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E-government development indices and the attainment of United Nations sustainable development goals in Africa: A cross-sectional data analysis

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ABSTRACT

This paper explores the relationship between the United Nations (UN) e-government index (EGDI) and e-government development in Africa from 2010 to 2020 and forecasts the effect of e-government on the actualization of the sustainable development goals (SDGs) in Africa by 2030. To achieve the objectives, secondary data were collected on EDGI, online service delivery index (OSI), telecommunication infrastructure index (TII) and human capital index (HCI) from UN e-government survey spanning 2010-2020. The study utilized an improved modelled technique of panel data regression for cross-sectional observations. The finding indicates that there exists a positive and significant impact of the OSI, TII, and HCI on the overall EGDI in Africa. The study also revealed that there is a strong and positive relationship between E-government Development Indicators and the achievement of UN SDGs in Africa. This implies that African nations will experience a slow and insignificant increase from 2022 with an EGDI value of 0.4208 to 0.4331 in 2024, implying a 2.9% slight increment. The predicted value further shows that there will be a decrease from the EGDI value of 0.4331 in 2024 to 0.4330 in 2026, while the average EGDI value will increase slightly to 0.4346 in 2028 and finally to 0.4369 in the year 2030, which is equivalent to a 0.5% increment. EGDI value obtained predicts that Africa may not attain UN SDGs by 2030. Accordingly, the study recommends that drastic measures be taken to improve the three indices.

Keywords: e-government, development index, United Nations, sustainable development goals, Africa, panel data approach

INTRODUCTION

Kiron and Unruh (2018) assert that the two most significant developments in modern life are digitalization and sustainable development. Reiterating the preceding position, Lopatkova et al. (2019) categorically stated that it is a widely held belief among academics and government officials that the utilization of e-government technology provides an integrated strategy for implementing sustainable development. Keying into this trend, governments across the globe are adopting e-government as a new strategy for generating effective, all-inclusive, human-centred public goods and public policies for sustainable development (Chima, 2020). The aforementioned supports the assertion of Vereinte (2018) who opined that to fully achieve the transformative potentials of sustainable development goals (SDGs) by 2030, deployment of technology is required in creative ways to make sure SDGs are accomplished on schedule. SDGs is the fixed time frame by which all countries have a targeted and shared vision to put an end to hardship and create a robust society for everyone (Vereinte, 2020).

There is no doubt from the aforementioned that the most significant themes in modern life are digitization and sustainable development, but there is little research on how these two things interact. Though many studies explained how e-governance solutions promote sustainable development, however, a large number of these studies used a stand-alone methodology. Impliedly, they consider the concepts of e-government and SDGs separately and some instances establish a nexus between them using only one United Nations (UN) e-governance survey at a country level as the basis for their study (Estevez & Janowski, 2013). Evaluating the effectiveness of e-government as instrumental to achieving SDGs has not received much research attention. More crucially, studies to establish the rate at which the African continent is advancing and forecast whether the African region will reach SDGs by 2030 via the instrument of e-government are lacking. This

creates a knowledge gap, which this study aims to address. Taking advantage of the above loophole, this study used UN survey data from 2010 to 2020 as a case study and utilized panel data statistical methodology to determine the extent to which the e-government indices relate to the development of e-government and as well forecast the possibility of achieving SDGs by 2030. This paper becomes more important as the SDGs have barely 10 years left to be achieved.

CONCEPTUAL ELUCIDATION

E-Government

E-government or e-governance as used interchangeably by some scholars is a concept that tries to incorporate ICT into the governance process to provide improved, effective, and economical delivery of public services, as well as effective communication with the general public. The above implies that the utilization of ICT and web-based infrastructure in a variety of ways to establish a network of numerous autonomous entities towards delivering public services is e-government. The significance of e-government is amply demonstrated by the aforementioned. For instance, by using e-government, citizens' centred services that support good governance could be provided (Oni et al., 2016). More importantly, according to Areses et al. (2017) and Lonn and Uppstrom (2016), e-government supports a country's long-term development because it can optimize cooperative efforts and sustain resource availability across government departments. Stating the importance of e-government further, Othman and Razali (2017) opine that the main instrument for revamping the traditional methods of delivering government services in a more effective, efficient, and transparent manner to businesses and individuals in electronic government. Relying on the foregoing, it has be reported governance and more precisely, electronic governance (e-governance) according to Chun et al. (2010), Layne and Lee (2001), Sabani et al. (2018), and Tores et al. (2006), has an essential role to play in accomplishing the objectives of sustainable development, as demonstrated by the numerous success stories coming out of the developed economies that have begun the transition to a digital world.

