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# ICT and Public Service Value Creation in Africa: Efficiency Assessment Using DEA approach

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## **Abstract**

Recently, researchers and international bodies have recognised the potential of ICT in public service value creation. Many countries have implemented ICT to transform public services and create public value. Citizens are increasingly demanding public value from the governments, the notion similar to return on investment from private sectors. However, little research has been conducted on ICT and public value creation. Using Data Envelopment Analysis and Cluster Analysis, data for 53 African countries were analysed. The findings indicate that for a period from 2005 to 2014, ICT has efficiently transformed public values in Africa by 5, 18, and 40 percent in countries of clusters one, two and three respectively. More compelling, the findings indicate that efficiency of ICT in transforming public values for more than three quarters of African countries was below fifty percent. The current study has theoretical, methodological and policy implications.

**Keywords:** ICT, Public Value, Accountability, Data Envelopment Analysis (DEA), Africa

## 1 INTRODUCTION

For the past three decades, government reforms across the World have been a top performance agenda. Governments are continuously experiencing pressure to provide public services with a public value notion in mind. Under the banner of New Public Management (NPM), reinventing governments has been touted as a solution to many government inefficiency related challenges. Public value is fundamental in public administration to ensure citizens satisfaction and trust (Moore 1995; Ott 2010). The increased pressure for citizens' demands for public value has contributed to the adoption of an entrepreneurial approach to governance (Blaug et al. 2006). Citizens are now emphasising on public value similar to return on investment in the private sector.

Public sector reform is important in socio-economic development and serves as a means of innovation in performance management. The objective of public sector reform since its inception has been geared towards innovative ways of bringing about socio-economic development. Performance management is the concept of the New Public Management (NPM) that has its roots from the agenda of continuously doing better in public administration (Van Dooren et al. 2015). Since the inception of the doctrine of NPM, many governments have implemented strategies to improve their public services delivery (Alonso et al. 2015).

ICT as enabler of public sector reforms has been implemented to reinvent governments for improved performance (Bannister and Connolly 2014; Gauld et al. 2010). Along this line, information communication technology (ICT) is touted to have a potential in creating public value (Bannister and Connolly 2014). However, many research related to value creation in Computer Information Systems have focused mainly on business (private) values. Value creation in private organisation is different from that of public organisations. In private organisations, value creation is normally premised on economic value such as return on investment (ROI) while in public organisations, being the non-profit making entities, focus on public value creation (Pang et al. 2014; Moore 1995).

The potential of ICT in public value creation has contributed to the importance of examining ICT pay back in public administration. The relationship between ICT and public sector reforms is an important area of study to interrogate the impact of ICT enabled initiatives on public sector reforms (Cordella and Bonina 2012). International bodies and researchers have recognised the importance of ICT in public administration in creating public value. For example, the World Public Sector Report (WPSR) produced by the United Nations emphasises that ICT should be harnessed in public services to achieve socio-economic development. Importantly, it emphasises that ICT should be a tool for creating public value (WPSR 2015). However, little research that focuses on ICT public value creation particularly in Africa exists (Bannister and Connolly 2014; Cordella and Bonina 2012; Pang et al. 2014). And as such, only a minuscule number of studies on ICT in the public sector have been published in major academic journals in Information Systems (Pang et al. 2014). The present study intends to fill this gap by investigating the efficiency of ICT in public value creation in Africa.

Therefore, the objective of the present study is to determine the efficiency of ICT in public value creation in Africa. We propose to analyse the data of ICT and public values in 53 African countries using Data Envelopment Analysis (DEA). In the present study, we focus on public values rather than on values created in the private sectors. In other words, we focus on the efficiency of ICT in creating public values. We intend to answer the main research question "How efficiently has ICT performed to enable or create public values in Africa?"

The rest of the paper is organised as follows: In section 2, we present the conceptual background of this study. Section 3 discusses the concept of efficiency, followed by methodology in section 4. In section 5, we present the results followed by contribution of the study in section 6. Lastly, we present our conclusion in section 7.

