

Full Paper

AN ANALYSIS OF THE NETWORKED READINESS INDEX DATA OF SOME SUB-SAHARAN AFRICA COUNTRIES

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ABSTRACT

African governments and businesses must accept the concept of Internet of Everything (IoE) by being fully digitized with highly robust computer network security in order to embrace modern technologies in the form of cloud, mobile, social and analytics. They must also realize the importance attached to achieving societal and economic transformation by fully understanding the connection between people, process, data and things in order to create the needed opportunities for African citizens. A country's Networked Readiness is an ideal indicator of a country's ability to implement and take a competitive advantage of Information Communication Technologies (ICTs). In this article we investigate 6 sub-Saharan Africa countries (Botswana, Mauritius, Namibia, Nigeria, South Africa and Zimbabwe) in terms of their Networked Readiness Index (NRI) rankings as published in the Global Information Technology Reports (GITR) from 2002 – 2015. We developed a number of statistical models for predicting the NRI for these countries for the next 9 years based on the NRI rankings of these countries in the previous 9 years. Our predictive models for NRI rankings suggest that on average over next the 9 years, the hierarchical ordering is namely, Mauritius (1st), South Africa (2nd), Zimbabwe (3rd), Namibia (4th), Botswana (5th) and Nigeria (6th) respectively. We conclude that in terms of Networked Readiness in Africa during the period of our predictions, data security will be crucial in three areas: confidentiality, integrity and availability. Furthermore, we are of the opinion that programmable security infrastructure (software-based security environment) will have the ability to secure dynamically a particularly sensitive data flow across the network on demand and according to the organization's security policy.

KEYWORDS: INFORMATION COMMUNICATION TECHNOLOGIES (ICTs), NETWORKED READINESS INDEX (NRI), SECURITY, REGRESSION ANALYSIS, SUB-SAHARAN

2. INTRODUCTION

In this article we studied the Networked Readiness Index (NRI) framework as documented in the Global Information Technology Reports over the past 14 years (2002 until 2015) and present statistical analyses of our NRI predictions of six sub-Saharan Africa countries (Botswana, Mauritius, Nigeria, Namibia, South Africa and Zimbabwe) for the next nine years (2016 – 2024) based primarily on the available published data from The World Economic Forum in the past nine years (2007 – 2015) and other sources. Despite the fact that sub-Saharan Africa are always in the bottom half of all the countries covered over the past 14 years, Mauritius, South Africa, Botswana and Namibia have consistently ranked higher than the other countries in the same continent. The rest of the paper is arranged as follows, a brief introduction to the Networked Readiness Framework, followed by background Information on the reporting of sub-Saharan Africa NRI rankings over the past 14 years by the Global Information Technology Reports, this is followed by secure infrastructure for Networked Readiness in sub-Saharan Africa, we then present statistical analysis using Simple Linear Regression to predict the NRI rankings for the 6 countries we have identified based on continuous available NRI data from 2007 until 2015 inclusive. Finally we offer some initial discussion of our results and conclude with our thoughts on possible future of the Networked Readiness Index for sub-Saharan Africa in general.

2. THE NETWORKED READINESS INDEX (NRI) FRAMEWORK

The Global Information Technology Report (GITR) has been updating its readers on the Networked Readiness Index (NRI) Framework since its 2001 – 2002 (first edition in the series) publication. Initially, a country's NRI was defined to be the degree to which a community is *prepared* to participate in the Networked world, however, in the 2001-2002 report, this definition was modified to include the community's potential to participate in the Networked World in the future. In the same article, it was pointed out that a single measure such as the NRI is too restrictive and limited in terms of understanding how a country's national

environment affect the adoption of Information Communication Technologies (ICTs). The 2002-2003 report further refined the NRI definition such that individuals, businesses, and governments are stakeholders within the community by including the potential and preparation of a community within its immediate environment.

A much more robust definition was offered in the 2003 – 2004 report, articulating that NRI is a community's degree of preparation to participate in and benefit from Information Communication Technology (ICTs) development. In the 2005 – 2006 report, Mia (2006) suggested that the NRI measures the tendency for a nations/economies to take a competitive advantage of the opportunities offered by ICT and establishes a broad international framework formulating the enabling factors of such capacity. The Networked Readiness Index is therefore a framework that could be regarded as a holistic approach to measure ICT access and impact. According to Bilbao-Osorio (2013), the NRI has provided policy / decision makers with a useful conceptual framework to evaluate the impact of information and communication technologies (ICTs) at a global level, and to benchmark the ICT readiness and the usage of their economies. In order to make any marked impact on ICT readiness, access and usage is of highest priority for developing economies given the need to narrow the so called 'digital divide' Bilbao-Osorio (2014, p.5).

