

ICT Efficiency in Creating Public Value, 2005-2014: A Cross-National Enquiry of BRICS Countries.

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Paper Category: Research Paper

ABSTRACT

Recently, BRICS countries have emerged as a powerful economic block envisaging to provide economic assistance to the member states. With the most populous countries, BRICS deserve a focused research to interrogate ICT in public value creation. Using Data Envelopment Analysis, the present study found that ICT transformed public value in BRICS countries by 0.4301, with India being the top performer (0.9984) over the period 2005 to 2014. Russia is the least performer by scoring 0.0516 regardless of its highest ICT development. Further, Brazil, China and Russia performed below fifty percent and below the BRICS average score. Findings further indicate that high ICT development is not necessarily a determinant for high ICT efficiency in creating public value. The current study has theoretical, methodological and policy implications.

Keywords: ICT, Public Value, Accountability, Impartiality, Data Envelopment Analysis (DEA), BRICS

1 INTRODUCTION

Governance challenges experienced in the past have contributed to a twist in public services. For the past three decades, the world has seen initiatives towards reinventing governments under the banner of New Public Management (NPM). NPM is believed to have a potential to resolve and provide solution to government inefficiency related challenges. Citizens have consistently insisted on public value in public services provision and their demands have contributed to adoption of an entrepreneurial approach to governance (Blaug, Horner, & Lekhi, 2006). As a

result, public value has become an important performance management issue in recent years due to its link to citizens' satisfaction and trust (Moore, 1995; Ott, 2010).

The international bodies contend that public sector reform is important in achieving socio-economic development (Estrin, Hanousek, Kocenda, & Svejnar, 2009). The objective of the public sector reform is to bring about socio-economic development through innovative performance management strategies. Consequently, performance management strategies such as New Public Management have been implemented to improve public services delivery (Alonso, Clifton, & Díaz-Fuentes, 2015). New Public Management (NPM) focuses on the agenda of continuously doing better in public administration (Van Dooren, Bouckaert, & Halligan, 2015).

In conjunction to the other strategies, Information and Communication Technology (ICT) has been implemented as one of the strategies in NPM to reinvent governments for improved performance (Bannister & Connolly, 2014; Gauld, Goldfinch, & Horsburgh, 2010). ICT is considered an enabler and has a potential in creating public value (Bannister & Connolly, 2014; OECD, 2003; Mimbi & Kyobe, Forthcoming).

However, many research related to value creation in Information Systems have focused mainly on private sector values and specifically focusing on business related values. Moore (1995) argues that value creation in private organisations 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 non-profit making entities, focus on public value creation (Pang, Lee, & DeLone, 2014; Moore, 1995).

The potential of ICT in public value creation has contributed to the importance of examining ICT pay back in public administration. While extensive research has been conducted to understand ICT in private sector, ICT and public value creation has not. Cordella and Bonina (2012) argue that the relationship between ICT and public sector reforms is an important area of study to understand the impact of ICT enabled initiatives on public sector reforms. The international bodies also have recognised the importance of ICT in public administration in creating public value. For example, the World Public Sector Report (WPSR) argues that ICT is a tool for creating public value and should be harnessed in public services to achieve socio-economic development (WPSR, 2015). OECD (2003) further argues that ICT and public sector reforms are

mutually reinforcing (p. 25). However, little research that focuses on ICT public value creation exists (Bannister & Connolly, 2014; Cordella & Bonina, 2012; Pang et al., 2014). Only a minuscule number of studies on ICT in the public sector have been published in Information Systems journals (Pang et al., 2014). However, recently, a notable study on this area has been conducted by Mimbi and Bankole (2016a). To fill this gap, the present study investigates the efficiency of ICT in public value creation in BRICS countries over the period of 2005 to 2014. Therefore, the objective of the present study is to determine the efficiency of ICT in public value creation in BRICS countries (Brazil, Russia, India, China and South Africa). To achieve this, we adopt the Data Envelopment Analysis (DEA) to analyse the data of ICT and public values in 5 BRICS countries.

The focus of the present study is on public values rather than on values created in the private sectors. This means that the study focuses on the efficiency of ICT in creating public values. The study intends to answer the main research question “How efficiently has ICT performed to enable or create public values in BRICS countries over the ten year period (2005 to 2014)?”

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 and its measure, 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 BRICS Countries Profiles

BRICS countries consist of five countries namely Brazil, Russia, India, China and South Africa. BRIC was initially coined by Jim O'Neill, of Goldman Sachs and was, for the first time, used in the report of economic growth prospects of the four countries known as BRIC. Later in 2010, South Africa was included in the association as a fifth country. Since then these countries have been known as BRICS. Over the years, BRICS have emerged as powerful countries within their respective zones. BRICS are developing countries which have registered a significant economic growth in the past years and hold significant influences in their respective regions. These countries have modern industrial sectors with a deepening global capitalist stance (Armijo,

2007). According to 2015 statistics, BRICS population commands 42% of the world's population and its land territory accounts for 26% of world's land territory.

Country	Population	Area (Sq Km)	Export of goods and services (% of GDP)	Import of goods and services (% of GDP)	ICT Development Index
Brazil	200,361,925	8,514,877	12.6	15.0	6.03
China	1,357,380,000	9,596,960	26.4	23.8	5.05
India	1,252,139,596	3,287,263	24.8	28.4	2.69
Russia	145,842,242	17,125,187	28.4	22.5	6.91
South Africa	52,981,991	1,219,912	31.1	34.0	4.90

Table 1. BRICS Countries Profiles Based on 2015 Statistics (Source: ITU, 2015; BRICS, 2015).

