Aspects of size and geography of African cyberspace

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ABSTRACT

In this study, data on web links collected from 15 African countries, three with the highest Internet penetration in each of North, West, Central, East and South sub-regions were used to study the number and origins of links to Africa. The sample has a ratio of one Internet user per 12 persons. Altogether, all African countries generated a total of 124,047,702 Web pages and 30,546,967 inlinks to the pages, an average of about 0.25 links per page. The study sample constituted 28% of all the countries in the region, which generated 98,629,700 pages and 21,272,500 inlinks, an average of about 0.21 inlinks per page. South Africa ranked the highest in web pages and web links per population and also received the highest number of inlinks from other African and the G8 countries. However, Kenya linked other African countries more than the others. The study also found that population size does not relate to number of web pages, self-inlinks, and inlinks or penetration, but relates positively with number of Internet users. A major step in boosting use of Internet resources in Africa will be in developing policies that will encourage African countries to use information developed by other African countries.

Keywords: Webometrics; Web presence; Web impact factor; Internet studies; African countries.

INTRODUCTION

Africa is the world's second-largest and second most-populous continent after Asia. With more than 900 million people, Africa accounts for about 14% of the world's human population. Inclusive of all the groups of islands, the continent consists of 57 countries. Given this huge mass of human population, it will be adequate to examine the use characteristics of the region regarding the Internet. A particular interest of this study is the World Wide Web (WWW), a global hypertext system that provides access to documents and allows its contents to be interlinked locally and remotely. The WWW is the largest decentralized but interlinked collection of documents and multimedia content that encourages the participation of many authors to publish information through a large number of web sites.

Many studies have addressed national and international web use characteristics in Africa. Boldi et al. (2002) were the first to initiate web use studies in the continent, with their focus on only nine of the 57 countries. There are other studies that focus on academic uses of the Web. For instance, Nwagwu and Agarin (2006) studied the academic pages of Nigeria, and found that apart from generally very low web presence, Nigerian universities do not link one another other. Onyancha and Ocholla (2006; 2007) studied the web presence and impact of South African universities as well as comparing performance of

South African and Kenyan universities on the WWW. Although these studies may be indicative of web use in the parts of the region, they do not give us a sufficient overview of web size and use characteristics in the continent. An understanding of the structure of web production and use in the region could be enhanced by examining the number of web pages produced by the most visible Internet user countries and number of links from African countries, as well as the links from both African and some developed countries. Extending this understanding to the sub-level domains and in relation to the countries' populations will also improve the understanding of the size and how African countries interlink themselves.

This problem is addressed in this study by the following research questions:

a) What is the size of the African web space?
b) What is the size of the web for the top fifteen Internet using African countries?
c) What is the size of the inlinks from G8 countries and China to the top Internet using African countries?
d) What is the Web Impact Factor of the countries' web?

Why do we need to study national and regional web use of Africa? The Web is a major global information medium that has influenced all aspects of human lives. It is a realistic mirror of the ways in which we work, play and socialize, and its beauty is in the complexity of global community participation. However, an asymmetry has been observed by several scholars about the pattern of supply of information to the Internet which favours the rich North (Nwagwu 2006). National or regional number of Web pages proxies the number of documents produced by a country or region, and linkages to them, to a large extent, proxy the popularity of the documents. The WWW is hypertext-powered, and a link can point to anything - be it personal, local or global, draft or highly polished thus making the Web a great indicator of number and quality of information supplied to the Internet by users including countries and regions. Furthermore, the Web has become an important medium of research and education in many parts of the world. It is widely used as one of the primary means of disseminating research findings (Goodrum et al. 2001; Halliday and Oppenheim 2001; Town et al. 2002). In the same way, both government and private organizations utilize the Web in their activities. Therefore, a systematic evaluation and analysis of links to the Web pages developed in Africa could help us understand how the Internet serves the general populace as well as government, education and organizational purposes. In addition to understanding the pattern of links among African countries, this study infers from link analysis how much of the information developed by African countries is used by the G8 countries.