3. GLOBAL INFORMATION TECHNOLOGY REPORTS ANNUAL INCLUSION OF SUB-SAHARAN AFRICA COUNTRIES

The Global Information Technology Report (GITR) started reporting on Networked Readiness Index (NRI) in its 2002 inaugural edition. In this first edition there were 4 sub-Saharan Africa countries included (Mauritius, Nigeria, South Africa and Zimbabwe) out of 75 countries worldwide. In the 2003 report there were 6 sub-Saharan Africa countries in which 2 additional countries were included (Namibia and Botswana) out of 82 countries investigated. The following year, 2004, there were 21 sub-Saharan Africa countries; 15 new countries were added (Angola, Cameroon, Chad, Ethiopia, Gambia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Senegal,

Tanzania, Uganda, and Zambia) out of 102 countries worldwide. The 2005 report excluded two existing sub-Saharan countries (Senegal and Cameroon), making a total of 19 countries reported out of 104 countries worldwide. The 2006 report excluded 3 existing countries (Angola, Zambia and Malawi) whilst 2 new countries (Benin and Cameroon) were added to make 18 reported sub-Saharan Africa out of a total of 115 countries. The 2007 report excluded 2 existing countries whilst 7 (Angola, Burkina Faso, Burundi, Lesotho, Malawi, Mauritania and Zambia) new countries were added, making 23 sub-Saharan countries out of a total of 122 investigated.

There were 23 sub-Saharan countries reported in the 2008, excluding 2 of the existing countries (Angola and Malawi) whilst 2 new countries were added, making 23 sub-Saharan Africa countries out of a total of 127 reported. In the 2009 report 26 sub-Saharan Africa countries were recorded, including 3 new countries (Cote d'Ivoire, Ghana and Malawi) out of 134 countries in total. In 2010 there were no new sub-Saharan countries added, however, one none sub-Saharan country (Moldova) was not covered to make a total number of countries covered to be 133. The 2011 report added three more sub-Saharan countries (Angola, Cape Verde, and Swaziland) to have 29 sub-Saharan Africa countries out of the 138 covered. In the 2012 report, Rwanda was added, making 30 sub-Saharan Africa countries out of the total of 142 worldwide. The 2013 report had recorded NRI scores for 34 sub-Saharan Africa countries, new inclusions are: Gabon, Guinea, Liberia, Seychelles and Sierra Leone. There was no NRI reported for Angola in the 2013 out of the 144 overall countries recorded. The 2014 report recorded NRI scores for 35 sub-Saharan Africa countries (the maximum numbers recorded since the first report in 2002) out of a worldwide total of 148 countries. The latest report in 2015 recorded NRI scores for 32 sub-Saharan Africa countries (Benin, Liberia, Sierra Leone were omitted) out of the 143 countries in the study. Oriogun et al. (2015) were of the opinion that Liberia and Sierra Leone must have been omitted due to the Ebola crisis in West Africa (p.34).

4. REVIEW OF THE GLOBAL INFORMATION TECHNOLOGY REPORTS ON SUB-SAHARAN AFRICA NETWORKED READINESS (2002 – 2015)

The Global Information Technology Report of 2001 – 2002 reported the Networked Readiness Index for 75 countries. Although the report was published in 2002, it actually captured the data for 2001. This has been the case until the reports produced in 2012, 2013, 2014 and 2015 (instead of reporting say, 2011 – 2012 following previous format, it simply reported 2012 etc.). This first report claimed that these countries represents more than 80% of the World's population and more than 90% of its economic output Kirkman et al., 2002 p.10. Furthermore each of the countries included had populations of more than one million. The four sub-Saharan countries included are Mauritius (NRI Ranking 51, NRI Score 3.4, Population 51 million), Nigeria (NRI Ranking 75, NRI Score 2.1, Population 75 million), South Africa (NRI Ranking 40, NRI Score 3.71, Population 40 million) and Zimbabwe (NRI Ranking 70, NRI Score 2.78, Population 70 million). It is interesting to note that the NRI ranking and population of these first four sub-Saharan Africa countries had a very close correlation. Kirkman et al., 2002 p.12 further reported that the NRI is a summary measure and had been designed as a tool for policy makers and global leaders to understand how nations are performing in relation to one another based on their participation in the Networked World. Dutta and Jain (2003) cautioned that it must be noted that the 82 countries considered in the NRI analysis had limitations due to availability of data from reliable sources. It further stressed that ranking other countries in future will possibly pose a serious challenge, and suggested that 'any overall rankings should be done with this taken into consideration'. Dutta et al, 2004 p20 explained that the 102 countries involved in the 2003 – 2004 limits the number of variables that can be considered because the methodology adopted imposed a 65% observation rate for each variable over the 102 countries; consequently, variables with fewer observations had been removed.

