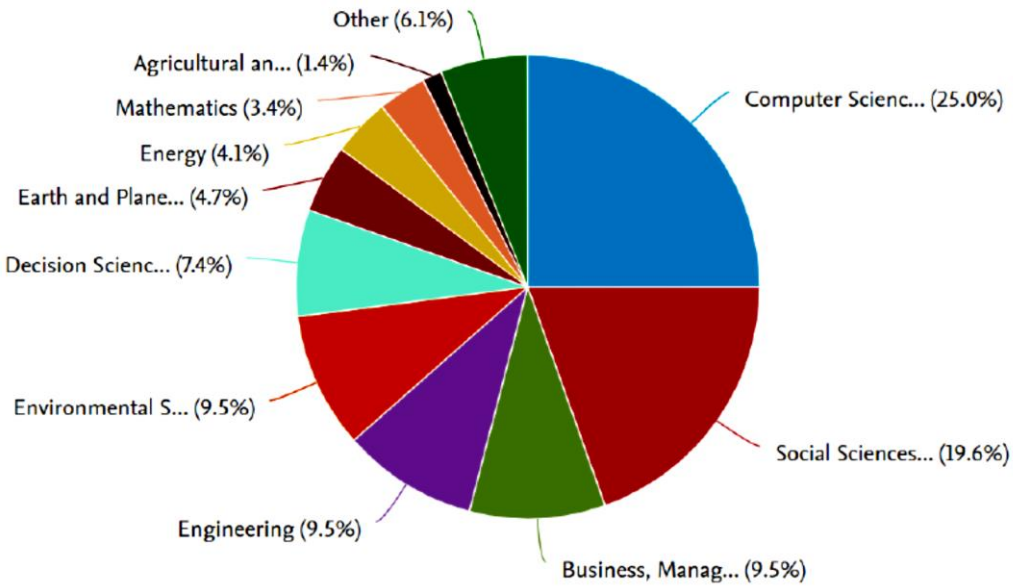

Figure 2: shows the proportion of articles in the Scopus database that discuss the relationship between sustainable development and the digitization of public administration.

3.1.2 Findings and Discussion

Perhaps highlighting the cytometric markers will convey the significance of bibliometric analysis. As a result, we see through the examination of articles in the Scopus databases that citations to works in this field accrue over time, albeit more recent works can also do so if they deal with strictly interesting subjects. The Ambition and Capability Gap and other SDG implementation issues with digital governance are discussed in one of the most frequently referenced publications from four years ago (Janowski, 2016).

The research that stands out from the majority of scientific papers found in the Web of Science and Scopus databases assumes that the integration of e-services technologies into the European Sustainable Development Policy would be part of the provision of public services through specific ICT solutions (Ursacescu, 2009). In the context of the difficulties associated with sustainable development strategies, it may be an effective illustration of the growth of the interaction between technology and public administration. A recent study demonstrates that institutions are not actors in and of themselves, and it is advised that adaptation actions be discussed with those social groupings that link institutions and technology. Four different methods of digitalization management in Russia are provided as examples in the study. This is proof of the expectation effect, which occurs when an organisation imports essential core activities and gains other functions linked to replicating energy ownership linkages. It is claimed that if Western Internet technologies are naturally linked to institutions that increase

opportunities for citizens to participate in democracy (e.g., electronic reporting by the government, electronic voting in elections), then the institutions developed by the Chinese people will limit these opportunities because of their developed system of social classification.

We believe that in order to better control the growth of computing in Russia, it is first necessary to shift the ingrained belief that ICTs are an unquestionable good that ensures society's well-being. Instead, ICTs are now viewed as merely a tool for processing data that, like any tool, can be used for either good or bad. It is believed that IT systems do not make decisions on their own; rather, they merely increase the opportunities for their preparation, implementation, and control. This can multiply the consequences, both good and bad, and may necessitate striking a balance between centralised management and decentralised civil control Lukashov et al. (2021). By giving instances of digital platforms that have been effectively implemented in the economy, research on the digitalization of society, including the economic sector, demonstrates the significance of building digital platforms in an economy focused on sustainable development. This considers the role played by the government in creating and implementing digital platforms for public administration. The purpose of this article is to demonstrate how a digital platform may be used as a tool for sustainable development by being evaluated as a monitoring system for decision-making Stepanova et al (2020).