Recognizing the relevance of e-government, particularly in light of the success stories of industrialized economies, African countries are making frantic efforts to embrace the tide of change. However, due to a lack of e-readiness for e-government, e-government is only slowly spreading throughout Africa. This is accounted for by the fact that African governments employ older generations of technology, have fewer e-government initiatives, and use ICTs less frequently than governments in industrialized nations (West, 2001, cited in Heeks, 2002). For instance, Cain (2001) asserts that data quality and data security in Africa are in short supply coupled with insignificant mechanisms to address the challenge. Institutions to harmonize, lead and drive e-governance are also lacking (Korac-Kakabadse et al., 2000). Additionally, there is a mindset gap, which is manifested in a general aversion to change, a lack of customer orientation, an unwillingness to share data, etc. Others are strategic thinking gap (limited number of senior officials willing to provide ICTs leadership in African governments) (Udo & Edoho, 2000). Thus, developing countries according to Vereinte (2016) underperformed compared with their European counterparts in the E-government ranking. Heeks and Bhatnagar (1999) and International Telecommunication Union (ITU) (ITU, 2009) attributed the low ranking to a digital gap, insufficient telecommunication infrastructure, and a lack of local expertise in Africa. What could be inferred from the literature is that the development of African and other developing-country e-government left much to be desired. Hence, the urgency of a study of this nature is to trigger the zeal of Africa towards the adoption of e-governance as a veritable instrument for realizing SDGs.

E-Government Development Index

UN EGDI debuted in 2001 as EGI with three variables and maintains those indices up to 2018. However, in successive years, the electronic participation index (EPI) was introduced and separately evaluated (Gupta et al., 2020). UN EGDI is a synthesis of three critical e-government indicators: the online service index (OSI), the telecommunication infrastructure index (TII), and the human capital index (HCI) (Chima 2020; Vereinte, 2018, 2020). OSI is measured by the maturity of a country's e-government websites, such as its national website and related portals. Whereas TII calculates a country's telecommunications infrastructure score using five parameters: the percentage of individuals who use Internet access, fixed telephone lines, mobile subscribers, fixed Internet subscriptions, and fixed broadband facilities. Finally, HCI is determined utilizing a country's adult literacy and education enrollment data (Kabbar, 2020).

EGDI is published biannually by the UN Department of Economic and Social Affairs and UN e-government survey data is used to generate EGDI. EDGI provides an in-depth survey of the 193 UN member states' online presence. This is combined with other access factors like infrastructure and educational attainment to determine the extent a nation uses ICTs to support access and inclusion for its citizens. According to Vereinte (2018), UN's EGDI is still the most efficient and globally recognized assessment index.

Sustainable Development Goals

SDGs is a product of history. The World Commission on Environment and Development (WCED) report provided the widely accepted definition of sustainable development as far back as 1987. According to the report, it is, development that satisfies current needs without risking future generations' capability to meet their own needs (Kocrarev & Kostoska, 2019; Zerafati et al., 2022). UN created SDGs in 2015 to strengthen the development of nations via ICT revolution by leveraging breakthroughs in ICT (Vereinte, 2018). The world leaders adopted a new 2030 Agenda for Sustainable Development at UN sustainable development summit in September 2015 (Nakicenovic et al., 2018). This was titled "a plan of action for people, planet and prosperity" designed to "shift the world onto a sustainable and resilient path". This worldwide, interconnected, and transformative Agenda was built around the 17 SDGs. The three components that make up SDGs goals are economic, social, and environmental indicators as obtainable in **Figure 1** ranging from goal (1) to goal (17).

Figure 1. Three components (adapted from Kocrarev & Kostoska, 2019)

The new SDGs framework comprises so many striking thresholds to be achieved by 2030. These thresholds are significantly more aggressive than the millennium development goals (MDGs). The target of SDG is to strive for a balance among the tripartite cornerstones (economic, social, and environmental) of the 2030 agenda to lessen the degree of inequality at the global level.

Although, no direct mention was made of ICT by SDG's 17 goals, a few targets mention ICT and technology. Profoundly, the importance of ICT was appreciated by the 2030 Agenda for a development that will stand the test of time. It appreciates ICT on the premise that global connectivity holds enormous opportunities to stimulate the development of human society, and close ICT gap, coupled with the stimulation of societal knowledge (UN DESA, 2015).

Digitally, SDGs are encouraging because there is a commitment to increasing online service usage and information access, especially in rural areas and least developed countries (LDCs) (Nakicenovic et al., 2018). SDGs, along with e-government, are acknowledged as essential factors in designing unique public services. A public service distinguished by effectiveness, trustworthiness, increased transparency, inclusiveness, accountability and improved accessibility to valuable government services, specifically, for the less privileged (Carey & Crammond, 2016; Vereinte, 2018). Additionally, SGD initiatives must address global issues spanning geography and population segments, including economics, social, cultural and environmental issues (Ojo & Millard, 2017).