## 2 CONCEPTUAL BACKGROUND

### 2.1 Africa and Information Communication Technologies (ICT)

Africa is the second largest continent which comprises 54 sovereign states, including the newest state of South Sudan that recently separated from its parent North Sudan. Africa has been growing economically at the highest rate. In 2013, Africa had an average GDP of 4 percent which was higher than the global average of 3 percent (African Economic Outlook 2013). Over the years, ICT in Africa has demonstrated its potential in fostering socio-economic development (Kayisire and Wei 2014). With the history of many disadvantages, Africa, for a short time has progressed well in ICT uptake. Currently, Africa is experiencing ICT boom and the world has been puzzled with the current ICT adoption.

Nowadays people in Africa cannot escape the influence of ICT and many countries have adopted ICT (Gatautis 2015). The World has seen the end of implementing the UN Millennium Development Goals (MDGs) with much success in adopting ICT. The year 2015 has ended with a progress to celebrate ICT adoption and usage such as mobile-cellular subscriptions, Internet use, fixed and mobile broadband services, home ICT and others (ITU 2015). For the past years, Africa has been adopting ICT at an increasing rate and the ICT implementation in Africa is appealing especially in mobile broadband subscriptions (Mimbi et al. 2011). ITU estimated that by end of 2015 there would be a 17.4 percent penetration rate of mobile broadband, a big jump from that 4 percent in 2011 (ITU 2011; ITU 2015). The year 2015 concluded with one in five people being Internet user in Africa, this is a 20 percent Internet penetration (see Table 1). However, ICT development in Africa is still behind that of Europe and America and more efforts are required to do much better.

<b>Indicator</b>	<b>Europe</b>	<b>America</b>	<b>Africa</b>
Percentage of households with Internet access	82.1	60	10.7
Percentage of individuals using the Internet	77.6	66	20.7
Mobile broadband subscriptions per 100 inhabitants	78.2	77.6	17.4

*Table 1. Selected ICT indicators(2015)*

### 2.2 Public Value and Public Value Creation

#### 2.2.1 Public Value

The concept of public value (PV) can be traced from the new public service theory. PV has been influential in public services reform initiatives since the mid-nineties. This concept is linked to the seminal work of Moore (1995). Public value refers to value that citizens and their representatives seek in relation to strategic outcomes and experience of public services (Moore 1995). Public value focuses on performance evaluation of public organisation in delivery of services (social outcomes) as desired by the collective. Public value is the equivalent of shareholder value in public management, with the public sector acting in the best interests of the collective (Moore and Khagram 2004). Brewer, Neubauer and Geiselhart (2006) argue that ICT public value creation as a priority refers to embracing the information revolution as a means of improving governance and enhancing the democratic process. Public value calls for a renewed emphasis on the significant role public managers can play in maintaining government organisation's legitimacy in the eyes of the public. It therefore focuses on the wider notions of valued public services and efficiency that call for more accountability of public managers (Blaug et al. 2006).

#### 2.2.2 Public Value Creation

The essence of public value creation is to evaluate the extent to which public organisations have achieved their set goals and objectives. In these cases, based on the scope of the present study, the set objectives are broad encompassing the national targets. In public administration, these objectives are set by either individual countries or by international bodies (e.g., The United Nations). However, these objectives are same worldwide. Importantly, the value created must be agreed (e.g., like those of millennium challenge goals) upon by all concerned stakeholders (Blaug et al. 2006). So, meeting goals of value creation requires a participatory approach in engaging the public managers and citizens to agree on the value to be created. Based on the new public service and governance theories, the government has a constitutional obligation

to implement public policies that ensure collective or shared public values are created. Thus, the government is responsible to the citizens in creating public value (Blaug et al. 2006). The public value moves beyond the value for individual by serving the wider public interests. For example, public interests could be served better by the government with public values that focus on efficiency and provision of public services with impartiality (Ahrens 2007; Teorell 2009). The question now is how these values are created? In the present study, we focus on the values oriented to duty, service and social aspects of public administration. Theory of new governance emphasises on collaborative approach to public administration. Governments and other stakeholders (non-governmental organisations such as citizens, civil societies etc.) have a role to play in public value creation.

Public value has attracted various approaches with regard to what exactly should be measured. There are competing and conflicting claims about the dimensions of value since some of them overlap. This requires a careful selection of performance elements that can be included in the evaluation program (Talbot 2008). However, the literature suggests that values must be convertible into some behavioural form to have meaning (Bannister and Connolly 2014). In this context, ICT is a tool that can enable this conversion. Therefore, the present study focuses on the behavioural form that ICT has the potential to modify or transform (Bannister and Connolly 2014). ICT use in public administration is both an “enabler and embedder”. It is an enabler because it makes possible actions or activities related to public value that would be impractical in its absence. It is an embedder because it is possible to create value into systems (Bannister and Connolly 2014). ICT is expected to impact on three dimensions related to public value: duty oriented public value, service oriented public value and socially oriented public value (Bannister and Connolly 2014).