3.2 Second Technique

Non-diminishing wealth will is the definition of sustainable development (Sato et al. 2018, Hamilton, 2000). Manufactured capital (K), human capital (H), and natural capital (N) are all components of wealth (W):

$$W_t = K_t + H_t + N_t \tag{2}$$

will provide sustainable development (SD)

$$SD = dW_t/dt = dK_t/dt + dH_t/dt + N_t/dt \geq 0 \tag{3}$$

In 103 countries, for whom all essential data was available, the empirical study on the effect of e-government and other factors on sustainable development was evaluated from 2003 to 2018. Table 6 contains a list of the included nations. As in earlier research, adjusted net savings in the percentage of gross national income (ANS) will counteract the effects of sustainable development. A binary variable (ANSbin) was chosen to represent whether a nation has a non-negative ANS from adjusted net savings:

$$SANSbin_i = \begin{cases} 1 \; if \; ANS_i \geq 0 \\ 0 \; if \; ANS_i < o \end{cases} \forall \; i \tag{4}$$

A logistic regression model was created using this binary variable to associate the likelihood of having a non-negative ANS with a number of important aspects of SD. The Logitech model is described as follows:

$$\ln(u_i/(1-u_i)) = \beta_0 + \beta_1 EGOV_i + \sum_j \beta_j X_{j_i} \forall \; i$$

where: $u_i = P(SANSbin_i = 1) = P(ANS_i \geq 0)$ is the probability that i a country will have a non-negative ANS and $(u_i/(1-u_i))$ is the odds ratio in favour of having a non-negative ANS, i.e. the ratio of a country's likelihood of sustainable development to its likelihood that air navigation services are unreliable. The remaining control variables are X_j and EGOV, which is an electronic Gov. The literature review's discussion of prior empirical research on the factors that influence sustainable development, including economic growth, per capita income, dependency on older populations, and the richness of natural resources, served as a reference for choosing the control variables. The model will be estimated individually for the sub-samples of emerging and transitional economies as well as for the total sample. Due to the fact that practically all observations had a non-negative ANS, the study was not conducted for industrialised nations.

In order to evaluate the extent of e-government's influence on sustainable development, sustainable development will also be replaced by the Human Development Index. According to the United Nations Development Programme (2020), the Human Development Index measures three key aspects of human development—a long and healthy life, knowledge, and a respectable level of living—on a scale of 0 to 1. Human development is divided into four ranges by the UN: low (less than 0.550), medium (0.550–0.699), high (0.700–0.799), and extremely high (0.800 and above). A binary variable named HDIbin was chosen from this grouping; it has the value 1 if the HDI is equal to or higher than 0.699 and 0 otherwise.

The United Nations E-Government Development Index, which is a weighted average of standardised scores on the three most crucial elements of e-government, is used to gauge e-government (EGOV). (i) The Online Services Index, which evaluates the breadth and calibre of online services; (ii) The Telecom Infrastructure Index, which gauges the level of advancement of the telecom infrastructure; and (iii) The Human Capital Index. Higher scores indicate stronger e-government development; the scale spans from zero to one (United Nations, 2018).

The 2018 E-Government Survey (United Nations, 2018) illustrates the ongoing good trend in the growth of e-Government, which is a field that is expanding quickly. With an e-government development level between 0.75 and 1, 40 of the 193 nations examined in this study score extremely high, an increase of 11 countries from 2016. From 0.44 in 2010 to 0.55 in 2018, the average worldwide e-government development index has grown. Denmark, Australia, the Republic of Korea, the United Kingdom, Sweden, Finland, Singapore, New Zealand, France, and Japan made up the top 10 nations in the e-government development index for 2018. Additionally, from 32 in 2016 to 16 in 2018, the number of nations with a low e-Government Development Index (0-0.25) has declined. Fourteen African nations are among the least developed nations and have a low e-Government Development Index. Economic expansion is anticipated to result in more investment resources, which in turn helps to build up the productive base and raise adjusted net savings Sato et al. (2018).

However, Güney (2017a) shows that economic growth might have a detrimental impact on sustainable development due to an increase in environmental pollution, even while the author finds no significant influence on adjusted net savings in a sample of developed and developing nations, but is notably favourable in The sample is made up of developed nations. National per capita income may benefit sustainable development since it will enhance savings as money is a major factor in saving. Gross national income per capita (GNIpc) is determined using constant 2010 US dollars. Through the cost of reliance, a country's population age structure might affect savings Hess (2010). Greater reliance on youth relative to net producers necessitates a bigger income share for children's social welfare, which raises consumption expenditures as a percentage of gross domestic product. Hess (2010) predicts that healthcare costs will rise and be unimpressive as the old-age dependency ratio rises. A higher age dependency (young and old) would be predicted to have a negative impact on adjusted net savings if a significant amount of resources are needed by a sector of the population that is substantially less productive. Age dependency was calculated as the proportion of the working-age population (those between the ages of 15 and 64) who are dependent, or younger than 15 or older than 64.