BRICS' Gross Domestic Product (GDP) accounts for 27% of world's GDP. BRICS is also considered to have made progress in Information and Communication Technology (ICT). ICT progress, measured by ICT development index (IDI) which assess the extent to which developments of ICT between countries and over time can be translated into socio-economic development (ITU, 2015). For example, Brazil and Russia have IDI of more than 6 in 2015 (See Table 1). Given their significant economic and ICT developments, BRICS countries deserve a specific research attention and the present study intends to accomplish this. However, ICT developments such as this would have socio-economic impact if ICT can create the envisaged public value. The next section discusses the concept of public value and its creation.

2.2 Public Value and its Creation

The concept of public value has its roots from the New Public Management (NPM) attributed to citizens' dissatisfaction with public services in the seventies. NPM originated from the United States and United Kingdom in the 1980s to address performance management challenges in the public sectors. NPM has been driven by social, political and economic challenges that took place in the 1970s (Larbi, 1999). NPM has been implemented to address these challenges using private sector approaches that can ensure efficiency and effectiveness in public administration; and implement cost cutting strategies to ensure delivery of public services at minimum costs (value for money). In developing countries, NPM has been implemented based on public sector reforms such as those focusing on public governance and administration reforms (Larbi, 1999; Mimbi & Kyobe, Forthcoming).

Importing private sector strategies, governments have implemented entrepreneurial strategies to provide solution to inefficiency, high cost and low quality services in public administration (Batley & Larbi, 2004). The public value concept is linked to the seminal work of Moore (1995) and for the past decades, it has been influential in public sector reforms. Defining public value is not a straight forward task and public value cannot be defined universally (Alford & Hughes, 2008). For that matter, the present study defines public value as value that citizens and their representatives seek in relation to strategic outcomes and experience of public services (Moore, 1995). To put it in simple analogy, public value is analogous to shareholder's value with the public sector acting in the best interests of the collective - citizens (Moore & Khagram, 2004). Therefore, public value focuses on performance evaluation of public organisation in delivery of services (social outcomes) as desired by the collective – who consume the public value (Moore, 1995).

As mentioned earlier, public value must be consumed by the collective and it moves beyond the value for individual by serving the wider public interests. However, it can be produced by any organisation – whether private through public private partnership arrangement or public (Alford & Hughes, 2008). What matters is that it must be consumed by the collective (the public) and the government has a sole responsibility in creating public value (Blaug, Horner, & Lekhi, 2006). The focus of public value is on serving public interests. For example, public interests could be served better by 'efficient' and 'impartial' government in its provision of public services (Ahrens, 2007; Teorell, 2009). When is public value created? Given the nature of public administration, governments consider that it is a good thing if results can be achieved with a minimum government spending (Alford & Hughes, 2008). As a result, governments that achieve the delivery of public value, for example, at minimum financial costs (input) are seen as efficient (Alford & Hughes, 2008). Thus, in public administration, public value is only created when the inputs used result into maximising outputs. In other words, "creating public value will mean maximising outputs within a constraint, that is, seeking the greatest possible benefit to the public within the available monetary or legal resources" (Alford & Hughes, 2008, p. 4).

Are value and values different? The literature has tried to distinguish these two terms but authors acknowledge that distinguishing them is a complicated task. Value refers to the worth of something while the word 'values' refers to a broader sense of 'right' than is normally

understood in ethics (Bannister & Connolly, 2014). In this case, public sector values, for example, can be leadership or innovation. The present study focuses on how public administration should behave in order to be effective in services provision. As indicated earlier, “in the context of ICT, values must therefore be convertible into some behavioural form that ICT has the potential to modify or transform” (Bannister & Connolly, 2014, p. 120).

2.3 Categorising Public Values

Creating public values entails getting maximum outputs out of limited resources used. This suggests that resources must be used to convert values into some behavioural form (Bannister & Connolly, 2014). ICT is a tool that can enable this conversion. Therefore, in the present study we focus on the behavioural forms that ICT is capable of modifying or transforming those. ICT use in public administration enables actions or activities related to public value that would be impractical in its absence. ICT is expected to enable or embed the three categories related to public value: duty oriented public value, service oriented public value and socially oriented public value (Bannister & Connolly, 2014) as discussed in the following section.

2.3.1 Duty Oriented Public Value

Public values in this category refer to the duties of the public servant to the government or to the state. These are non-financial related values that amount to accountability of the public servant (Bannister & Connolly, 2014). Accountability ensures public servants perform their duties in an ethical manner by making those controllable or answerable for their actions in public administration to the citizenry who are the principles (Gregory & Hicks, 1999). Accountability is a mechanism used to enforce individuals’ ethical related values such as integrity and honesty by forcing individuals to comply with the law guiding the public service provision (Bannister & Connolly, 2014; Gregory & Hicks, 1999). Gregory and Hicks (1999) summarise accountability as a mechanism to instill the spirit of the public servant to do things right by choosing the right thing.

ICT, on the other hand, can make a public servant accountable in many ways. Under the principal – agent environment, public servants, referred as agents are accountable to the citizens, who are the principals. However, accountability is only possible when performance information about the public servant is available to citizens (Heeks, 2009). Given the transparency nature of

ICT, particularly the Internet makes the performance information available to citizens for which the citizens can evaluate the performance of the public servant.

Further, in the same line of argument, ICT can also force the public servants to comply with the laws and behave in an honesty manner (Bannister & Connolly, 2014). In this way, ICT helps in ensuring responsiveness, integrity and honesty of public servants (Gregory & Hicks, 1999; Islam, 2006). A number of studies have found that ICT increases honesty, improve compliance with law and improve fairness by removing human element process and decision making chain (Bannister & Connolly, 2014; Quah, 2011). However, ICT does not act alone but operates based on the environment such existing policies where is implemented (Mimbi & Kyobe, Forthcoming; Wong & Welch, 2004). This means that presence of ICT in a particular country does not necessarily guarantee transparency practices.