The GITR of 2004 – 2005 and that of 2005 – 2006 were not in line with other measurement

protocol adopted the in previous 3 years. The maximum NRI score for the 2004 – 2005 report was 1.73 for Singapore and the lowest score was - 1.69 for Chad. In the 2005 – 2006 report USA scored the maximum NRI of 2.02 whilst the lowest NRI was 1.39 by Ethiopia. From the available literature to date, there was no particular reason supplied by the GTR pre and post the 2004 – 2005 and the 2005 – 2006 reports to explain the circumstances surrounding the huge difference in the methodology employed. Consequently, for the purpose of the statistical analysis that we offer in this study on the NRI rankings for sub-Saharan Africa, we have excluded the NRI data for 2004-2005 and 2005-2006. Figure 1 is a graphical depiction of the 35 sub-Saharan Africa countries represented from 2002 to 2015 respectively. Mia and Dutta (2008) concluded that sub-Saharan Africa still lags behind in its Networked Readiness Index due to what they referred to as 'lack of extensive and well-functioning infrastructure,

overregulated and inefficient business environments, and poor governance and educational standards are all important hindrances in these countries' (p.16). It was further noted that a 'number of its domestic market that could benefit from networked readiness has thus far been largely ignored' (p16). Dutta e al., 2010 agreed with Dutta et al., 2011 that most of sub-Saharan Africa countries are still lagging behind other economies in terms of its networked readiness. A couple of years later, Bilbao-Osorio et al. (2013) reported that the region has improved its ICT broadband Infrastructure through mobile network coverage, however, only a limited number of its population are poised to take advantage of this improvement. We have concentrated on the statistical analysis of 6 sub-Saharan Africa countries on the basis of continuous availability of the Networked Readiness Index (NRI) data for these countries from 2003 to 2015 inclusive.