The level to which a country's economy depends on natural resources for revenue is shown by natural resource rents. Since they are not generated, some nations' natural resource income makes up a portion of their GDP in the form of rents (revenues are larger than the cost of resource extraction). Due to the relatively fixed nature of the supply of natural resources, the rents erode the capital stock, and when used to finance current consumption rather than investment, those nations are borrowing money for the future. Therefore, it is anticipated that a significant percentage of natural rents in GDP will hinder sustainable growth. The variable

utilised was total natural resource rents (% of GDP), which is the total of the rents for metals, oil, natural gas, coal (hard and soft), and forest rents.

Indicators and measurements for the independent variables considered, together with their data sources and predicted signs, are summarised in Table 1. The variables' descriptive statistics for the entire sample are shown in Table 2. Angola saw the lowest value of the ANS throughout the analysis period, in 2008, and Kuwait saw the greatest value in 2006. In the years 2003 to 2018, Angola reported the systemic problem with the highest average value of ANS (24.6%), followed by Guinea (16.6%) and Lebanon (15.3%). Singapore's average value during the time period is the highest (35.1%). The sample's median adjusted net savings rate is 9.14%.

The highest degree of e-government development was recorded in the Korean Republic in 2014 at 0.946, while the lowest level was recorded in Guinea in 2013 at 0.048. The average e-Government Development Index for Guinea is 0.124, which is the lowest. In regions like Africa (Guinea, Malawi, Madagascar, Cameroon, Angola, and Nigeria), but also some Asian nations (Lao People's Democratic Republic, Pakistan, Bangladesh, Cambodia, and Nepal), there are nations with an average e-Government Development Index below 0.30 during the analysis period. Governments may not be able to take advantage of ICT use due to poor connection, high access charges, a lack of the required skills and credentials, and insufficient investment. The results of a simple regression analysis revealed that $F(1, 1649) = 82{,}932$ for the entire sample and $F(1, 1144) = 96{,}116$ for developing and in transition economies, respectively, with a (p) value of 0.0001 (Figure 3). This indicates that the model of e-government is statistically significant in predicting adjusted net savings. The findings of these regressions point to a statistically significant positive relationship between the e-Government Development Index and adjusted net savings, which not only suggests that e-government may be a relevant variable in explaining sustainable development but also that the impact is greater in the last group of countries. However, this relationship is particularly striking in the case of developing and transition economies. While a rise of 0.1 in the e-Government Development Index causes an increase in ANS of 1.29 in the global sample, the same increase in e-government causes an increase in ANS of 2.29 in emerging and transition economies.

Table 1: Summary of measurements, sources and expected sign

Variables	Measurement	Data source	Expected sign
Independent variables			
e-Government	e-Government Development Index: from 0 (least developed) to 1 (most developed)	UN Department of Economic and Social Affairs (UNDESA)	+
Economic growth	Real GDP per capita growth (annual %)	World Development Indicators from the World Bank	+
Gross national income per capita (GNIpc)	Constant 2010 USD		+
Age dependency	Ratio of dependents—people younger than 15 or older than 64—to the working-age population—those ages 15–64. Data are shown as the proportion of dependents per 100 working-age population		-
Natural resources rents	Total natural resources rents (% of GDP) Total natural resources rents are the sum of oil rents, natural gas rents, coal rents (hard and soft), mineral rents, and forest rents		-

Table 2: Descriptive statistics for the whole sample

Variable	Mean	Median	SD	Min	Max
Adjusted net savings (ANS)	9.14	8.68	10.88	− 42.17	42.73
Human Development Index (HDI)	0.739	0.752	0.134	0.338	0.954
E-government (EGOV)	0.551	0.534	0.184	0.0477	0.946
Age dependency	55.59	52.06	14.77	26.99	107.82
Economic growth	2.64	2.54	3.60	− 14.56	33.00
Natural rents	5.98	1.91	9.71	0.00019	62.05
Gross national income per capita (GNIpc)	16,444.30	7,353.82	19,568.41	367.95	103,039.30

3.2.1 The Findings and Discussion

The logit model that has to be estimated is provided in Eq. (6), and Table 3 contains the results of the model estimation.

$$\text{Ln}\left(\frac{u_i}{1-u_i}\right) = \beta_0 + \beta_1 EGOV_i + \beta_2 dependency_i + \beta_3 Eonomic\ growth_i + \beta_4 Natural\ rents_i + \beta_5 GNIpc_i \quad (6)$$

Table 3 displays the logit model coefficients, odds ratios, standard errors, and p values for the Wald test. Since there were no significant issues with multicollinearity and all of the variance inflation factors (VIF) were under 4, all of the variables were included in the model.