### **2.2.3 Duty Oriented Public Value**

In this category, public values are related to the duties of the public servant to the government or to the state. Basically, these are non-financial related values that amount to accountability of the public servant (Bannister and Connolly 2014). Accountability arises from the fact that public servants must be controllable or answerable for their actions in public administration (Gregory and Hicks 1999). Accountability has been used to enforce individuals’ ethical related values including integrity and honesty by forcing individuals to comply with the law guiding the public service provision (Bannister and Connolly 2014; Gregory and Hicks 1999). Further, Gregory and Hicks (1999) posit that accountability instils the spirit of the public servant to do things right by choosing the right thing. ICT in the duty oriented public value affects the accountability value.

How can ICT accomplish in making public servants accountable for their actions? The literature indicates various mechanisms in which ICT can ensure accountability of public servants (governments). Under the principal – agent environment, public servants are agents and citizens are principals. As agents, public servants are accountable for their actions to the citizens (the principals). For the public servants to be accountable there must be one prerequisite condition – transparency. Without transparency it is almost impossible for a public servant to be held accountable (Heeks 2009; Islam 2006). For citizens to hold the public servant accountable they must know what the public servant – ‘accountee’ is doing (Heeks 2009). This means that performance information about the public servant must be available to the citizens. In this case, ICT and in particular the Internet makes the performance information transparent and available to a wider population (i.e., citizens) for which the citizens can evaluate the performance of the public servant. While ICT helps in providing information that can assist in performance evaluation of the public servant, it can also enforce the public servants to comply with the laws and behave in an honesty manner (Bannister and Connolly 2014). Knowing that performance information about the public servants is available to the public helps in ensuring responsiveness, integrity and honesty of public servants (Gregory and Hicks 1999; Islam 2006). However, ICT cannot make people more honest, but can make people behave in a more honest way (Bannister and Connolly 2014). Several empirical studies show that ICT increases honesty, improve compliance with law and improve fairness by removing human element process and decision making chain (Bannister and Connolly 2014; Quah 2011).

### **2.2.4 Service Oriented Public Value**

Service oriented public value refers to values related to provision of high level public administration services to the citizens. This is analogous to provision of good services by private companies to the clients or customers (Bannister and Connolly, 2014). The values in this category are considered to be of NPM

(Van Der Wal et al. 2008). They include effectiveness, efficiency, and transparency. Government effectiveness is a pivotal public value for provision of public services in the new governance. According to the World Bank, government effectiveness refers to the perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies (Kaufmann et al. 2008). Unfortunately, effectiveness and efficiency are two phenomena that may not co-exist because there is always a trade-off between them. In the present study, only government effectiveness will be considered as a public value rather than government efficiency.

Since the 1990s, measuring government performance has been a top agenda and governments have established performance measure in public services. For instance, the Government Performance Project in the US has been one of the most elaborate projects for assessing government effectiveness across all levels of government (Lee and Whitford 2009). Government effectiveness initiatives focus on making the citizenry happy by providing high value public services. Research evidences show that there is a relationship between government effectiveness and happiness of citizenry. For instance, Ott (2010) found that quality of government was positively related to happiness. The literature also suggests that when the citizenry are happy they tend to feel respected by the government and consequently trust their government (Ott 2010).

On the other hand, transparency is important in ensuring accountability of the government (Grigorescu 2003). Transparency refers to the full flow of information within a polity (Hollyer et al. 2014). Importantly, the full flow of information should lead to useful information that can assist the citizenry in performance evaluation of governments (Grigorescu 2003). Transparency is the lateral value of accountability which assumes the prerequisite condition for government accountability and responsiveness (Grigorescu 2003; Hollyer et al. 2014). Previous studies indicate that transparent government are more accountable than opaque ones and tend to be governed better (Islam 2006).