2.3.2 Service Oriented Public Value

Service oriented public value refers to values related to provision of high level public administration services to the citizens. The values in this category are considered to be of New Public Management (NPM) nature, which focus on effectiveness and efficiency of the government or public organisation (Van Der Wal, Pevkur, & Vrangbaek, 2008). Government effectiveness is a pivotal public value for provision of public services in the new governance arena. Government effectiveness is defined as 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, Kraay, & Mastruzzi, 2008). Government effectiveness is central to making the citizenry happy by providing high value public services. Study findings indicate that there is a relationship between government effectiveness and happiness of citizenry. For instance, a study by Ott (2010) found that quality of government was positively related to citizenry happiness. Since effectiveness and efficiency are two phenomena that tend to have a trade-off between them, the present study only focuses on government effectiveness as a public value rather than government efficiency.

ICT as an enabling tool, it has the potential to enable or create effectiveness value (Bannister & Connolly, 2014). The transformative impact of ICT on effectiveness is a well-established

phenomenon in the Information Systems literature. Over the years, effectiveness has been one of the motivations of implementing ICT in public and private sectors. The role of ICT in service oriented public values is to enable or create government effectiveness to improve service provision for citizenry satisfaction. For instance, ICT can streamline activities of the organisation, reduce principal-agent challenges and reduce transaction costs thereby saving time and costs (Bekkers, 2003). In this case, by using ICT, citizenry can receive improved public services.

2.3.3 Socially Oriented Public Value

Public values in this category refer to those which incorporate quasi-political view encompassing broader social goals (Bannister & Connolly, 2014). These include aspects related to inclusiveness; and equal treatment of the members of the public in a just way and granting them access to public services. Socially oriented public value can be grouped together to refer to ‘impartiality’ in public services provision (Bannister & Connolly, 2014).

Teorell (2009) defines impartiality as a “norm of the output side that is most compatible with the normative principle of treating everyone with equal concern and respect” (p. 4). Impartiality is generally implemented under the banner of rule of law. Impartiality is 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). Ahrens (2007) contends that rule of law is a mechanism to enforce impartiality by ensuring laws are applied equally to all people.

The topology provided above for the sets of public value is neither exhaustive nor mutually exclusive. Some public values tend to overlap and no consensus has been reached by public administration scholars on the universally agreed topology (Bannister & Connolly, 2014). However, for the purpose of this study, the three categories of public value is sufficient to interrogate the impact of ICT on those.

Over the years, ICT has been a dominant mode of public services delivery for many governments. ICT offers a less expensive mode of access to public services than the traditional face-to-face mode thereby reducing challenges related to equity and access (Mimbi & Kyobe, Forthcoming). Given the advantage of using ICT, a number of governments have implemented

ICT for public value creation. For example, Bannister and Connolly (2014) report that Denmark and the UK governments have established ICT policy of ‘digital by default’ in providing public services. And it is apparent now we measure the extent to which ICT has efficiently created public value. The next section presents the Data Envelopment Analysis (DEA) methodology used to measure efficiency of a production function.

3 USING DEA TO MEASURE ICT EFFICIENCY

Over the years, there has been a great interest of legislators and citizens alike in performance information to assist in program evaluation and resource allocation decisions. Efforts of various organisations and professional associations are currently geared towards making governments more results-oriented (Municipal Research and Services Centre, 2015). This has contributed to increased efficiency evaluation programmes of governments in converting inputs into outputs. Efficiency is a measure of how well the government resources are utilised to achieve specific goals (Neely, Gregory, & Platts, 1995). As presented in section 2.3, ICT represents input and public value represents output that can be enabled by ICT (input) in public administration. Efficiency in the present study refers to how well ICT has transformed or enabled public values in BRICS countries over the period from 2005 to 2014. In other words, this is what we refer to ICT value creation in the public sector.

ICT value creation is a performance (efficiency) phenomenon that can be analysed using the Data Envelopment Analysis (DEA) methodology. DEA is a non-parametric analytical procedure that concerns the relationship between inputs and outputs. DEA is appropriate where the objective of the investigation is to evaluate efficiency of a production entity in which inputs are converted into final outputs (Saranga & Moser, 2010). Since ICT and public value represent input and output respectively, then DEA is an appropriate methodology to analyse the present phenomenon. Further discussion about DEA is presented in the methodology section.

4 METHODOLOGY

4.1 Data Envelopment Analysis (DEA)

For the past decades, Data Envelopment Analysis (DEA) has been used to interrogate efficiency of organisations and economies (Mimbi & Bankole, 2015; Mimbi & Bankole, 2016a; 2016b; Samoilenko, 2008). DEA was initially introduced by Farrell (1957) and years later Charnes,

Cooper and Rhodes (1978) improved on its earlier version. The changing production environments has contributed to a need to combine multiple inputs of a production entity into an efficiency measure (Farrell, 1957). DEA has been a methodology of choice for performance measure and its main objective is to improve productivity of a production entity (Cook & Seiford, 2009).

DEA uses the linear programming concept to extract information about a population of observations to evaluate efficiency of a decision making unit (DMU) with reference to an imposed efficient frontier. To extract information, DEA uses a set of referent decision making units (DMUs) to calculate a discrete piecewise frontier.

This process leads to identifying the efficient DMUs, which are characterised by the ability to utilise the same level of inputs and produce same or higher outputs (Coelli, 1996; Cooper, Seiford, & Zhu, 2011). In production terms, this measure is referred as efficiency and is calculated for each DMU relative to all the other DMUs in the production entity (Cooper et al., 2011). Through this process, efficiencies of all DMUs are evaluated to see whether all observations lie on or below the extreme frontier (Cooper et al., 2011).