The overall goodness of fit of the model is demonstrated by the log-likelihood ratio test, which is significant at a 1% level. The omnibus model coefficient tests $X_5^2 = 284.566$, with a $\rho < 0.001$ with a test of Hosmer and Lemeshow $X_8^2 = 11.981$, with a $\rho = 0.152$ and suggests a model good fit.

Table 3: Results of the logit model estimation for the whole sample Logit, using 1587 observations Dependent variable: ANSbin

	Coefficient β	Odds ratio e^{β}	Std. error	z	p value		VIF
const	1.628130	5.094339	0.725850	2.243	0.0249	**	
EGOV	2.352390	10.510660	0.820507	2.867	0.0041	***	3.535
Age dependency	−0.020412	0.979795	0.006714	−3.040	0.0024	***	1.657
Economic growth	0.118523	1.125833	0.025370	4.672	<0.0001	***	1.095
Natural rents	−0.059703	0.942044	0.007650	−7.804	<0.0001	***	1.080
GNIpc	5.59221e-05	1.000056	1.23858e-05	4.515	<0.0001	***	2.501
Mean dependent var		0.867675	S.D. dependent var				0.338951
McFadden R-squared		0.229425	Adjusted R-squared				0.219750
Log-likelihood		−477.8895	Akaike criterion				967.7789
Schwarz criterion		999.9965	Hannan-Quinn				979.7473

In addition, despite moderate values for pseudo R^2 ($R^2_{cox\ \&\ Snell} = 0.164$; $R^2_{Nagelkerke} = 0.303$; $R^2_{MacFadden} = 0.229$, the model properly predicts the result in 88.6% of the instances. The examination of the ROC (receiver operating characteristic) curve shows that the model has a good capacity for discrimination, proving the utility of the model for categorising fresh observations (Figure 5), with an area under the curve of 0.815, substantially greater than

0.5 ($\rho < 0.001$). None of the observations may be regarded as being relevant because the Cook distance was discovered to be less than one. The Wald test demonstrates that all explanatory factors (e-government, economic growth, age dependence, natural rents, and GNI per capita) are statistically significant at a 1% significance level in influencing the chance of having non-negative ANS. The findings imply that e-government has a significant role in influencing the likelihood of sustainable development. The probability of sustainable development should rise by around $\left(\left(e^{\beta_i^{0.1}} - 1\right)\text{x}100\right)$ with a 0.1 increase in the e-Government Development Index while holding the other factors constant.

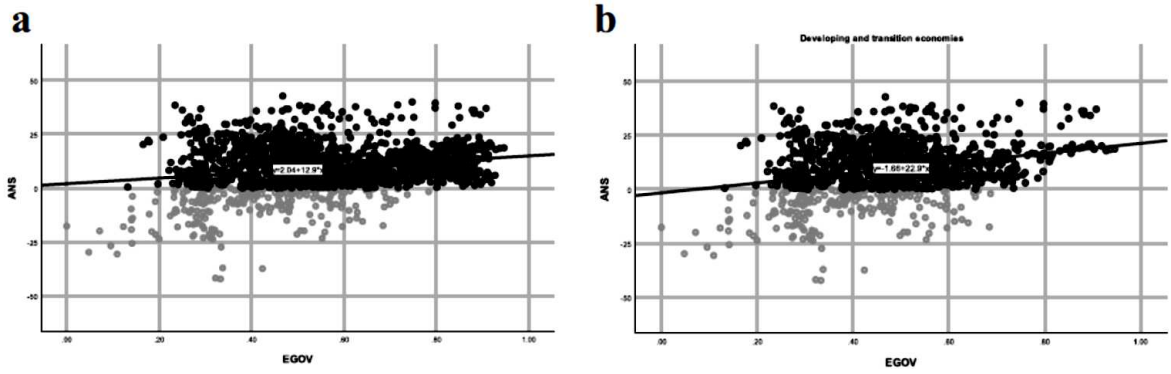

Figure 3: shows a scatterplot of the adjusted net savings and the e-Government Development Index for all countries (a) and for emerging and transition economies (b).