ICT as a tool for enabling government functions, it has a potential to create or transform effectiveness and transparency values (Bannister and Connolly 2014). The transformative impact of ICT on effectiveness is a well-established phenomenon in the Information Systems literature. Effectiveness was one of the motivations of implementing ICT systems in both the public and private sectors. However, of recent, the Internet in particular has transformed transparency and citizenry are now expecting more from government disclosure. ICT has changed the way transparency used to be previously by opening more avenues for information availability to the wider public (Hollyer et al. 2014; Pang et al. 2014). For instance, the case of Korean open system is a demonstration of how ICT has altered the information landscape (Lee and Lee 2009). The essence of ICT in service oriented public values is to enable or create effectiveness and transparency in public administration to improve service provision for citizenry satisfaction (Mimbi and Kyobe Forthcoming). For instance, ICT can facilitate transparency strategies by exposing wrong doing thereby deterring public servants from committing corrupt practices (Jaeger and Bertot 2010). In this case, citizenry may be assured of improved public services.

### **2.2.5 Socially Oriented Public Value**

Public values in this category refer to those which incorporate quasi-political view encompassing broader social goals. They include aspects of providing public services to all citizens (inclusiveness), by treating them equally in a just way and granting them access to public services. Socially oriented public value can be bundled together to refer to impartiality in public services provision (Bannister and Connolly 2014).

Impartiality refers to the “norm of on the output side that is most compatible with the normative principle of treating everyone with equal concern and respect” (Teorell 2009, p. 4). Rothstein and Teorell (2008) add that “when implementing laws and policies, government officials shall not take into consideration anything about the citizen/case that is not beforehand stipulated in the policy or the law” (p. 170). These values are implemented under the banner of rule of law defined as the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence (Kaufmann et al. 2008). This means that rule of law ensures impartiality by ensuring laws are applied equally to all people (Ahrens 2007). ICT in public services offers a relatively much less expensive mode of access than the traditional face-to-face thereby significantly impacting equity and access. Recognising this impact, several governments have implemented ICT for public value creation in this regard. For example, the UK and Denmark governments

have established ICT policy of 'digital by default' in providing public services (Bannister and Connolly 2014). In this section, the literature points out how ICT can impact on or create public values. ITU (2006) recommends that ICT impacts can be assessed in two ways - its efficiency or its impacts on social dimensions. We chose the former approach to assess ICT performance (efficiency) in creating public values as discussed in the next section.

### **3 USING DEA TO MEASURE EFFICIENCY IN PUBLIC SECTORS**

Performance management is one of the growing research areas in Computer Information Systems and Public Administration. This growth particularly in governments is driven by increased citizen demands for government accountability in service delivery. On the other hand, there is a greater interest on the part of legislators in performance related information to assist in program evaluation and resource allocation decisions. Similarly, the efforts of various organizations and professional associations are geared towards making governments more results-oriented (Municipal Research and Services Centre 2015). It has become important to determine the efficiency of governments in converting inputs into outputs. ITU (2006) contends that the best way to examine ICT impacts is to assess its efficiency in producing outputs. This means that ICT is an input which is used to produce output (public values). Efficiency is a measure of how well the government resources are utilised to achieve specific goals (Neely et al. 1995). Efficiency in the present study refers to how well ICT has transformed/enabled public values in Africa.

ICT value creation is a performance (efficiency) phenomenon that can be analysed using the DEA methodology. DEA is appropriate where the objective of the investigation is to evaluate efficiency of a production organisation (e.g. country) in which inputs are converted into final outputs (Saranga and Moser 2010). Since ICT and public value represent input and output respectively, then DEA is an appropriate methodology to analyse the present phenomenon. DEA has several advantages which include the ability to evaluate each Decision Making Unit (DMU) relative to its peers such as one country can be compared to other countries in the same group (Saranga and Moser 2010); and the ability to allow for the use of multiple inputs and multiple outputs that eliminates the use of unidimensional measures that may promote dysfunction behaviour (Easton et al. 2002). As such, DEA provides performance managers with a comprehensive measurement that enable them to take strategic actions on DMUs performance that lag behind their peers (Easton et al. 2002). Based on these advantages, DEA is an analytical technique of choice for many efficiency studies (Nataraja and Johnson 2011). Many researchers have investigated efficiency using DEA (Bankole et al. 2011; Kayisire and Wei 2015; Mimbi and Bankole 2016 Samoilenko and Osei-Bryson 2008). For example, Mimbi and Bankole (2015) adopted DEA to investigate the efficiency of ICT and health systems in Africa. However, DEA has not been used extensively in ICT and public value creation. Pang et al. (2014) argue that little research on ICT value creation in the public sectors has been published in Information Systems. The present study therefore investigates the relative efficiency of ICT in public value creation in 53 African countries. DEA was adopted in the present study, which is discussed further in the methodology section.