E-Government and Sustainable Development Goals: A Nexus

According to Estevez and Janowski (2013), "e-government for sustainable development" is the application of ICT to improve public administration, essential services for the public and the interaction between the people and the government. The goals are to safeguard natural resources, promote social equity, and make citizens' engagement in the decision of government possible, coupled with enhancing socio-economic development for future generations. Studies on digitalization, especially e-government and sustainable development have shown and present a positive relationship between the variables (Goli & Golmohammadi, 2022; Janowski, 2016; Jovanović et al, 2018; Lopatkova et al., 2019; Malhotra, 2018; Moghadam & Ebrahimi 2021). As a result, it is incumbent on UN member states to develop robust e-government skills. According to a study on the factors influencing the digitalization of sustainable development in 157 nations with various socioeconomic levels of development, e-government was found crucial for enhancing global sustainability (Lopatkova et al., 2019). Recognising its relevance, governments around the world have started several initiatives to decrease digital divides, uphold citizen trust, and boost transparency and openness in governance services to achieve sustainable development (Othman, 2020). Electronic government or e-government is an appropriate platform for implementing such insights. Leaning on the study of Alhassan (2019), this paper suggests that e-governance should be a key tool for achieving SDGs. It follows that e-government and sustainable development should be pursued simultaneously if developing countries are to fully benefit from SDGs by 2030. Without mincing word, it should be noted that the realization of ICTs' significant gains for SDGs according to Kocrarev and Kostoska (2019) is overly dependent on the presence of related elements. The essential ICT infrastructure must first be set up. This calls for the ubiquitous opportunity for broadband infrastructure, which must be readily available at an affordable rate and universally accepted (Sharafat et al., 2017). Second, citizens must have the required skills to effectively utilize ICT infrastructure. Unbalanced development and social and economic discrepancies could result from unequal access to ICTs and the required skill sets.

MATERIALS AND METHODS

Data

The relationship and effect of UN EGDI: OSI, TII, and HCI on the actualization of UN SDGs in Africa using 54 African countries are investigated in this study. To achieve these objectives, secondary data were collected for EDGI, OSI, TII and HCI from the UN e-government survey from 2010-2020. This study used panel data estimation, which explicitly considers heterogeneity and analyzes the dynamic behavior of the parameter. The study utilized an improved modelled technique of Panel data regression for cross-sectional

observations. The balanced panel data of 54 African countries spanning 10 years and involving three EGDI viz, OSI, TII, and HCI was utilized.

Statistical Method

EGDI is determined numerically as the weighted normal of three standardized scores on the main e-government parts. These are the extension and worth of online administrations, the condition of improvement of telecom framework, and the current human resources. Every one of the lists is a composite measure that can be removed, and free investigations directed.

EDGI=(Online service index+telecommunication index+human capital index)/3.

Prior to the normalization of the three EGDI indices, z-score standardization procedure is implemented for each indicator to ensure that the overall EGDI is equally decided by the three component indices. The previously mentioned proposes that every part record shows a similar change after z-score normalization. EGDI would essentially depend on the part record with the most elevated scattering without even a trace of zscore normalization treatment score normalization, where "equivalent loads" really signifies "equivalent significance." to compute every part marker's standard z-score

$$Z = \frac{x-\mu}{\sigma},$$

where x is a raw score to be normalized, μ is the population mean, and σ is the population standard deviation.

Panel Data Analysis

Panel data is a collection of cross-sectional units that are periodically observed, it combines cross-sectional data with time series. To put it another way, panel data includes a dataset on explicit miniature units that are tracked after some time (Hill et al., 2011). Panel data has various benefits, these incorporate the way that it gives more data, greater fluctuation, less collinearity among the factors, more data, more levels of opportunity, and more prominent productivity, including controlling for individual heterogeneity that time series can not oblige (Hsiao, 2004).

Controlling for all shared period factors and time-invariant country-specific factors using panel data is possible (Adams & Balogun, 2010; Torre & Myrskyla, 2014). The panel data is alluded to as a decent board on the off chance that each cross-sectional unit has a similar number of time series perceptions. Again, assuming the numbers vary between perceptions, the panel is named an unequal panel. Panel data regression equation contrast from time series and cross-segment regression equations in the accompanying ways:

$$Y_{it} = \beta_1 + \beta_2 X_{2it} + \beta_3 X_{3it} + \beta_4 X_{4it} + u_{it},$$

where Y stands for EGDI, β for regression coefficient, X represents the three e-government indices in 54 African countries, namely, OSI, TII, and HCI and i represents the cross-sectional units representing 54 countries.