METHODOLOGY

This study focuses on Africa, a continent that accounts for about 14% of the world's human population. The percentage of African Internet users is 9.03 while Internet penetration is 8.28 (Milliwatts Marketing Group 2008). Generally access to the Internet in this region is very poor, and this is often believed to be due to poor national leadership which leads to poor resource management, with the consequences of low availability of infrastructure and poor utilities supply, among others. There are 57 countries in the region including all the islands. This study adopted a sample survey design to describe the inlinks to Web pages in selected countries in Africa.

The 57 countries were categorized according to the five subregions: Central, East, North,

South and West. Internet usage statistics of all the African countries were retrieved from the Milliwatts Marketing Group (2008) – an organisation that maintains global Internet statistics. From these statistics, we obtained the Internet penetration statistics and the number of Internet users for each country shown in Table 1. Thereafter, for ease of data management, 3 countries in each region with the highest percentage of Internet penetration were selected, yielding the 15 countries listed in Table 2.

Data collection was carried out in June, 2008 using AltaVista, a search engine that presents the documents that the search engine expects one would find most relevant at the top of the list (Spink and Jansen 2004). The following syntax *linkdomain:.A* was used to retrieve all pages that inlink pages within the .A domain. For instance, *linkdomain:.ng* would retrieve all pages that inlink a page within the *.ng* (Nigeria) domain. The syntax *site:* was used to retrieve the number of Web pages indexed per site or domain. To extract the number of external inlinks, the Boolean statement, *linkdomain:.A* NOT *site:.A* was used to report number of Web pages not under .A domain but that link to .A domain. Another Boolean operator, *linkdomain:.A* AND *site:. A*, was used to report the number of Web pages under domain *A* that link to domain *A.*

Using this procedure, data was collected from the fifteen selected countries on the following:

(i) the number of pages in a country's top level and sub-level domains,
(ii) number of inlinks within a domain,
(iii) number of self-inlinks within a domain and
(iv) population of the country.

Given the constraints of establishing the country of origin of sites, we attributed a website to a country if the IP address of that website is assigned to a network physically in that country; in addition to checking if the Web site's suffix is the official one assigned to the country. The data was initially tabulated using an Excel spreadsheet and then transferred to the Statistical Products, Services and Solutions (SPSS) software where descriptive analysis was carried out. Spearman correlation analysis was used to examine the bivariate relationship between pairs of the variables, describing values less than or equal to 0.5 as low and values greater than 0.5 as high.

FINDINGS

Size of African Web Space

Number of Internet Users and Penetration

Table 1 shows that Seychelles has the highest overall Internet penetration (35.4), while Liberia has the lowest (0.03), values for Western Sahara and Mayotte were not available. Nigeria has the largest number of Internet users while Mayotte recorded only one Internet user. It can be further seen from Table 1 that African countries generated a total of 124,047,702 web pages and 30,546,967 inlinks to the pages, an average of about 0.25 links per page. South Africa has the highest number of web pages as well as the highest number of web links, while Western Sahara has the lowest in each case. At the subregional level, Southern Africa subregion has the highest number of both links and pages while the West has the lowest of both. Southern Africa received 19,615,964 inlinks, 64.2% of the total inlinks received by Africa, Central Africa received 4,796,760 (15.7%), North Africa received 2,983,211 (9.8%), East received 1,859,430 (6.08%) and West 1,291,602 (4.2%). Table 1 illustrates these findings.