Over the years, DEA has undergone two major improvements. Charnes, Cooper and Rhodes (1978) introduced a DEA model (or CCR model) which assumes constant returns to scale (CRS). Six years later, Banker, Charnes and Cooper (1984) proposed a DEA model known as BCC which assumes variable returns to scale (VRS).

DEA models can be used to estimate efficiency in two orientations namely input and output. (i) Input orientation involves the minimisation of inputs to achieve a given level of output. (ii) Output orientation, on the other hand, involves the maximisation of outputs for a given level of inputs (Cooper et al., 2011). However, the CCR model yields the same efficiencies regardless of whether it is input or output-oriented, contrary to the BCC model.

The growing concerns over public value creation, nations are compelled to demonstrate the public value of tax payers' money spent in improving public services. Nations are pressed hard to advance their public value frontier by 'maximising' and achieving multiple public value outcomes given the available resources (Alford & Hughes, 2008; Pang et al., 2014). Following this claim, the present study adopted CCR output-oriented approach.

4.2 Variable Selection and Principal Component Analysis

Variable selection in DEA is a crucial aspect of performance evaluation of the production entity. It requires the researcher to have knowledge about the variables to include in the production function. Over the years, two selection methods have been used in selecting DEA variables. In the first method variables are selected based on the researcher's expert judgment and knowledge about the variables (Golany & Roll, 1989; Ueda & Hoshiai, 1997; Nataraja & Johnson, 2011). In the second method, the statistical approach is used to select variables. This method is basically ideal for use by researchers who do not know the variable characteristics (Ueda & Hoshiai, 1997). The present study adopted both methods. DEA variables were selected based on the theoretical foundation explained earlier in the literature review (see section 2.3) and were further subjected to Principal Component Analysis (PCA) to confirm their inclusion in the DEA model (see section 5.1).

Principal Component Analysis is a “statistical method used to reduce the dimensionality of the data set by expressing the variance structure of a matrix of data through a weighted linear combination of variables” (Nataraja & Johnson, 2011, p. 3). PCA focuses on retaining only principal components that explain the maximum variance (relevant) by assessing a weighted linear combination of variables (Nataraja & Johnson, 2011). Nataraja and Johnson (2011) conducted performance assessment of several variable selection methods and concluded that PCA is the most appropriate for DEA studies involving a small number of observations (less than 300). Given a small number of observations in the present study, we therefore adopted PCA to select variables for the DEA model specification.

4.3 Data Sources and Variable Explanation

Given the objective of the study, data sources pertaining to input (ICT) and output (public value) variables were carefully thought. Several data sources were used to obtain archival data for the present study. Mobile cellular subscribers, Internet users and main telephone line data were obtained from the International Telecommunication Union - ITU (<http://www.itu.int>). These data represent ICT dimension in BRICS countries and all are measured as percentage (i.e. 100 inhabitants). On the other hand, public values (Voice and accountability, government effectiveness and rule of law) data were obtained from the World Bank

(<http://databank.worldbank.org>). These variable indicator scores representing public values (in units of a standard normal distribution) range from -2.5 to 2.5.

The data were readily available for all BRICS countries for a ten-year period from 2005 to 2014. The data from ITU and World Bank are reliable and have been used in many studies (e.g., Bankole, Osei-Bryson, & Brown, 2015; Mimbi & Bankole, 2015). Table 2 presents the summary of variables and their data sources.

Variable	Data Source
Mobile cellular subscribers (per 100 inhabitants)	International Telecommunication Union
Internet users (per 100 inhabitants)	International Telecommunication Union
Main telephone line (per 100 inhabitants)	International Telecommunication Union
Voice and accountability	World Bank
Government effectiveness	World Bank
Rule of law	World Bank

Table 2. Variables and their Sources.

4.4 Development of Data Envelopment Analysis (DEA)

Data development analysis involves two steps: (i) Selection of DMUs based on homogeneity: This step ensures the selected DMUs are homogenous units which perform the same tasks and intend to achieve the same operational objectives (Tyagi, Yadav, & Singh, 2009). Based on homogeneity, BRICS countries are homogeneous countries in terms of economic aspects. (ii) Number of DMUS: It is recommended that the number of DMUs in the DEA model must be larger than the number of product of inputs and outputs for effective discrimination between efficient and inefficient DMUs (Avkiran, 2001). Mathematically, this relationship can be represented by $D > (I \times O)$. Where D = number of DMUs, I = number of input variables and O = number of output variables. Three input variables representing ICT were selected (see Table 3). On the other hand, three output variables representing public value were also selected as indicated below (see Table 3).

Based on five BRICS countries, 10 DMUs were developed for each country over the period of ten years making a total of 50 DMUs. Complying with this condition, 50 DMUs representing 5 BRICS countries were operationalised in the DEA model of 3 input and 3 output variables and can be represented in the above expression as $50 > (3 \times 3)$. This means 50 (the number of DMUs) is larger than 9 (the product of 3 inputs and 3 outputs) as recommended by (Avkiran, 2001).

No	Input variables of the DEA model
1	Mobile cellular subscribers (per 100 inhabitants)
2	Internet users (per 100 inhabitants)
3	Main telephone line subscribers (per 100 inhabitants)
Output variables of the DEA model	
1	Voice and accountability (Duty oriented public value)
2	Government effectiveness (Service oriented public value)
3	Rule of law (Socially oriented public value)

Table 3. Input and Output Variables of the DEA Model.

The input variables used in the present study have been used in previous studies (e.g., Bankole et al., 2015; Mimbi & Bankole, 2015; Mimbi & Bankole, 2016b). The output variables used in the present study were derived from the literature relating ICT and public value creation (Bannister & Connolly, 2014) and also have been used in previous studies (e.g., Mimbi & Bankole, 2016b). Further, Principal Component Analysis was also used to confirm the selected variables as reported in the results section.