Pooled-effect model

This model assumes that the values of intercepts and slopes in the regression results are the same. Put differently, the coefficient is independent of the individual or the passage of time. The pooled effect model employs the ordinary least square (OLS) method, and the model equation is expressed as

$$Y_{it} = \beta_1 + \sum_{k=2}^{k} \beta_k X_{kit} + \mu_{it},$$

where i is ith of the 54 countries (i=1, 2, ..., 54), t represents the time period, and X_{kit} is the kth explanatory variables, which are the three e-government indices. β_1 addresses for catch and β_k is incline coefficient or slant of the relapse line

Fixed-effect model

Individual differences are present in the fixed-effect model, but the slope does not change. Because time-invariant characteristics were not considered, the assessed coefficients of the fixed-impact models cannot be one-sided (Hsiao, 2004). This study's fixed-effect model is, as follows:

$$Y_{it} = \beta_{1i} + \sum_{k=1}^{k} \beta_k X_{kit} + \mu_{it,}$$

where i= 1, 2, ..., 54 (all Africa countries), t is the period, X_{kit} is the kth independent variables, β_1 represents the intercept and β_k is the slope of the regression model.

Least square dummy variable (LSDV) is a supplementary technique included in this method. A dummy variable is a technique used in regression models to separate out individual or temporal effects. The fixed effect model with dummy variables of each country over time (Dit), where intercepts are different for each country (Adams & Balogun, 2020):

$$Y_{it} = \alpha_0 + \alpha_i D_{it} + \sum_{k=1}^{k} \beta_k X_{kit} + \mu_{it}.$$

Random-effect model

The dummy and fixed effect brings about the reduction in df with the inability to recognize the original model. In order to gauge the panel data regression, this model employs the generalized least square (GLS) method. The random effect model makes two assumptions: the intercept and slope are unique for all the countries investigated in this study:

$$Y_{it} = \beta_{1i} + \sum_{k=1}^{k} \beta_{ki} X_{kit} + \mu_{it.}$$

Durbin-Wu-Hausman specification test

A regression model's endogenous regressors (predictor variables) are found using Durbin-Wu-Hausman (DWH) specification test, also referred to as Hausman specification. Before the best panel data regression method can be selected, the decision on whether the predictor variables are endogenous must be determined first through testing with Hausman check. Both the fixed-effects model and the random-effects model can be selected using Hausman check. The favored model's proper impacts is the invalid speculation (H_0), while the model's arbitrary impacts is the other theory (H_I).

Basically, the tests endeavor to uncover in the event that there is a relationship between's the novel blunders and the regressors in the model. Deciphering the outcome from a Hausman test is genuinely direct: if the p-esteem is little (under 0.05), reject the invalid speculation (Chmelarova, 2007; Hausman, 1978). The hypotheses tested are **H_0.** Fixed effect (preferred is a fixed effect regression model) vs. **H_1.** Random effect (preferred is random effect regression model).

Table 1. Current ranking of Africa countries' EGDI

Rank	Countries	EGDI
1	Mauritius	0.7196
2	Seychelles	0.6920
3	South Africa	0.6891
4	Tunisia	0.6526
5	Ghana	0.5960
6	Namibia	0.5747
7	Morocco	0.5729
8	Cape Verde	0.5604
9	Egypt	0.5527
10	Gabon	0.5401
11	Botswana	0.5383
12	Kenya	0.5326
13	Algeria	0.5173
14	Zimbabwe	0.5019
15	Eswatini	0.4938
16	Rwanda	0.4789
17	Lesotho	0.4593
18	Uganda	0.4499
19	Cote d'Ivoire	0.4457
20	Nigeria	0.4406
21	Cameroon	0.4325
22	Togo	0.4302
23	Zambia	0.4242
24	Senegal	0.4210
25	Tanzania	0.4206
26	Sao Tome	0.4074
27	Benin	0.4039
28	Angola	0.3847
29	Congo	0.3786
30	Libya	0.3743
31	Mozambique	0.3564
32	Burkina Faso	0.3558
33	Malawi	0.3480
34	Burundi	0.3227
35	Sudan	0.3154
36	Mali	0.3097
37	Madagascar	0.3095
38	Sierra Leone	0.2931
39	Mauritania	0.2820
40	Comoros	0.2799
41	Ethiopia	0.2740
42	Djibouti	0.2728
43	Gambia	0.2630
44	Liberia	0.2605
45	Guinea	0.2592
46	DR Congo	0.2580
47	Equatorial Guinea	0.2507
48	Guinea-Bissau	0.2316
49	Niger	0.1661
50	Chad	0.1557
51	Central African Republic	0.1404
52	Somalia	0.1293
53	Eritrea	0.1292
54	South Sudan	0.0875

RESULTS

Summary Statistics

Table 1 and **Figure 1** show EGDI breakdown by African countries in the year 2020. It is noticed that only four Africa countries have high EGDI values greater than the current world average of 0.60 (UN DESA, 2020). The top-four African countries in descending order include Mauritius (0.7196) ranked first in Africa. Seychelles follows closely as the second-ranked country in Africa with EGDI value of 0.6920. South Africa (0.6891) and Tunisia (0.6526). The following African countries fall in H3 in terms of the overall EGDI world ranking: Ghana (0.5960), Namibia (0.5747), Morocco (0.5729), Cape Verde (0.5604), and Egypt (0.5527). Some of the middle-EGDI ranking countries in Africa that fall within H2 categories are Tanzania (0.406), Sao Tome (0.407), Benin (0.4039), Angola (0.3837), and Libya (0.3743). Some of the lowest EGDI-ranking countries that fall in H1 ranking in Africa are Niger (0.1661), Chad (0.1557), Central African Republic (0.1404), Somalia (0.1292), Eritrea (0.1292), and South Sudan with EGDI value of (0.0875).