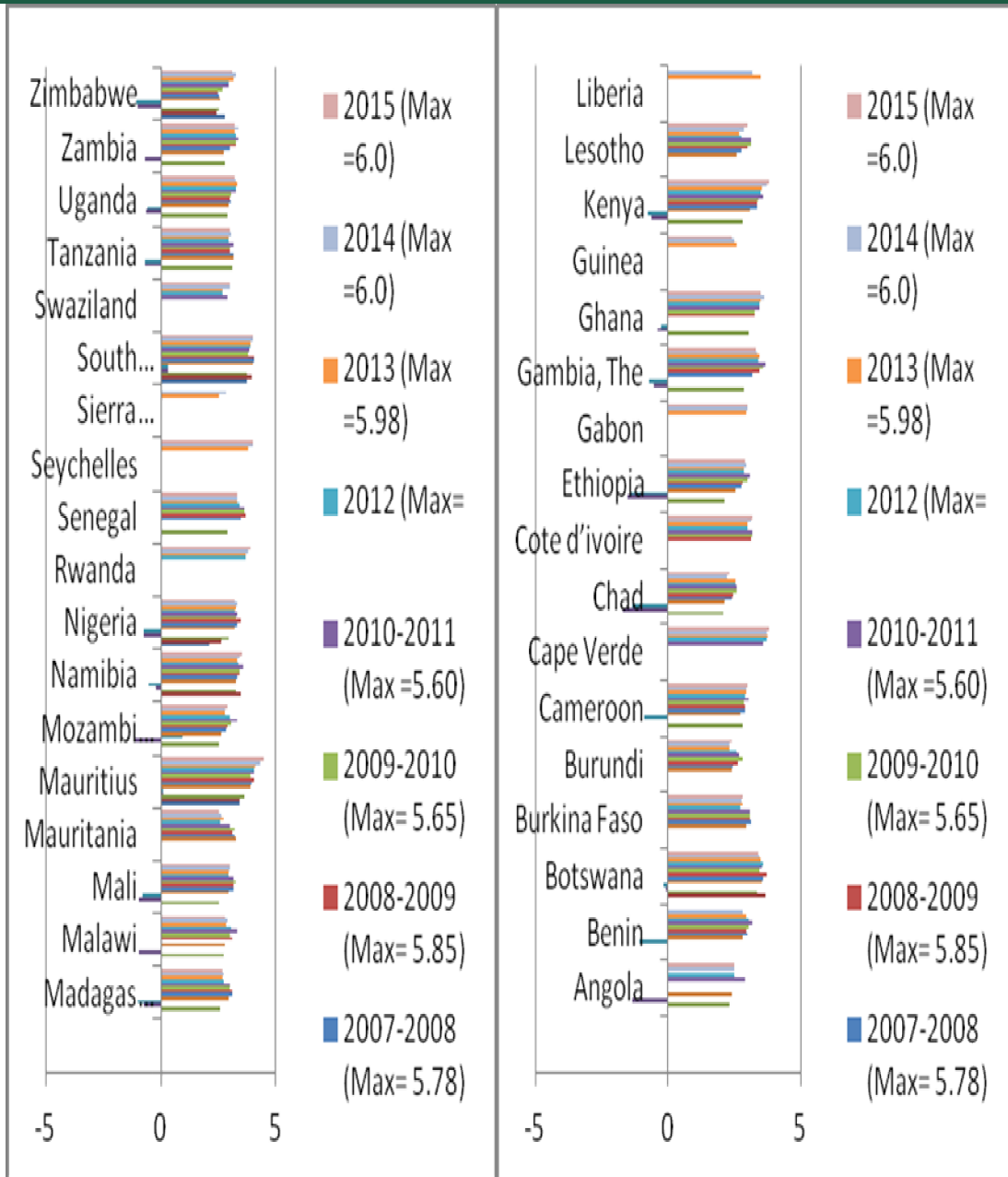


Figure 1: Graphical Representation of the 35 Sub-Saharan Africa Countries NRI Scores (2002 – 2015)

We note the huge difference in the NRI data in the GITR report of 2005 and 2006 respectively compared to the rest of the reports to date; consequently we relied heavily on the NRI data of the past 9 consecutive years (2007 to 2015) as the basis for the prediction of the next 9 consecutive years (2016 to 2024) as documented in this article. Details of our statistical analysis of the available NRI data are as shown and explained in Figures 2 – 8 together with the corresponding regression equations 2 – 8 respectively.

$$y = 3.53111 - 0.024167 x \quad R^2 = 0.470428 \quad (2)$$

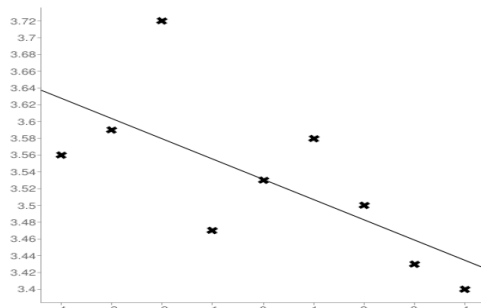


Figure 2: Botswana: Predicted Networked Readiness Index Rankings for 2016 – 2024.

5. EXPLANATION OF REGRESSION LINE

$$y = \alpha + \beta x \quad (1)$$

According to Oriogun and Gilchrist (2002), the equation above is saying that the expected (mean) y is given by this relation. Note however that this is an estimated relation, with a sampling variability. We could estimate a confidence interval for this mean relation. A given sub-Saharan Africa country's NRI ranking will vary about the true mean value, with a variance which could be estimated. Thus, for example, if $x = 0$, then $y = \alpha$ is the average for such a country's NRI ranking. However, a country with $x = 0$ will not actually have $y = \alpha$. We can estimate the variance about α , but the actual observation is of course unknown. Similarly, if $x = 100$, $y = \alpha + 100\beta$ is the average /expected score for such a country, but the actual NRI ranking will vary about the expectation. Again, we can estimate the variance about the line, although not the actual observation (p.104). Figures 2 – 8 shows Wessa (2015) simple Linear Regression prediction plots of Networked Readiness Index rankings for the next 9

years (2016 – 2024) based on the dataset from the Global Information Technology Reports from the past 9 years (2007 – 2015) for the six Sub-Saharan Africa countries considered for this study. Each of these plots have 95% confidence limit, and F-Test of 6.218224(Botswana), 21.020528 (Mauritius), 1.016126 (Namibia), 0.82249 (Nigeria), 0.420348 (South Africa) and 36.929807 (Zimbabwe) respectively (2007 – 2015) for the six Sub-Saharan Africa countries considered for this study.