5 RESULTS

5.1 Variable selection

The DEA variables operationalised in the present study were also subjected to Principal Component Analysis (PCA) to ensure that they are relevant for inclusion in the DEA model. PCA using Varimax with Kaiser Normalisation rotation method was applied to examine the factors structures. Varimax with Kaiser Normalisation rotation method refers to an orthogonal rotation that focus on getting the simplest structure of factors by first normalising the factors before rotating them, then denormalising them after rotation. This approach was proposed by Henry Felix Kaiser in 1958. The PCA produced two factors that appeared to explain much of the variance. Factor one with Eigen value of 3.348 explains a total variance of 55.8%; while factor two with Eigen value of 1.377 explains a total variance of 22.942%. We used the cut-off Eigen value of 1 and item loading of > 0.3 . These values fall above the minimum accepted range that guides variable selection (Hair, Anderson, Tatham, William, & Black, 1992). Item loadings >0.30 are considered significant, >0.40 are more important, and >0.50 are considered very significant (Hair et al., 1992). Table 4 presents the component matrix indicating factor loadings and their corresponding variables. Factor one represents public value and factor two represents ICT.

Rotated Component Matrix^a

	Component	
	1	2
Government effectiveness	.700	-.163
Rule of law	.940	-.206
Voice and accountability	.827	.041
Fixed telephone subscriptions per 100 inhabitants	-.844	.367
Internet users per 100 inhabitants	-.230	.892
Mobile cellular subscribers per 100 inhabitants	-.083	.945

Extraction method: Principal Component Analysis.

Rotation method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Table 4. Component Matrix

5.2 Descriptive Analysis Results

The analysis of the five BRICS countries indicates that ICT has a higher standard deviation compared to those of public values. This shows that ICT data is more spread compared to those of public values over the period of ten years under investigation. Fixed telephone subscription per 100 inhabitants analysis indicates that there was a standard deviation of 10.0808 fixed telephone subscription (per 100 inhabitants) from the mean of 17.3508 fixed telephone subscription (per 100 inhabitants); while the minimum and maximum fixed telephone subscription per 100 inhabitants for BRICS countries were 2.1304 and 31.6956 respectively (see Table 5).

In respect of ICT components, fixed telephone subscription per 100 inhabitants in BRICS countries had the lowest subscription of a mean of 17 percent. On the other hand, Mobile cellular subscribers per 100 inhabitants topped the ICT components list by which 89 percent of the BRICS population had mobile cellular subscribers. Although mobile cellular subscription is the highest during the ten year period, the data also shows that there is a wide gap (42.1307) from the mean value (see Table 5). This shows that BRICS countries differ substantially in mobile cellular subscribers.

Variable	Min	Max	Mean	Std Deviation
Fixed telephone subscriptions per 100 inhabitants	2.1304	31.6956	17.3508	10.0808
Internet users per 100 inhabitants	2.3881	70.5200	28.3840	18.7695
Mobile cellular subscribers per 100 inhabitants	7.9972	165.5011	89.0470	42.1307
Government effectiveness	-0.4594	0.6446	-0.0042	0.2921
Rule of law	-0.9494	0.2372	-0.2696	0.3558
Voice and accountability	-1.6816	0.6528	-0.2071	0.8956

Table 5. Descriptive Analysis Results.

On the other hand, public values variables indicate means of negative values (see for example in Table 5 government effectiveness has a mean of -.00042). Just to remind the readers that these values range from -0.25 to 2.5. The important thing to note in these data is that the BRICS countries differ substantially in upholding public values. For example, in voice and accountability they have a standard deviation of 0.8956 and the mean of -0.2071 (Table 5). A similar trend can be observed in government effectiveness and rule of law.

5.3 DEA Results

Data for DEA was prepared by inspecting presence of missing values or negative values in the dataset. However, there were only negative input values. The negative input values were transformed to positive ones by adding the same smallest positive number known as non-negative constraint (NNC) to each input as recommended by Ueda and Hoshiai (1997). We then used MaxDea Basic version 6.4 software to calculate the relative efficiency scores for the BRICS countries.

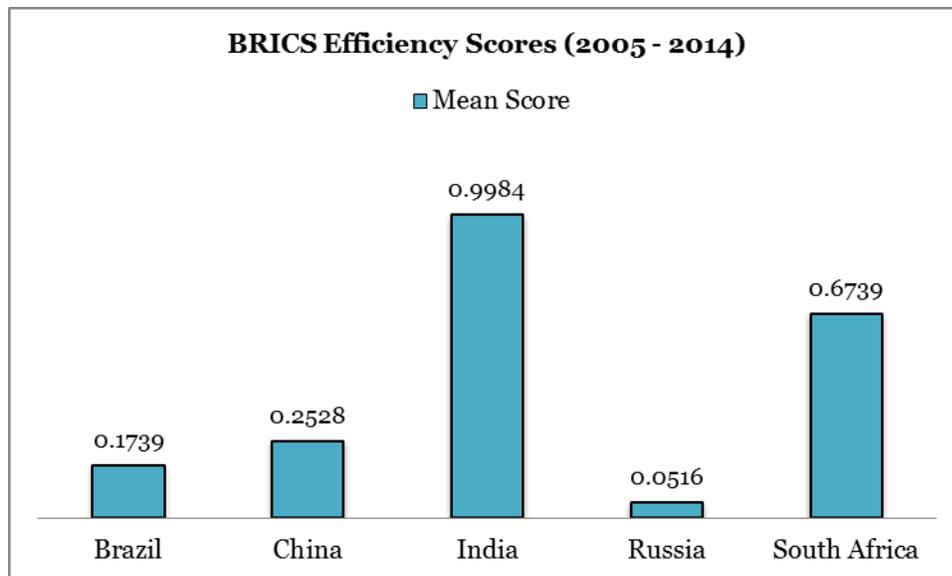


Figure 1. ICT Efficiency in Creating Public Values in BRICS Countries

Over the ten-year period from 2005 to 2014, ICT infrastructure has efficiently created public values in some BRICS countries. The results show that only India and South Africa have the most efficient utilisation of their ICT infrastructure to create public values. India and South Africa utilised ICT to transform public values by 0.9984 and 0.6739 respectively (see Figure 1). The three countries (Brazil, China and Russia) performed below fifty percent and below BRICS average score (0.4301) of which the least performer is Russia (0.0516) followed by Brazil (0.1739) and China (0.2528).