Table 2. Summary of Africa's EGDI from 2010-2020

Year	EGDI	OSI	TII	HCI
2010	0.267	0.045	0.022	0.199
2012	0.282	0.260	0.102	0.478
2014	0.266	0.201	0.149	0.452
2016	0.288	0.256	0.172	0.435
2018	0.342	0.364	0.203	0.460
2020	0.391	0.371	0.316	0.487

Note. Source: United Nations E-Government Survey, 2010-2020. EGDI: E-government development index; OSI: Online service index; TII: Telecommunication infrastructure index; & HCI: Human capital index

Table 3. Summary statistics of Africa counties EGDIs

	EGDI	OSI	TII	HCI
Mean	.306164	.249760	.160751	.419627
Standard error of mean	.0075262	.0111703	.0082870	.0106950
Median	.281600	.208300	.116150	.433350
Mode	.0000	.0000	.0000	.0000
Standard deviation	.1354720	.2010657	.1491658	.1925102
Skewness	.469	.693	1.253	-.104
Standard error of Skewness	.135	.135	.135	.135
Kurtosis	.141	-.432	1.091	-.869
Standard error of Kurtosis	.270	.270	.270	.270
Range	.7196	.8333	.6925	.8204
Minimum	.0000	.0000	.0000	.0000
Maximum	.7196	.8333	.6925	.8204
Sum	99.1971	80.9221	52.0833	135.9592
Observation	324	324	324	324

Note. EGDI: E-government development index; OSI: Online service index; TII: Telecommunication infrastructure index; & HCI: Human capital index

As shown in **Table 2**, Africa continues to lag behind the remainder of the world with an EGDI average of 0.26, which is significantly lower than 0.45 global average. There was a little improvement in Africa's EGDI value in 2012 as EGDI value increased from 0.267 to 0.282, then a reduction to 0.266 in 2014. A slow and steady increase was however noticed between the year 2016 to 2020, with an increase in EGDI values of 0.288 in 2016 to 0.342 in 2018 and 0.391 in 2020.

The summary of the African countries EGDI displayed in **Table 3** shows that the mean of EGDI, OSI, TII, and HCI portrays different values, and the standard deviations also exhibit wide variation. A close examination of the dependent and predictor variables' descriptive statistics uncovers a number of problems. The average ranking for EGDI in 54 African countries between 2010-2020 is 0.31, while the standard deviation is 0.14. The result also shows that the mean