$$y = 4.09 + 0.064 x \quad R^2 = 0.750183 \quad (3)$$

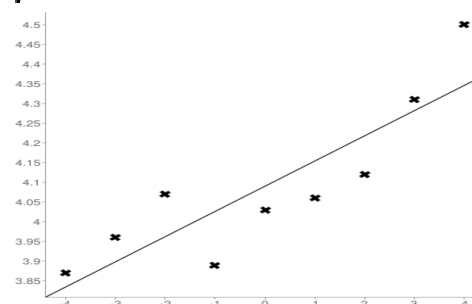


Figure 3: Mauritius: Predicted Networked Readiness Index Rankings for 2016 – 2024.

$$y = 3.397778 + 0.012833 x \quad R^2 = 0.12676 \quad (4)$$

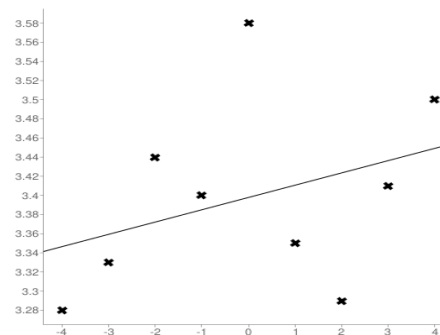


Figure 4: Namibia - Predicted Networked Readiness Index Rankings for 2016 – 2024.

According to Dutta, Geiger and Lanvin (2015, p29-30) Networked Readiness Index has four sub-indexes, namely, Environmental (political and business), Readiness (infrastructure, affordability and skills), Usage (individual business and government) and Impact (economic and social). In this article, we have selected specific pillars of the sub-indexes that directly relate to security within sub-Saharan Africa. The infrastructure must have

appropriate political and business environment to have impact on the population. The infrastructure will include secure internet server per million population, mobile network coverage (% population), international internet broadband (Kb/s per user) and electricity production (KWh/capita). The Government will have laws relating to ICTs, software piracy rate and intellectual property protection. The business environments will then be able to have the latest technologies and procurement of advance technology products. According to Oriogun, Abaye, Forteta and Shorunke (2015, p.108) governments, through ICT regulatory bodies plays a pivotal role in auditing ICT infrastructure projects. This is done through setting national policies, standards, specifications and requirements to govern the execution of projects. Within the context of developing economies, this role cannot be ignored as "best practices" are yet to be developed in many parts of the industry.

$$y = 3.285556 - 0.009 x \quad R^2 = 0.105144 \quad (5)$$

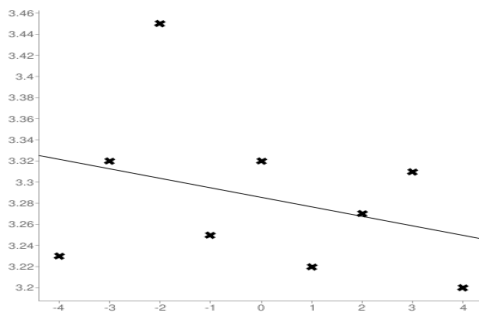


Figure 5: Nigeria - Predicted Networked Readiness Index Rankings for 2016 – 2024.

$$y = 3.942222 - 0.008667 x \quad R^2 = 0.056548 \quad (6)$$

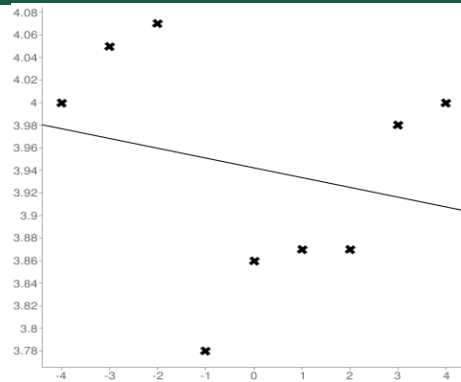


Figure 6: South Africa: Predicted Networked Readiness Index Rankings for 2016 – 2024.