## **4 METHODOLOGY**

### **4.1 Data Envelopment Analysis (DEA)**

Efficiency measurement has been implemented in organisations and economies in order to improve productivity (Cook and Seiford 2009). Efficiency measurement is concerned with the relationship between inputs and outputs. Scholars emphasise on a need to combine the measurements of the multiple inputs into a satisfactory measure of efficiency (Farrell 1957). DEA focuses on a principle of extracting information about a population of observations to evaluate efficiency with reference to an imposed efficient frontier. The extraction of information occurs when DEA calculates a discrete piecewise frontier which is determined by a set of referent decision making units (DMUs). The DMUs which are considered to be efficient are identified by the ability to utilise the same level of inputs and produce same or higher outputs (Coelli 1996; Cooper et al. 2011). This process makes use of the linear programming concept to calculate a performance measure referred as efficiency. Efficiency is calculated for each DMU relative to all the other DMUs (Cooper et al. 2011). All DMUs efficiencies are checked against the condition that all observations lie on or below the extreme frontier (Cooper et al. 2011).

DEA was initially introduced by Farrell (1957) and years later Charnes, Cooper and Rhodes (1978) improved on the earlier version by proposing a DEA model which assumed constant returns to scale (CRS). Later on, Banker, Charnes and Cooper (1984) proposed alternative theoretical assumptions known as the variable returns to scale (VRS). The two models of DEA, the CCR which was developed by Charnes et al. (1978) and the BCC which was developed by Banker et al. (1984) are basic models for investigating efficiency. DEA models are flexible and straightforward to use in estimating input/output in two common orientations: (i) input orientation which involves the minimisation of inputs to achieve a given level of output. (ii) Output orientation which is the maximisation of outputs for a given level of inputs (Cooper et al. 2011).

Given the emphasis on value creation in public administration, all governments across the World are under pressure to demonstrate the public value created from the resources used. Therefore, the public sector is under immense pressure to advance its public value frontier for which its objective is to maximise multiple public values that are achievable given the available resources (Pang et al. 2014). Based on this claim, we adopted input-oriented approach based on CCR model (Charnes et al., 1978) in the present study.

## 4.2 Cluster Analysis

Cluster Analysis is a data reduction technique used to group cases based on multivariate attributes. The principle behind Cluster Analysis is to minimise the within group members difference (homogeneity) and increasing the groups difference – heterogeneity (Ketchen and Shook 1996). Cluster Analysis can be performed using either hierarchical algorithm or non-hierarchical algorithm. Hierarchical algorithm focus on adding and deleting element operations to form clusters while non-hierarchical algorithm (K-means) partitions a data set into a pre specified number of clusters (K) to arrive at optimal cluster solution (Ketchen and Shook 1996). Non-hierarchical algorithm is favoured against hierarchical algorithm because is not affected by outlier elements contrary to hierarchical algorithm (Hair, Anderson, Tatham and Black 1992). Therefore, Non-hierarchical algorithm was adopted in the present study.

## 4.3 Data Sources and Variable Explanation

The data for this study were obtained from several archival sources: ICT infrastructure data was obtained from the International Telecommunication Union (<http://www.itu.int>). Accountability and rule of law data was obtained from Ibrahim Index of African Governance (<http://www.moibrahimfoundation.org>). Accountability and rule of law scores are expressed out 100, with 100 being the best. Government effectiveness data was obtained from the World Bank (<http://databank.worldbank.org>), while government transparency data was obtained from Freedom House (<https://freedomhouse.org>). To measure government transparency, the present study adopted the press freedom index as a proxy for transparency. Press freedom index has been used in previous studies investigating transparency (Hollyer et al. 2014). Press freedom index ranges from 0 to 100, with smaller score corresponding to greater freedom (in this case transparency of the government). Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5. In addition, we also obtained Human Development Index (HDI) data that was used to cluster the 53 countries into three clusters. HDI is a measure of average achievement in key dimensions of human development encompassing a long and healthy life, being knowledgeable and have a decent standard of living.