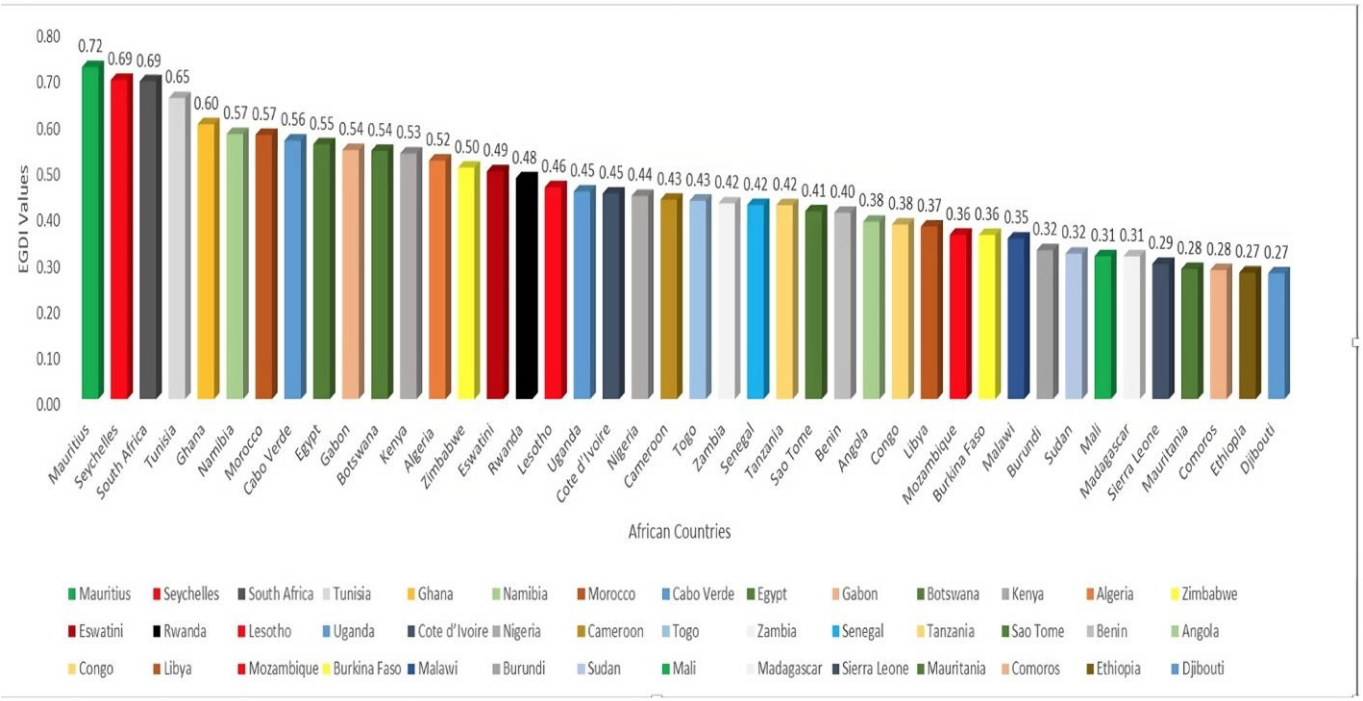

Figure 2. Current ranking of Africa countries' EGDI (Source: United Nation E-government survey from 2010-2020)

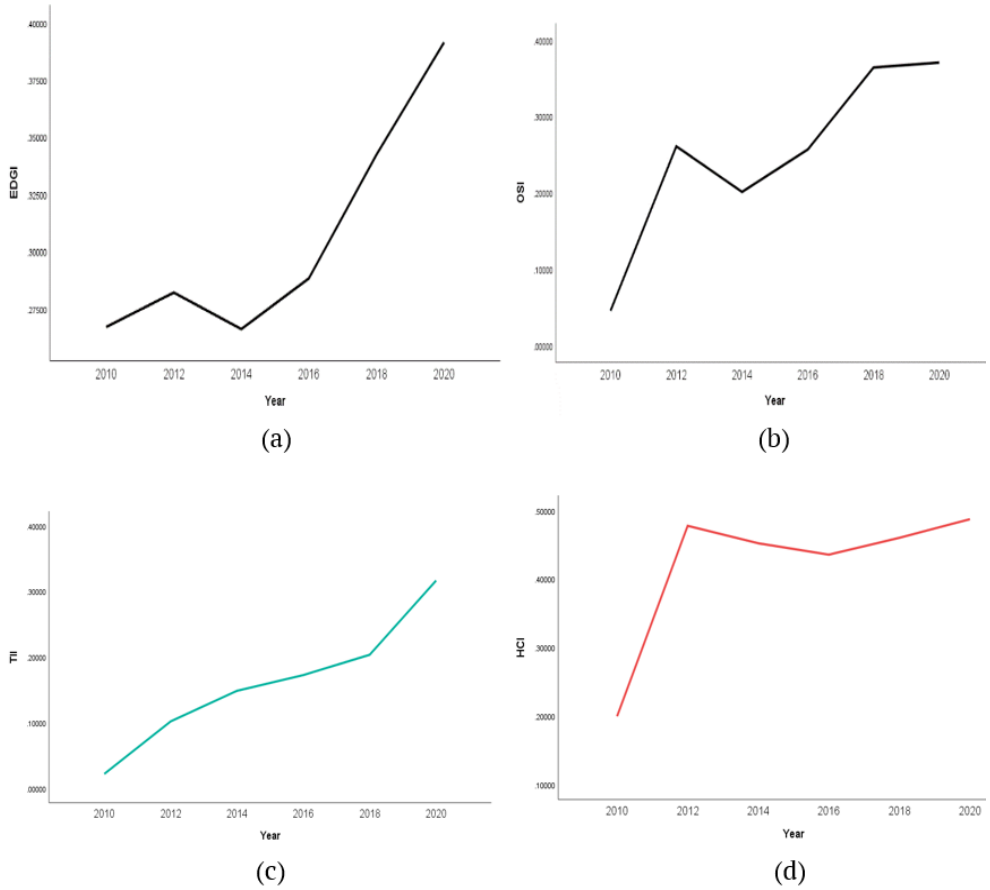

Figure 3. Time plots of EGDI (a), OSI (b), TII (c), & HCI (d) from year 2010-2020 (Source: United Nation E-government survey from 2010-2020)

value of the OSI is 0.25, TII is 0.16 and the HCI is 0.42. The foregoing mean values reflect a low performance of African countries since UN EGDI world average is 0.60 as at 2020.

Figure 2 shows current ranking of Africa countries' EGDI.

Figure 3 presented the time-series graph of EGDI (a), OSI (b), TII (c), and HCI (d) for 54 African countries from 2010-2020. It was observed that the four values increased steadily within 10 years period.