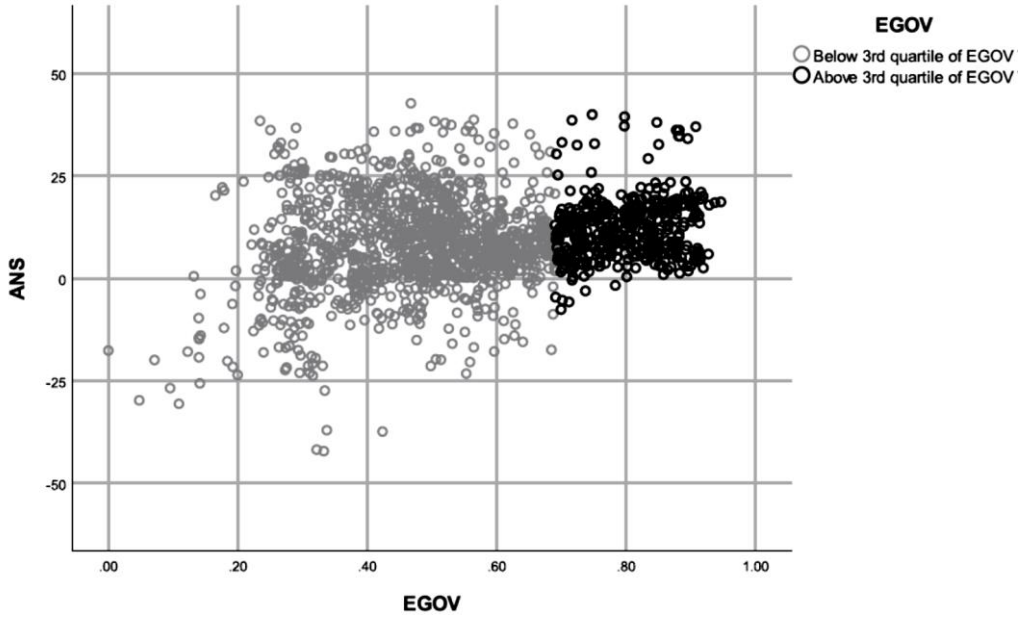

Figure 4: shows a scatterplot between the e-Government Development Index and adjusted net savings for all nations, emphasising the top 25% of e-government countries.

The predicted odds ratio for an increase of one percentage point in age reliance is 0.979795, which indicates that while the other factors stay constant, an increase of one percentage point in age dependency reduces the likelihood of having a non-negative ANS by 2.02%. The results of Sato et al. (2018) and Dietz et al. (2007), where this variable is also substantial and negative in several of the estimated models, are comparable to the ones presented here. Sustainable development is also more likely to occur if economic growth is higher: for every unit percentage point rise in economic growth, the likelihood of sustainable development increases by 12.58%. According to Sato et al. (2018) and Dietz et al. (2007), economic expansion promotes sustainable development.

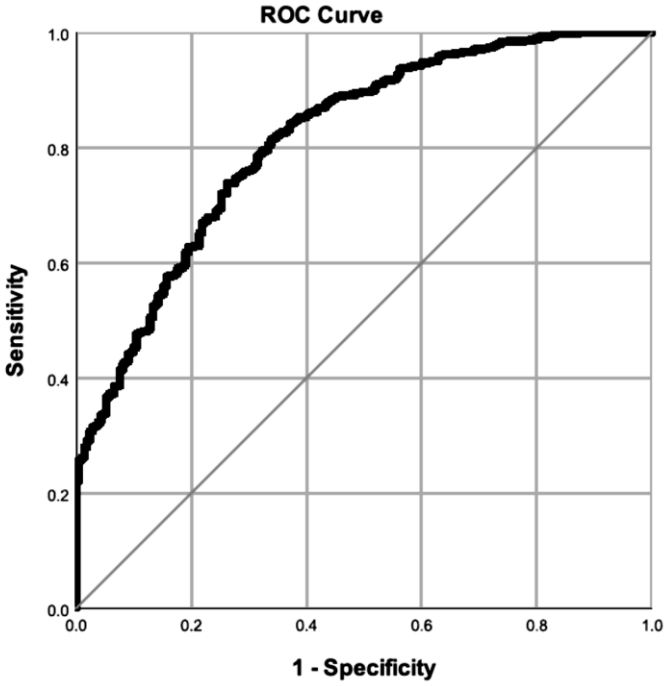

Figure 5: The logistic regression model's ROC curve from Table 3.

Keeping the other factors fixed, it is anticipated that the likelihood of achieving sustainable development will rise by 0.0056% for every USD increase in GNI per capita. According to the findings of Koirala and Pradhan (2019) and Dietz et al. (2007), an increase in GNI per capita, a key factor influencing savings, will favourably impact adjusted net savings. In contrast to other factors and as predicted, an increase in the age structure biassed towards the inactive age cohort (younger than 15 and more than 64) and greater revenue generated by natural resources result in a decreased likelihood of a non-negative ANS event. The resource curse theory and Koirala's and Pradhan (2019) and Sato et al. (2018) findings support the idea that natural resource rents have a detrimental impact.