The data were readily available for 53 African countries (see Table 3) covering a ten-year period from 2005 to 2014. The present study is one of the largest studies to include such a large number of countries in a single study. The data from the mentioned sources have often been used in ICT research. The International Telecommunication Union (ITU) provides the most reliable data for the ICT sector. The Ibrahim Index of African Governance (IIAG) has been collecting data specifically tailored for the African context. We feel this is a reliable and appropriate data source for studies involving the African continent. The World Bank (WB) is also a reliable source of data for governance and developmental issues covering the entire world. Lastly, the Freedom House has been collecting data related to freedom and democracy since 1941 and its data is reliable and has been used in many studies (Hollyer et al. 2014).

#### 4.4 Development of Data Envelopment Analysis (DEA)

The first step in this design is to select the DMUs required for the investigation. There are factors to consider when selecting DMUs - Homogeneity and number of DMUs (Tyagi et al. 2009). DMUs must be homogeneous units performing same tasks and have similar objectives. Based on homogeneity, 53 African countries were selected and data for ten years from 2005 to 2014 were obtained from sources stated above. As a second requirement of running DEA, Avkiran (2001) recommends that the number of DMUs has to be larger than the number of product of inputs and outputs for effective discrimination between efficient and inefficient DMUs. However, Banker et al. (1989) contend that the number of DMUs should be at least three times larger than the combined number of inputs and outputs. Complying with this requirement, 530 DMUs representing 53 countries for the period of ten years were developed.

With respect to variable, the literature does not provide specific guidelines in selecting DEA variables and has entirely left the selection to the researcher to decide based on expert judgment and knowledge about the variables (Nataraja and Johnson 2011). However, wrong variable selection may have negative implications for the results and thus it has been recommended to include only the relevant inputs and outputs variables (Nataraja and Johnson 2011). We carefully selected the variables based on the theoretical foundation. Input variables for DEA model for ICT were represented by mobile cellular subscribers (per 100 inhabitants), Internet users (per 100 inhabitants), and main telephone line (per 100 inhabitants). These input variables have been used in previous studies (e.g. Bankole et al. (2015); Mimbi and Bankole (2015)). On the other hand, output variables (public values) were represented by accountability, government effectiveness, transparency (press freedom), and rule of law (Table 2). These output variables were derived from the literature relating ICT and public value creation (Bannister and Connolly 2014).

Value/dimension	Input and Output variables
Duty oriented public value	Accountability (O)
Service oriented public value	Government effectiveness(O) Press freedom (O)
Socially oriented public value	rule of law(O)
ICT infrastructure	Mobile cellular subscribers (per 100 inhabitants) (I) Internet users (per 100 inhabitants) (I) Main telephone line (per 100 inhabitants) (I)

Note: "I" stands for input and "O" for output

*Table 2. Inputs and Outputs Variables for DEA model of ICT Public Value Creation*

## 5 RESULTS

We used MaxDea Basic version 6.4 software to calculate the relative efficiency scores for the 53 African countries. Results indicate that no any country scored hundred percent indicating that ICT infrastructure did not efficiently create public values in Africa for the ten-year period from 2005 to 2014. To perform relative efficiency comparison, we performed cluster analysis to group countries based on their multivariate attributes. This approach has been used in other studies (e.g., Mimbi and Bankole 2015; Samoilenko 2008).

### 5.1 Classification of African Countries

After running the DEA on the 53 countries, we then clustered the countries in three clusters based on their Human Development Index (HDI) over the period 2010 - 2014. HDI is more encompassing than economic measure alone as it provides a comprehensive picture about development outcomes of a nation. Economic measure such as GNI per capita may result into different economic outcomes of two countries while they have the same GNI per capita. HDI classification scheme has been used in other studies (e.g., Bankole et al. 2013). SPSS software was used to cluster the three clusters and the ANOVA test confirmed that these groups (clusters) were significantly different from one another ( $F=172.776$ ,  $Sig = .000$ ). After clusters were developed, average efficiency score for the period 2005 - 2014 for each country was included as indicated in Table 3.