Table 4. Correlation matrix of Africa counties EGDIs

	E-government development index	Online service index	Telecommunication infrastructure index	Human capital index
E-government development index	1			
Online service index	0.751**	1		
Telecommunication infrastructure index	0.719**	0.583**	1	
Human capital index	0.699**	0.505**	0.635**	1

Note. **Correlation is significant at the 0.01 level (2-tailed)

Table 5. Panel data result of Africa counties EGDIs

EGDI	Pooled effect model				Fixed effect model				Random effect model			
	C	SE	t-test	p-value	C	SE	t-test	p-value	C	SE	t-test	p-value
OSI	.2960	.024353	12.16	0.0000	.3802	.0156548	24.29	0.000	.3683	0.01709	21.6	0.000
TII	.2454	0.03669	6.69	0.0000	.2478	.0259575	9.55	0.000	.2437	0.02803	8.69	0.000
HCI	.2141	.026760	8.00	0.0000	.3460	0.018030	19.19	0.000	.3308	0.01959	16.9	0.000
Constant	.1029	.009541	10.79	0.0000	0.026	0.006659	3.93	0.000	.0362	0.01082	3.34	0.001
	Rho		0.8625		Rho		0.750358983		Rho		0.75384039	
	Sigma				Sigma		0.04222011		Sigma		0.01800232	
	R square		0.7367		R square		0.8930		R square		0.56827533	
	Adjusted R square		0.7342		Adjusted R square		0.5472		Adjusted R square		0.5500	
	F-statistic		298.44		F-statistic		876.5		F-statistic		2,144	
	p-value		0.0000		p-value		0.000		p-value		0.000	

Correlation Matrix

Table 4 presents Pearson correlation coefficient matrix of EGDI and OSI, TII, and HCI. The result shows that there is a strong non-negative and significant relationship between the three indices and EGDI in Africa. It was also observed that OSI, TII, and HCI are positively correlated with (r=0.751), (r=0.719) and (r=0.699), respectively.

Panel Data Result

The report of the pooled, fixed, and random effect regression models in **Table 5** indicates that the OSI has a significant effect on SDG measured by EGDI with coefficient and p-value (β_1=0.2960, p=0.000). It was also discovered that TII also has a non-negative effect EGDI, the coefficient and p-value are β_2=0.2454, p=0.000 and HCI with coefficient and p-value given as β_3=0.2141, p=0.000). The correlation index, R square and adjusted R square is R=86.3%, R^2=74.4%, and adjusted R^2=73.4% according to the pooled effect regression model at a 1% and 5% significant level, respectively.

The result displayed in **Table 5** also indicated that OSI, TII, HCI, and EGDI has a non-negative significant effect with β_1=0.3802, p-value=0.000, β_2=0.2478, p-value=0.000, and β_3=0.3460, p-value=0.000 as the fixed-effect regression model provides. R, R square, and adjusted R square is R=75.0%, R^2=56.3%, and adjusted R^2=55%, respectively. This result implies that more than 75% of the variation in the EGDI has been explained by the countries' OSI, TII, and HCI, leaving the remaining percentage unaccounted for due to the presence of the stochastic error term. F-statistics and p-value of F=876.5, p-value=0.000 indicate that the results were satisfactory and significantly appropriate at the 5% and 1% levels of significance for use in making a useful inference.

The random effect regression model shows that African countries' OSI, TII, HCI have a significant impact on EGDI with β_1=0.3683, p-value=0.000, β_2=0.2437, p-value=0.000, and β_3=0.3308, p-value=0.000, respectively. The correlation index, R square and adjusted R square is R=75.4%, R^2=56.8%, and adjusted R^2=55%, respectively. This result implies that more than 75% of the improvement gained so far in EGDI, has been caused by the countries' OSI, TII, and HCI values. F-statistics and p-value of F=2,144, p-value=0.000 indicate that the random effect model was satisfactory and significantly appropriate at the 5% and 1% significance levels for use in making a useful inference.

Durbin-Wu-Hausman Specification Test Result

To determine which regression model: random or fixed effect, should be used, DWH test was applied. The null hypothesis ($\mathbf{H_0}$) states that the fixed effect is the preferred model, whereas, the preferred model, according to the alternate hypothesis ($\mathbf{H_1}$), is a random effect. DWH Chi-square test result and p-value for fixed and random effect regression models are provided as p>0.296 and p>0.214, p>0.245 and p>0.234, p>0.215 and p>0.291 for OSI, TII, and HCI accordingly. Three p-values are all greater than the 0.05 level of significance. This implies that the null hypothesis stating that the preferred model has a fixed effect cannot be rejected.

As shown in **Table 6**, the fixed effect model produces more efficient and consistent results than the random effect models. Therefore, for the forecast of EGDI values from 2022-2030, the results from the fixed effect model are preferred.