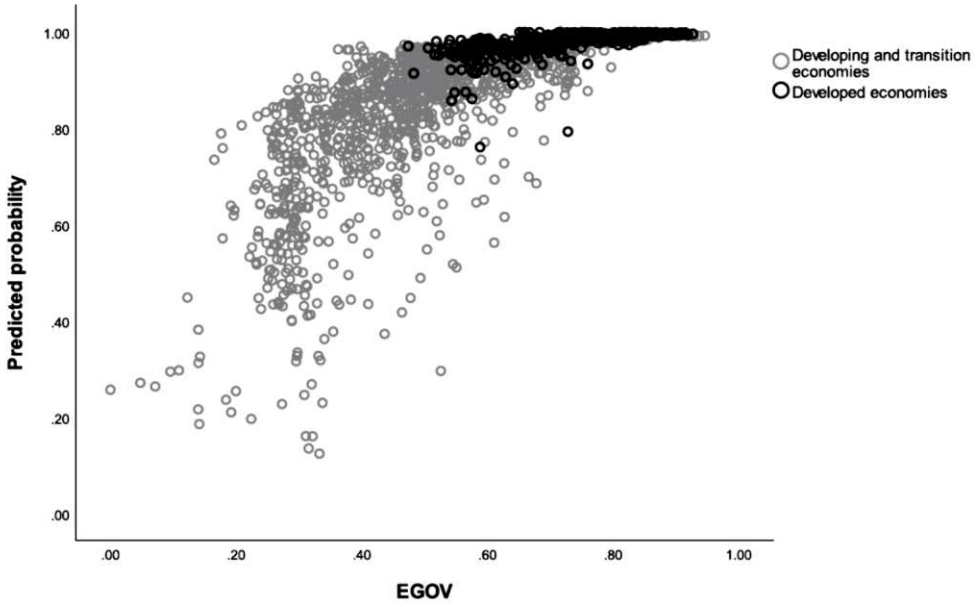

Figure 6: shows a scatterplot showing the likelihood of sustainable development and e-government in established, emerging, and transition economies.

Table 4: Results of the logit model estimation for developing and transition countries Logit, using 1096 observation-dependent variable: ANSbin

	Coefficient β	Odds ratio e^{β}	Std. error	z	p value		VIF
const	0.623007	1.864526	0.814647	0.7648	0.4444		
EGOV	3.106550	22.34383	0.932447	3.332	0.0009	***	2.651
Age dependency	−0.010138	0.989913	0.007576	−1.338	0.1808		2.083
Economic growth	0.136516	1.146273	0.028893	4.725	<0.0001	***	1.091
Natural rents	−0.083380	0.920001	0.010481	−7.956	<0.0001	***	1.125
GNIpc	0.000123036	1.000123	2.49798e-05	4.925	<0.0001	***	1.967
Mean dependent var		0.827555	S.D. dependent var				0.377939
McFadden R-squared		0.215353	Adjusted R-squared				0.203445
Log-likelihood		−395.3660	Akaike criterion				802.7321
Schwarz criterion		832.7286	Hannan-Quinn				814.0820

Number of cases 'correctly predicted' = 930 (84.9%) ; f(beta'x) at mean of independent vars = 0.378 ; Likelihood ratio test: Chi-square(5) = 217.023 [0.0000] ; *The z-statistic is significant at 10% level, **significant at 5% and ***significant at 1%

The model's findings indicate that as e-government advances, a higher chance of sustainable development is expected (Figure 6). Additionally, established economies and emerging and transitional economies differ from one another. As a result, only the subsample of emerging

and transitional economies will be used to estimate the model. The estimation of the model provided by Eq. (6) results for developing and transitional countries are shown in Table 4. The VIF shows that there are no significant multicollinearity issues with the data. The findings of the various metrics of R square are still reasonable in terms of model-fitting data. The remaining fitting statistics, however, are pretty good: the Hosmer and Lemeshow test ($X^2_{(4)} = 4.433$ with a $\rho = 0.816$) and Omnibus testing of model coefficients ($X^2_{(5)} = 217.023$ with a $\rho < 0.001$) show that there are no significant discrepancies between observed and projected values. Since the logistic model properly categorises 84.9% of the data, its power is good. The discriminant power of the model was shown by the area under the ROC curve, which yielded a value of 80.2%.