5.4 Theoretical Elaboration

As indicated in the findings, India is the best performer in ICT public value creation over the period 2005 to 2014 besides its lowest ICT development index of only 2.69 (see Table 1). Brazil and Russia have relatively the same level of ICT development but differ significantly in ICT efficiency in creating public values (see Figure 1). Based on performance management theory, by utilising the same level of inputs (ICT) we would expect Brazil and Russia to produce almost the same outputs – public values (Coelli, 1996; Cooper, Seiford, & Zhu, 2011). Why is India ahead of China and the rest of BRICS countries in ICT public value creation besides its lowest ICT development index? The plausible reasons could be the censorship policy in some of BRICS countries. For example, the Freedom House 2015 report indicates that China censorship policy has been implemented over the years. This has significantly affected the Internet freedom in

China (Freedom House, 2015). Based on this situation, People don't use the Internet to send information that can make the government accountable (Freedom House, 2015). Other researchers also point to similar China's stance towards Internet governance which imposes content restriction and users' control (Cui & Wu, 2016; Liang & Lu, 2010; Yang, 2013). Similar argument can be attributed to the observed low ICT efficiency in creating public value in Russia. Russia has the lowest ICT efficiency score (0.0516, see Figure 1) regardless of its highest ICT development index (6.91, see Table 1). Freedom House (2015) also points to increased Internet contents blocking and online information censorship in Russia. Internet freedom in Russia has deteriorated steadily over the past few years, with a steeper decline from 2013 to 2014 (Freedom House, 2015). All these issues may have contributed to the observed low ICT efficiency in creating public values in China and Russia regardless of high Internet users in these countries. South Africa, besides its second lowest ICT development in BRICS countries, seemed to have performed the second best in ICT efficiency in creating public values over the ten year period. South Africa has been categorised as an Internet free country for several years by the Freedom House reports. These reports indicate that South Africa neither implemented Internet censorship nor arrested Internet users in the past (Freedom House, 2013).

In summary, the findings of the present study indicate that ICT has not been leveraged much in public value creation in Brazil, China and Russia while India and South Africa leveraged their ICT substantially (Figure 1). However, regardless of varying ICT efficiencies in BRICS countries, ICT shows the potential in public value creation. These empirical findings confirm the many researchers' suggestion about ICT value creation potential (Bannister & Connolly, 2014; Jaeger & Bertot, 2010; Mimbi & Kyobe, Forthcoming). These researchers have expressed the potential of ICT in enabling the public sector values. Given the results, there is still a room to improve ICT usage to create public values in BRICS countries. India (the best performer) is the only country in the BRICS block that has efficiently transformed its public values the most (i.e., 0.9984). Further, the findings indicate that ICT value creation is independent of ICT development index. As indicated, countries with highest ICT development are not necessarily the highest performers in ICT value creation. This suggests that national contexts influence ICT value creation (Bankole, Osei-Bryson, & Brown, 2011).

Our findings also point to the challenges of implementing New Public Management in BRICS countries due to institutional constraints (e.g., policy) existing in these countries.

6 CONTRIBUTION OF THE STUDY

The present study has several implications: First, ICT and public value creation is an emerging area of research (Bannister & Connolly, 2014). A few scholarly articles regarding this nascent area of research have been published in Information Systems (Pang et al., 2014). The present study has investigated the extent to which ICT has efficiently created public value in BRICS countries. Thus, the present study contributes to the body of knowledge in this emerging area of research. The findings of our study indicate that at most, ICT has been leveraged in public value in BRICS countries by an average of 0.4301 or forty three percent over the ten year period (2005 – 2014). Only India and South Africa efficiently utilised their ICT in creating public values the most compared to China, Brazil and Russia which utilised their ICT in creating public values below fifty percent and below the BRICS average of 0.4301.

Second, the literature review carried out in the present study involves literature from ICT and public administration theories. The variables of DEA model were grounded on theories from these disciplines. This integration demonstrate the efficiency of ICT in public value creation which contributes to interdisciplinary approach to Information Systems research.

Third, the findings of our study indicate that performance varies significantly in the BRICS countries. Being countries considered to have almost similar level of economic growth and ICT development, we expected ICT efficiency in creating public values not to vary substantially. ICT efficiency in creating public values in most BRICS countries lie far below the efficient frontiers (i.e., India and South Africa). These findings call for strategic ICT usage in public value creation. Policy makers may adopt and implement strategies used by efficient countries (India and South Africa) to achieve the same or more ICT efficiency in creating public value.

7 CONCLUSION

The New Public Management paradigm has attracted a major concern regarding the public sector reforms all over the world. Since the 1990s, public value creation, a concept similar to ‘value for money’ in the private sector has been a top agenda in public sector reforms. Researchers and the

international community have recognised the potential of ICT in creating public values. They argue 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 & Connolly, 2014). To fill this gap, we used DEA to investigate the efficiency of ICT in public value creation in BRICS countries for the period from 2005 to 2014.

The findings indicate that ICT efficiently transformed public values in BRICS countries by only 0.4301 (average). Among the BRICS countries, India emerged the best performer followed by South Africa. The rest three countries performed below the BRICS average of 0.4301 and Russia being the least performer in utilising ICT to create public values. Given the empirical findings, this study has policy and practical implications. The findings call for policy makers and practitioners to adopt strategic use of ICT in creating public values to bring about socio-economic development in BRICS countries.