Forecasting With Preferred Fixed-Effect Models

The model selected was utilized to explain and forecast the future value of EDGI for the next 10 years (2020-2030) as displayed in **Table 7**. Using the preferred fixed-effect model given as

$$y = 0.026 + 3802X_1 + 0.2478X_2 + 0.3478X_3.$$

The predicted average EGDI value for the 54 African countries for the year 2022 was 0.4208, with an increase of about 0.000% to 0.4331 for 2024. The predicted value shows that there will be a decrease from 0.4331 to 0.4330 in 2026, while the average EGDI value will increase steadily to 0.4346 in the year 2028 and 0.4346 in the year 2030. The lower and

Table 6. Hausman test result

E-government development index	Fixed effect model	Random effect model
Online service index	.2960875	.296087
Telecommunication infrastructure index	.2454164	.245416
Human capital index	.2141482	214148

FooterWillBeHere

Table 7. Forecast of EGDI values from period 2022-2030

Year	LCL	Forecast	UCL
2022	0.1718	0.4208	0.6697
2024	0.1821	0.4331	0.6841
2026	0.1819	0.4330	0.6841
2028	0.1835	0.4346	0.6856
2030	0.1848	0.4369	0.6870

upper 95% confidence interval of the predicted EGDI can deviate from a lower value of 0.1848 to an upper limit value of 0.6870. This predicted average EGDI value indicates that African countries may not attain UN SDGs by 2030, unless drastic steps are taken by the African countries to improve on the three indices. The lower and upper confidence interval of the predicted EGDI can deviate from a lower value of 0.1848 to an upper limit value of 0.6870.

DISCUSSION OF FINDINGS

This study confirms that the E-government development indicators, namely, online service, telecommunication infrastructure and human capital are positively and significantly related to the attainment of UN SDGs in Africa. The strength and direction of the correlation between OSI and e-government development was (r=0.751), telecommunication infrastructure and e-government development was given as (r=0.719) while HCI in relation to e-government was (r=0.719). These findings are comparable to studies by Janowski (2016); Jovanović et al. (2018), Lopatkova et al. (2019), and Malhotra (2018), which indicate a positive relationship between digitalization (e-government) and sustainable development.

Finding also indicates that there exists a positive and significant impact of OSI, TII, HCI on the overall EGDI. The regression and p-value were given as β_1=0.2960, p=0.000, β_2=0.2454, p=0.000 and p-value given as β_3=0.2141, p=0.000 while the values of R, R square, and adjusted R square were given as R=86.3%, R^2=74.4%, and adjusted R^2=73.4% respectively, implying that more than 74% of the variation in EGDI, has been explained by the Africa countries' OSI, TII, and HCI, due to the presence of the stochastic error term, the remaining percentage is left unaccounted for. This corroborates the finding of Adams et al. (2022) and Krishnan et al. (2013), which demonstrated a direct correlation between e-government maturity and ICT infrastructure, e-participation, and human capital. The predicted EDGI value indicated that African countries would experience a slow and insignificant increase from the year 2022 with an EGDI value of 0.4208, to 0.4331 in the year 2024, implying a 2.9% slight increment. The predicted value shows that there will be a decrease from the EGDI value of 0.4331 in 2026 to 0.4330 in 2026, while the average EGDI value will increase slightly to 0.4346 in 2028 and finally to 0.4369 in the year 2030, which is equivalent to a 0.5% increment.

CONCLUSIONS AND RECOMMENDATIONS

Despite existing socioeconomic disparities, developed and developing countries have been and continue to embrace the delivery of public services through e-government. It thus becomes crucial that studies wade into the impact of these phenomena called e-government to determine whether the change that the majority of people want is taking place and will take place via it in the near future. Notably, therefore, this study determines the relationship between the various e-government indicators like; OSI, TII, and HCI and e-government growth in Africa utilizing the biannual reports produced by UN Department of Economic and Social Affairs (UNDESA, 2015) and subsequently, envisage the effect of e-government on the realization of sustainable development by 2030 in Africa. The research discovered a strong and favourable connection between the e-government indicators and EGDI in Africa within the period under study. Though the forecast shows that e-government development indicators are positively and significantly related to the attainment of UN SDGs in Africa, but the progression toward the actualization of SDGs by 2030 will be staggered in nature. The study, therefore, concludes that the voyage towards UN sustainable development by 2030 is fairly achievable if all the necessary conditions are put in place. Consequently, the study recommends that ICT infrastructure must be provided in Africa. It is not just enough to provide the ICT infrastructure, but people should access it easily. This can be achieved easily when the government step up public knowledge of the benefits of online services to encourage users. Online content should be accessible in local dialects and at the regional level to pique users' interest. The aforementioned might be made available in the right quality and quantity but may not lead to the realization of the goals except digital literacy is provided to the general public. This is very important because it determines the ability of the users of e-services.

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