$$y = 2.84889 + 0.0975 x \quad R^2 = 0.840655 \quad (7)$$

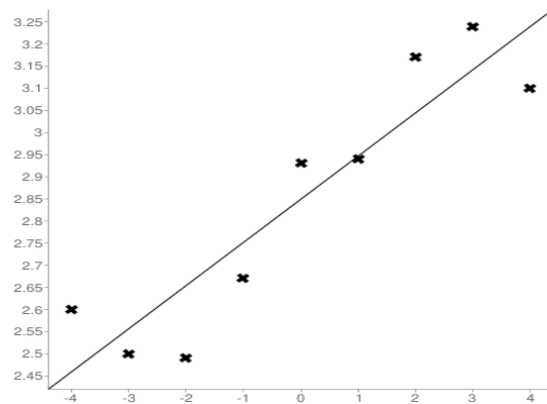


Figure 7: Zimbabwe: Predicted Networked Readiness Index Rankings for 2016 – 2024.

6. SECURE INFRASTRUCTURE FOR NETWORKED READINESS IN SUB-SAHARAN AFRICA

According to Dutta et al. (2015, p29-30) Networked Readiness Index has four sub-indexes, namely, Environmental (political and business), Readiness (infrastructure, affordability and skills), Usage (individual business and government) and Impact (economic and social). In this article, we have selected specific pillars of the sub-indexes which relates directly to security within sub-Saharan Africa. The infrastructure must have appropriate political and business environment to have impact on the population. The infrastructure will include secure

internet server per million population, mobile network coverage (% population), international internet broadband (Kb/s per user) and electricity production (KWh/capita). The Government will have laws relating to ICTs, software piracy rate and intellectual property protection. The business environments will then be able to have the latest technologies and procurement of advance technology products. According to Oriogun, Abaye, Forteta and Shorunke (2015) governments, through ICT regulatory bodies plays a pivotal role in auditing ICT infrastructure projects. This is done through setting national policies, standards, specifications and requirements to govern the execution of projects. Within the context of developing economies, this role cannot be ignored as “best practices”, are yet to be developed in many parts of the industry (p.108).

7. DISCUSSION OF RESULTS

Our predictive models for NRI rankings suggest that on average over the next 9 years, the hierarchical ordering is namely, Mauritius (1st), South Africa (2nd), Zimbabwe (3rd), Namibia (4th), Botswana (5th) and Nigeria (6th) respectively. We observe from Figures 2 – 8 three countries (Botswana NRI = 3.314, Nigeria NRI = 3.203 and South Africa NRI = 3.864) had decreases in average predicted NRI while the other three countries (Mauritius NRI = 4.665, Namibia NRI = 3.512 and Zimbabwe NRI = 3.726) in our investigation had increases in their average predicted NRI. The computed R² of the regression equation of each of these countries indicates the percentage increase or decrease in the total population of the data considered. The increase or decrease of the predicted NRI could be due to population (increase or decrease), political climate and other related factors such as security, business environment and ICT infrastructure environment. Consequently we believe that our predictive models are in line with Oriogun et al. (2015) previous findings, as well as other researchers working on NRI, suggesting that the NRI framework is based on political and regulatory framework of each country as well as the business and innovative environment. Furthermore, the affordability of ICT infrastructure has to match the appropriate knowledge and skills acquisition before the environment is deemed to be at the state of *Readiness*. This same environment has to interact with business, government and individuals in order to have meaningful state of usage of the available ICTs resources (p.34).

8. CONCLUSIONS

Three (Botswana, Mauritius and Namibia) out of the six countries investigated are estimated to have average population of less than 3 million each in the next 9 years. Two (South Africa and Zimbabwe) of the countries investigated have a predicted population average of just under 40 million each. Nigeria has the largest economy in the region, based on our prediction, with estimated population of just over 216 million in 9 years’ time. It is possible that in general, the political and economic environment together with lack of infrastructure investments underpins the low NRI rankings of sub-Saharan Africa compared to countries in developed economies.

In terms of Networked Readiness in sub-Saharan Africa during the period of our investigation, we believe that *data security* will be crucial in three major areas: confidentiality, integrity and availability. Furthermore, we are of the opinion that programmable security infrastructure (software-based security environment) will have the ability to secure dynamically a particularly sensitive data flow across the network on demand and according to the organization’s security policy.

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