Our study has limitations. First, while DEA has empirically demonstrated the potential of ICT in creating public value, to some extent DEA may not be used in performance comparison among decision making units (DMUS) in a conclusive way (Charnes, Cooper, Lewin, & Seiford, 2013). Operating environments of individual DMUs may differ significantly which require further analysis to get more insight into the performance comparison. Future studies may adopt multi-method approach to investigate the phenomenon and enable them to reach a robust comparison conclusion.

Second, although many countries tend to emphasise public values, they also focus their attention on public values differently. For example, findings indicate that in the United Kingdom, there was a stronger focus on values such as impartiality and neutrality. On the other hand, in France the focus was more on the values related to public provision of services (Vandenabeele, Scheepers, & Hondeghem, 2006). Future studies may investigate if BRICS countries place different weight on public values as the present study assumed the same focus on public values across the BRICS countries.

Third, the use of PCA to select DEA variables is limited to 80% information retention level which can misrepresent efficiency levels of DMUs (Nataraja & Johnson, 2011). Other

approaches of DEA variable selection such as efficiency contribution measure or regression-based test can be used to validate the results of the present study.

8 REFERENCES

- Ahrens, J. (2007). *Governance in the process of economic transformation. System Transformation in Comparative Perspective. Affinity and diversity in institutional, structural and cultural patterns*, Munster: LITVerlag.
- Alford, J., & Hughes, O. (2008). Public value pragmatism as the next phase of public management. *The American Review of Public Administration*.
- Alonso, J. M., Clifton, J., & Díaz-Fuentes, D. (2015). Did new public management matter? An empirical analysis of the outsourcing and decentralization effects on public sector size. *Public Management Review*, 17(5), 643-660.
- Armijo, L. (2007). The BRICS countries (Brazil, Russia, India, and China) as analytical category: Mirage or Insight? *Asian Perspective*, 31(4), 7-42. Retrieved from <http://www.jstor.org/stable/42704607>
- Avkiran, N. K. (2001). Investigating technical and scale efficiencies of Australian universities through data envelopment analysis. *Socio-Economic Planning Sciences*, 35(1), 57-80.
- Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management science*, 30(9), 1078-1092.
- Bankole, F. O., Osei-Bryson, K. M., & Brown, I. (2015). The impacts of telecommunications infrastructure and institutional quality on trade efficiency in Africa. *Information Technology for Development*, 21(1), 29-43.
- Bankole, F.O., Osei-Bryson, K.M., & Brown, I. (2011). Exploring the impact of ict investments on dimension of human development in different contexts: A regression splines analysis. Proceedings of annual workshop of the AIS special interest group on ICT for global development. Retrieved from <http://aisel.aisnet.org/cgi/viewcontent.cgi?article=1007&context=globdev2011>.
- Bannister, F., & Connolly, R. (2014). ICT, public values and transformative government: A framework and programme for research. *Government Information Quarterly*, 31(1), 119-128.
- Batley, R., & Larbi, G. A. (2004). *The changing role of government: the reform of public services in developing countries*. Basingstoke; New York: Palgrave Macmillan.
- Bekkers, V. (2003). Reinventing government in the information age. International practice in IT-enabled public sector reform. *Public Management Review*, 5(1), 133-139.

- Blaug, R., Horner, L., & Lekhi, R. (2006). Public value, politics and public management: A literature review. Retrieved November 12, 2016 from www.theworkfoundation.com
- BRICS: Retrieved July 12, 2016 from <http://en.brics2015.ru/>
- Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research*, 2(6), 429-444.
- Charnes, A., Cooper, W. W., Lewin, A. Y., & Seiford, L. M. (Eds.). (2013). *Data envelopment analysis: Theory, Methodology, and Applications*. Springer Science & Business Media.
- Coelli, T.J. (1996). *A Guide to Deap Version 2.1: A Data Envelopment Analysis (Computer) Program* Department of Econometrics, University of New England, Armidale, Australia
- Cook, W. D., & Seiford, L. M. (2009). Data envelopment analysis (DEA)—Thirty years on. *European Journal of Operational Research*, 192(1), 1-17.
- Cooper, W. W., Seiford, L. M., & Zhu, J. (2011). *Handbook on data envelopment analysis* (Vol. 164). Springer Science & Business Media.
- Cordella, A., & Bonina, C. M. (2012). A public value perspective for ICT enabled public sector reforms: A theoretical reflection. *Government Information Quarterly*, 29(4), 512-520.
- Cui, D., & Wu, F. (2016). Moral goodness and social orderliness: An analysis of the official media discourse about Internet governance in China. *Telecommunications Policy*, 40(2), 265-276.
- Estrin, S., Hanousek, J., Kocenda, E., & Svejnar, J. (2009). The effects of privatisation and ownership in transition economies. *Journal of Economic Literature*, 47(3), 699 – 728.
- Freedom House. (2013). Freedom on the Net 2013, South Africa report: Retrieved from <https://freedomhouse.org/report/freedom-net/2013/south-africa>
- Freedom House. (2015). Freedom on the Net 2015, privatizing censorship, eroding privacy. Retrieved from <https://freedomhouse.org/report/freedom-net-2015/freedom-net-2015-privatizing-censorship-eroding-privacy>
- Gauld, R., Goldfinch, S., & Horsburgh, S. (2010). Do they want it? Do they use it? The ‘Demand-Side’ of e-Government in Australia and New Zealand. *Government Information Quarterly*, 27(2), 177-186.
- Golany, B., & Roll, Y. (1989). An application procedure for DEA. *Omega*, 17(3), 237-250.
- Gregory, R., & Hicks, C. (1999). Promoting public service integrity: A case for responsible accountability. *Australian Journal of Public Administration*, 58(4), 1-15.