Table 5: shows the results of the logit model estimation for the entire sample and for the dependent variable for developing and transitional countries: HDIbin

	All countries			Developing and transition countries		
	Coefficient β	p value		Coefficient β	p value	
EGOV	8.53031	0.000	***	8.43031	0.000	***
Age dependency	− 0.114130	0.000	***	− 0.112760	0.000	***
GNIpc	0.000601	0.000	***	0.000591	0.000	***
Mean dependent var	0.678639			0.534672		
Cox & Snell R square	0.655			0.601		
Log-likelihood	− 256.6081			− 255.7030		
Schwarz criterion	535.3250			532.4042		
S.D. dependent var	0.467146			0.499024		
Nagelkerke R square	0.873			0.802		
Akaike criterion	519.2162			517.4059		
Hannan-Quinn	525.2004			523.0809		
Number of observations	1587			1096		
Number of cases 'correctly predicted'	1477	(93.1%)		987	(91.0%)	

*The z-statistic is significant at the 10% level, **significant at 5% and ***significant at 1%

It should be noted that in this subsample, the probabilities of sustainable development increasing by about 36.43%, greater than in the entire sample, are predicted with an increase of 0.1 units in the e-Government Development Index. This indicates that with the digital transformation of governments, emerging and transitional economies may raise the likelihood of sustainable growth. The results thus imply that these economies might benefit more than

developed economies from public investments in the adoption of technology. Increases in economic growth or GNI per capita also boost the likelihood of having a non-negative ANS in these nations more so than in developed ones. At any level, there was no statistically significant age dependence. Given their greater reliance on natural resources, these nations' increased natural rents reduce their chances of achieving sustainable development. A measure that evaluates the changes in capital stocks (manufactured, human, and natural) that may result in future changes in income is adjusted net savings, as was previously indicated. It gives information on the nation's economic, social, and environmental progress and serves as a sustainability indicator by taking these types of capital into account (World Bank, 2006).

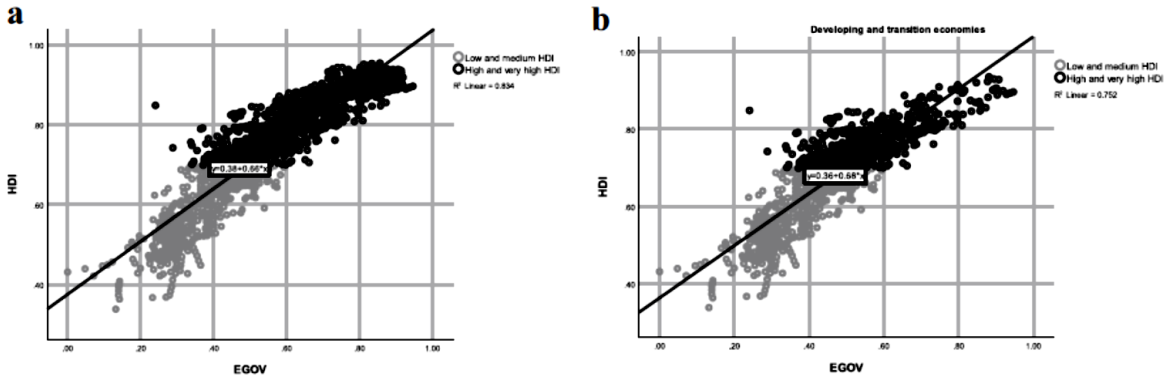

Figure 7: Scatterplot between e-Government Development Index and Human Development Index for all countries (a) and for developing and transition economies (b)

Although it excludes the ecological components of sustainability, the Human Development Index is also employed as a measure of sustainable development (Kerk & Manuel, 2008; Witulski & Dias, 2020). Given that the HDI utilises national averages for the metrics it includes, wealth distribution discrepancies are not directly reflected by it; but, because it also takes into account lifespan and knowledge, it does so inadvertently. The effects of e-government on sustainable development as represented by the HDI will be examined to assess the reliability of the findings. The examination of the effect of e-government development on HDI is summarised in Table 5 for the global sample as well as for developing and transitional economies. When it comes to model fitting data, the results of x 2 tests (AIC and Hannan-Quinn criteria, $\rho\ value$ 0.0001) show that the model is well-fitted. Additionally, the area under the ROC curve measures strong discrimination (0.981 and 0.966, respectively) with a proportion of accurate classification in the global sample of 93.1% and in the subsample of developing and transition nations of 91%.

Neither economic growth nor natural rents were statistically significant, as in other earlier

research, such as Khan et al. (2018). The literature by Choi et al. (2017) highlights the observable beneficial influence of income on human development. The growth of e-government enhances the likelihood of continued human progress, which supports our earlier findings. From the perspective of human development, it is acknowledged in the literature that digital government might be a development instrument since the advantages of public policy could be distributed to individuals more effectively, enhancing the quality of life and reducing poverty. Choi and others (2017). Scatterplots were created between the two variables in order to better evaluate the connection between e-government and HDI. The scatterplots in Figure 7 demonstrate the strong positive correlation between e-government and HDI, which is also evident for the global sample and the subsample of developing and transition economies. Countries with high or very high levels of HDI also have high levels of digital government development.