Cluster one (n=12) has an average efficiency score of 0.0452 which was the lowest among the three clusters (Table 3). This means that cluster one was a least performer in terms of ICT efficiency in creating public value. In this cluster, Seychelles and Botswana scored the lowest (0.0268) and highest (0.0746) ICT efficiency respectively.

<b>Cluster 1</b>	<b>Efficiency</b>	<b>Cluster 2</b>	<b>Efficiency</b>	<b>Cluster 3</b>	<b>Efficiency</b>
<b>Countries</b>	<b>Score</b>	<b>Countries</b>	<b>Score</b>	<b>Countries</b>	<b>Score</b>
Mauritius	0.0338	Congo	0.1194	Côte d'Ivoire	0.1057
Seychelles*	0.0268	Equatorial Guinea	0.1193	Malawi	0.3292
Algeria	0.0340	Zambia	0.2104	Ethiopia	0.5113
Libya	0.0342	Ghana	0.1606	Gambia*	0.0639
Tunisia	0.0393	Sao Tome and Principe	0.0760	DR Congo **	0.6880
Botswana**	0.0746	Kenya	0.1639	Liberia	0.3669
Egypt	0.0359	Angola	0.1208	Guinea-Bissau	0.1927
Gabon	0.0553	Swaziland*	0.0685	Mali	0.2931
South Africa	0.0474	Tanzania	0.2785	Mozambique	0.3371
Cape Verde	0.0546	Nigeria	0.1636	Sierra Leone	0.6104
Morocco	0.0407	Cameroon	0.1086	Guinea	0.5901
Namibia	0.0657	Madagascar	0.3065	Burkina Faso	0.2794
<b>Mean Score</b>	<b>0.0452</b>	Zimbabwe	0.1105	Burundi	0.4788
<b>Total Countries</b>	<b>12</b>	Mauritania	0.1310	Chad	0.3324
<b>Cluster 1</b>		Comoros	0.1008	Eritrea	0.6854
Minimum	0.0268	Lesotho	0.1265	Central African Rep	0.5136
Maximum	0.0746	Togo	0.1299	Niger	0.4542
<b>Cluster 2</b>		Rwanda**	0.5999	Somalia	0.2662
Minimum	0.0685	Uganda	0.2931	<b>Mean Score</b>	<b>0.3944</b>
Maximum	0.5999	Benin	0.1581	<b>Total Countries</b>	<b>18</b>
<b>Cluster 3</b>		<b>Mean Score</b>	<b>0.1773</b>		
Minimum	0.0639	<b>Total Countries</b>	<b>23</b>		
Maximum	0.6880				

Key: \* represents countries with lowest efficiency score and \*\* represent countries with highest efficiency scores

Table 3. DEA Results for ICT Public Value Creation (2005 – 2014)

Cluster two (n=23) has an average efficiency score of 0.1773 and has the largest number of countries among the three clusters. Rwanda in this cluster performed the best by scoring 0.5999 (60 percent) ICT efficiency in creating public value and the lowest score (0.0685) in this cluster was taken by Swaziland (Table 3).

Cluster three (n=18) has an average efficiency score of 0.3944 which is the highest among the three clusters. Similarly, Democratic Republic of Congo is the highest and overall highest performer in this cluster and among the three clusters respectively. It has a score of 0.688. On the other hand, Gambia scored the lowest (0.0639) ICT efficiency in creating public value in cluster three.

Based on the theoretical underpinnings of DEA methodology, efficiency comparison of DMUs (i.e., countries) can only be performed among the peers – members of the same cluster (Saranga and Moser 2010). This is to say that in cluster one member countries, having the same level of human development can be compared to their peers (Saranga and Moser 2010). Therefore, Botswana is efficient in cluster one by its ability to utilise the same level of inputs and produce higher outputs than other countries in this cluster (Coelli 1996; Cooper et al. 2011). Similarly, Rwanda and Democratic Republic of Congo utilised

the same level of inputs to produce higher outputs than other countries in their respective clusters. However, there is a room for ICT to do much better in public value creation especially for those countries that scored less efficiency than those of their respective cluster average.