- Hair Jr, J. F., Anderson, R. E., Tatham, R. L., & William, C. Black. (1992). *Multivariate data analysis with readings*, 3rd Edition, Macmillan, New York.
- Heeks, R. (2009). Emerging markets IT and the world's bottom billion, *Communications of the ACM*, 52(4), 22-24.
- ICT Development Index 2015. Retrieved from <http://www.itu.int/net4/ITU-D/idi/2015/>
- Islam, R. (2006). Does more transparency go along with better governance? *Economics & Politics*, 18(2), 121-167.
- Jaeger, P.T., & Bertot, J.C. (2010). Transparency and technological change: Ensuring equal and sustained public access to government information. *Government Information Quarterly*, 27(4), 371-376.
- Kaufmann, D., Kraay, A., & Mastruzzi, M. (2008). Governance matters VII: aggregate and individual governance indicators, 1996–2007". World Bank Policy Research Working Paper No. 4654, World Bank 2008. www.govindicators.org.
- Larbi, G. A. (1999). The new public management approach and crisis states. Retrieved from https://scholar.google.co.za/scholar?q=The+New+Public+Management+Approach+and+Crisis+States&btnG=&hl=en&as_sdt=0%2C5
- Liang, B., & Lu, H. (2010). Internet development, censorship, and cyber-crimes in China. *Journal of Contemporary Criminal Justice*, 26(1), 103-120.
- Mimbi, L., & Bankole, F. O. (2015). ICT and health system performance in Africa: A multi-method approach. In *Proceedings of the 26th Australasian Conference on Information Systems*, Adelaide, Australia.
- Mimbi, L., & Bankole, F. O. (2016a). ICT and public service value creation in Africa: Efficiency assessment using DEA approach. In *Proceedings of the 27th Australasian Conference on Information Systems*, Sydney, Australia.
- Mimbi, L., & Bankole, F. O. (2016b, September). Factors influencing ICT service efficiency in curbing corruption in Africa: A bootstrap approach. In *Proceedings of the Annual Conference of the South African Institute of Computer Scientists and Information Technologists* (p. 25). Johannesburg, South Africa. ACM, New York, NY, USA.
- Mimbi, L., & Kyobe, M. (Forthcoming). Public perceptions of the role of IT in resolving governance challenges in a transition state: The case of Tanzania. *Electronic Journal of Information Systems in Developing Countries*.
- Moore, M. (1995). *Creating public value: Strategic management in government*. Cambridge, MA: Harvard University Press.

- Moore, M., & Khagram, S. (2004). On creating public value: What business might learn from government about strategic management. *Corporate Social Responsibility Initiative Working Paper, 3*. Cambridge, MA: John F. Kennedy School of Government, Harvard University
- Municipal Research and Services Centre. (2015). Performance measurement. Retrieved from: <http://mrsc.org/Home/Explore-Topics/Finance/Budgets/Performance-Measurement.aspx>
- Nataraja, N. R., & Johnson, A. L. (2011). Guidelines for using variable selection techniques in data envelopment analysis. *European Journal of Operational Research, 215*(3), 662-669.
- Neely, A., Gregory, M., & Platts, K. (1995). Performance measurement system design: A literature review and research agenda. *International Journal of Operations & Production Management, 15*(4), 80-116.
- OECD. (2003). *The e-Government imperative*. Paris: Organisation for Economic Co-operation and Development.
- Ott, J. C. (2010). Good governance and happiness in nations: Technical quality precedes democracy and quality beats size. *Journal of Happiness Studies, 11*(3), 353-368.
- Pang, M. S., Lee, G., & DeLone, W. H. (2014). IT resources, organisational capabilities, and value creation in public-sector organisations: A public-value management perspective. *Journal of Information Technology, 29*(3), 187-205.
- Quah, J.T. (2011). *Curbing corruption in Asian countries*. Bingley, UK: Emerald Publishing Group.
- Samoilenko, S. (2008). Contributing factors to information technology investment utilisation in transition economies: An empirical investigation. *Information Technology for Development, 14*(1), 52-75.
- Saranga, H., & Moser, R. (2010). Performance evaluation of purchasing and supply management using value chain DEA approach. *European Journal of Operational Research, 207*(1), 197-205.
- Teorell, J. (2009). The impact of quality of government as impartiality: Theory and evidence. In *APSA 2009 Toronto Meeting Paper*.
- Tyagi, P., Yadav, S. P., & Singh, S. P. (2009). Relative performance of academic departments using DEA with sensitivity analysis. *Evaluation and Program Planning, 32*(2), 168-177.
- Ueda, T., & Hoshiai, Y. (1997). Application of principal component analysis for parsimonious summarisation of DEA inputs and/or outputs. *Journal of the Operations Research Society of Japan, 40*(4), 466-478.

- Van Der Wal, Z., Pevkur, A., & Vrangbaek, K. (2008). Public sector value congruence among old and new EU member-states?: Empirical evidence from the Netherlands, Denmark, and Estonia. *Public Integrity*, 10(4), 317-334.
- Van Dooren, W., Bouckaert, G., & Halligan, J. (2015). Performance management in the public sector. Routledge.
- Vandenabeele, W., Scheepers, S., & Hondeghem, A. (2006). Public service motivation in an international comparative perspective: The UK and Germany. *Public Policy and Administration*, 21(1), 13–31.
- Wong, W. & Welch, E. (2004). Does e-government promote accountability? A comparative analysis of website openness and government accountability. *Governance*, 17(2), 275-297.
- WPSR: World Public Sector Report (2015). Responsive and accountable public governance. Department of economic and social affairs. United Nations, New York, 2015.