3.2.2 The List of the Sample Countries

Table 6: List of countries

Albania	Brunei Darussalam	Egypt	Israel	Malawi	Pakistan	Sri Lanka
Angola	Bulgaria	El Salvador	Italy	Malaysia	Panama	Sweden
Argentina	Cambodia	Estonia	Jamaica	Mauritius	Paraguay	Switzerland
Armenia	Cameroon	Eswatini	Japan	Mexico	Peru	Tanzania
Australia	Canada	Finland	Jordan	Mongolia	Philippines	Thailand
Azerbaijan	Chile	France	Kazakhstan	Morocco	Poland	Tunisia
Bahamas	China	Georgia	Kenya	Namibia	Portugal	Turkey
Bahrain	Colombia	Germany	Korea, Rep	Nepal	Romania	Uganda
Bangladesh	Costa Rica	Ghana	Kuwait	Netherlands	Russian Federation	Ukraine
Belarus	Croatia	Greece	Kyrgyz Rep	New Zealand	Saudi Arabia	United Kingdom
Belgium	Cyprus	Guatemala	Lao PDR	Nicaragua	Singapore	United States
Belize	Czech Republic	Guinea	Latvia	Nigeria	Slovak Republic	Uruguay
Bolivia	Denmark	Hungary	Lebanon	North Macedonia	Slovenia	Vietnam
Botswana	Dominican Rep	India	Luxembourg	Norway	South Africa	
Brazil	Ecuador	Indonesia	Madagascar	Oman	Spain	

4. Conclusion

The process of developing a nation's riches sustainably depends on the level of institutional advancement and changes in governance, and digital transformation can help governments utilise their resources more effectively. This study clarifies the connections between e-government with sustainable development across both of its analytical sections. It was the first time that an analysis of the effects of a digital government in sustainable development in 103 countries from 2003 to 2018 used adjusted net savings, the Bank-recommended indication of sustainable development. international. Adjusted net savings accurately inform public policy by measuring wealth changes. Digital government is the governmental digital transformation organisations to function more effectively, transparently, and efficiently, to deliver better, quicker, and less expensive public services, to encourage business participation and citizen, and to enhance governmental performance.

The analysis's findings offer some new perspectives on the sustainable development literature. They provide proof that higher e-government development countries are more likely to experience sustainable development because higher e-government development is projected to result in better odds of net savings with non-negative adjusted. Furthermore, when the e-government development rises, developing economies and economies in transition have higher chances of growing sustainable development than industrialised nations, as determined by accounting for net savings. This manual emphasises the significance of developing and transitioning economies investing in ICT use in government. The findings also imply that rents for natural resources and a rise in age dependency may lessen the possibility that nations would achieve sustainable growth.

The study results inform policymakers about the crucial part that digital government plays in attaining sustainable development. Even though all nations, regardless of the level of development, can make use of e-government potential, those in developing and transitional economies stand to gain the most. The growth of digital government also means promoting more efficacy and public administration efficiency, as well as more equity, and supporting sustainable development, as many developing nations struggle with issues of governance and weak institutions. This promotes the 2030 Agenda about Sustainable Development and affirms the UN's endorsement of e-government as a tool to enhance public services and integrated policies. But rather than being an aim in itself, digital governance should be considered a tool for facilitating and advancing sustainable development. To achieve the right way to sustainable development, an overarching public policy approach should include elements of e-governance, which is essentially about governance change. It also calls for a strong commitment on the part of all social actors to advance inclusion and social welfare.

The logarithmic approach is built on a non-linear model of the logistic curve, hence the second portion of this study concentrates on non-linear effects. Future studies will examine in depth other non-linear effects of digital governance (digital Gov. transform) on sustainable development, nevertheless. The development of digital government may have varied effects on the different quantities in the distribution of the adjusted net savings, and this can be examined using quantitative regression methods. E-government has been regarded as a driving factor for fostering good governance because it blends the exterior component of the reciprocal link between governments and citizens with the interior component of modernising and rationalising public administration.

The COVID-19 pandemic in 2020 served as a case study of the worth of digital government in responding to crises as rapidly as possible, making swift judgements about public policy based on real-time data, and primarily offering online services to those who need them. they, in order to exchange knowledge and address the related social and economic issues. It has been especially difficult and has expedited governments' digital transformation. Future studies must examine the effects of e-government according to the pandemic's unprecedented COVID-19 and economic crisis, which has produced a hyperconnected society. Although government digital transformation has a long way to go before realising its full potential, it should be focused on improving governance to promote sustainable growth.

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