From the findings we can infer the following. First, the present study has empirically demonstrated that ICT creates public value. Second, based on the level of human development, cluster three is the highest performer among the clusters followed by cluster two. The findings indicate that cluster one which is characterised by the highest level of development among the three clusters is the least performer. The findings further indicate that the most efficient countries in using ICT to create public value in their respective clusters were Botswana, Rwanda and Democratic Republic of Congo. Third, the findings indicate that ICT has not been leveraged much in public value creation particularly in countries of cluster one. For example in cluster one, the 4.5 percent cluster average of ICT efficiency in transforming public values is considerably low. However, regardless of its efficiency, ICT shows a potential in public value creation as suggested by many scholars (Bannister and Connolly 2014; Jaeger and Bertot 2010; Hollyer et al. 2014). Given the results, we feel that African countries still need to improve on using ICT efficiently to create public values. This is due the fact that for more than a decade of using ICT in Africa, the most efficient cluster (18 countries) has used ICT to transform public values by 39 percent.

## 6 CONTRIBUTION OF THE STUDY

The present study has several implications: First, given a minuscule number of published articles regarding ICT and public value creation in Information Systems (Pang et al. 2014), this study contributes to the body of knowledge in this emerging field of research (Bannister and Connolly 2014). Our study has empirically demonstrated the potential of ICT in creating public values. The present study findings indicate that at most, ICT has been leveraged in public value creation in Africa by 39 percent over the ten year period (2005 – 2014). Second, this study has integrated ICT and public administration theories to demonstrate the efficiency of ICT in public value creation. The variables of DEA model were drawn on theories linking ICT and public administration. This integration contributes to interdisciplinary approach to Information Systems research. Third, the present results have policy and practical implications. The findings indicate that efficiency of ICT in transforming or creating public values for most countries is far below the efficient frontiers in their respective countries categories. This means that those countries that lag behind their peers should take strategic efforts to improve ICT efficiency in public value creation. Policy makers may adopt and implement strategies used by efficient countries (peers) to achieve the same or more ICT efficiency in creating public value. Lastly, the findings also suggest that investment in ICT is a worthwhile venture and should be encouraged.

## 7 CONCLUSION

The present study was set to investigate the efficiency of ICT in public value creation in Africa. Since the 1990s, development actors have been involved in public sector reforms for improved services. These reforms have been linked to the New Public Management paradigm, which emphasise public value creation in the public sectors. This notion of value creation is similar to the value for money notion in the private sector. Citizens have continuously pressed for public value in public administration. International bodies and researchers alike have recognised the potential of ICT in public sector reforms. It has become clear that ICT can be used in performance management to create public values. International bodies have emphasised that ICT should be harnessed in public services for socio-economic development (WPSR 2015). However, little research has investigated this nascent field of research (Bannister and Connolly 2014). Using DEA, this study investigates the efficiency of ICT in public value creation in 53 African countries for the period from 2005 to 2014. The findings indicate that at most ICT efficiently transformed public values by only 39 percent. This means that at minimum there is still a room for improvement of about 61 percent. To compare performance, the 53 countries were grouped into three clusters. The findings indicate that, by using ICT, cluster one countries efficiently transformed the public values by an average of only 4.5 percent. Clusters two and three performed higher than cluster one by scoring average ICT efficiencies of 17.73 and 39.44 percent respectively. Cluster three countries seem to have performed the best compared to those in other clusters. The present study has empirically demonstrated the role of ICT in public value creation in Africa. Therefore, policy makers are urged to leverage ICT in public values to bring about socio-economic development in Africa.

Besides its contribution, our study has limitations. First, while DEA has produced credible results in the present paper, to some extent DEA may not provide concrete performance comparison among decision making units (Charnes et al. 2013). Future study may adopt multi-method approach to take analysis to the next level that may provide robust comparison conclusion. Second, the present study has assumed the same focus of public values in Africa. However, it may appear that different countries focus on and press weight on values differently. For example, Vandenabeele et al. (2006) found that in the United Kingdom, there was a stronger focus on values such as impartiality and neutrality, while in France the focus was more on the values related to public provision of services. Further, the results for 53 countries grouped into three clusters seem to inform policy at an aggregate level of each cluster and the Africa continent. But some countries may have different performance scores when studies are conducted in individual countries. Future research may conduct case studies in individual countries to get more insights into the state of affairs about ICT and public value creation at country levels.

It is also recommended that investigation into factors that would provide answers as to why other countries' ICT infrastructure efficiently transformed public value while others did not be conducted. Such studies would have practical implications for finding better ways of maximising public values out of limited resources available in the public sectors for socio-economic development.

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