Table 1: Internet Penetration, Number of Users and Inlinks of African Countries

Countries	Region	Penetration	No of Internet users	Total pages	Inlinks
Sao Tome and Principe	Central	14	6500	5900000	3420000
Angola	Central	8.7	700000	1470000	217000
Congo DR	Central	0.3	180000	921000	925000
Rwanda	Central	0.7	65000	355000	81600
Gabon	Central	5.6	81000	122000	25200
Cameroon	Central	2.0	370000	116000	107000
Equatorial Guinea	Central	1.5	8000	25800	2490
Congo	Central	1.9	70000	21700	11200
Central African Rep.	Central	0.3	13000	1370	5430
Chad	Central	0.6	60000	93	1840
Seychelles	East	35.4	29000	900000	556000
Uganda	East	2.5	750000	1660000	390000
Kenya	East	7.5	2770300	1300000	331000
Djibouti	East	2.2	11000	508000	235000
Tanzania	East	1.0	384300	917000	185000
Ethiopia	East	0.2	164000	417000	75300
Burundi	East	0.7	60000	99700	43500
Sudan	East	8.6	3500000	172000	35700
Somalia	East	0.8	94000	3	4650
Eritrea	East	2.0	100000	12000	3280
Egypt	North	7.5	6000000	4970000	934000
Algeria	North	7.4	2460000	953000	163000
Libya	North	3.8	232000	218000	133000
Morocco	North	18.1	6100000	5620000	1380000
Tunisia	North	15.7	1618440	2180000	373000
Western Sahara	North	n/a	n/a	0	211
Botswana	South	3.3	60000	888000	152000
Comoros	South	3.0	21000	5150	3810
Lesotho	South	2.4	51500	165000	31800
Madagascar	South	0.6	110000	570000	106000
Malawi	South	0.4	59000	182000	47800
Mauritius	South	24	300000	2340000	716000
Mayotte	South	n/a	n/a	1	154
Mozambique	South	0.9	178000	548000	90900
Namibia	South	3.9	80600	1030000	219000
Reunion	South	27.4	220000	396000	159000
Saint Helena	South	13.3	1000	1420000	747000
South Africa	South	11.6	5100000	80600000	16900000
Swaziland	South	3.7	41600	380000	68500
Zambia	South	4.4	500000	607000	119000
Zimbabwe	South	9.9	1200000	803000	255000
Benin	West	8.7	700000	70000	35000
Burkina Faso	West	0.6	80,000	529000	131000
Cape Verde	West	6.8	29000	422000	63400
Cote D'Ivoire	West	1.6	300000	301000	86600
Gambia	West	4.9	82300	267000	58400
Ghana	West	2.7	609000	440000	107000
Guinea	West	0.5	50000	89100	12600
Guinea-Bissau	West	2.5	37000	485	602
Liberia	West	0.03	1000	89400	28900
Mali	West	0.7	88400	166000	42200
Mauritania	West	3.1	100000	316000	62600
Niger	West	0.3	40000	85100	165000
Nigeria	West	5.9	8000000	726000	147000
Senegal	West	5.2	650000	1570000	315000
Sierra Leone	West	0.2	10000	89400	14300
Togo	West	5.6	320000	93400	22000
Total		4.7	44845940	124047702	30546967

Table 2: Fifteen African Countries with High Internet Penetration

Country	Population 2007	Internet Users 2007	(%) Penetration (P)	(%) Users (U)
Seychelles	81895	29000	35.40	0.10
Morocco	33757175	6100000	18.10	13.80
Tunisia	10276158	1618440	15.70	3.60
South Africa	43997828	5100000	11.60	11.50
Zimbabwe	12311143	1220000	9.90	2.80
Benin	8078314	700000	8.70	1.60
Sudan	39379358	3500000	8.60	7.90
Egypt	80335036	6000000	7.50	13.60
Kenya	36913721	2770300	7.50	6.30
Cape Verde	423613	29000	6.80	0.10
Nigeria	135031164	8000000	5.92	18.10
Gabon	1454867	81000	5.60	0.20
Zambia	11477447	500000	4.40	1.10
Cameroon	18060382	370000	2.00	0.80
Congo	3800610	70000	1.90	0.20
	435378711	36087740	8.28	9.03

Source: Miniwatts Internet Marketing Study (2008).

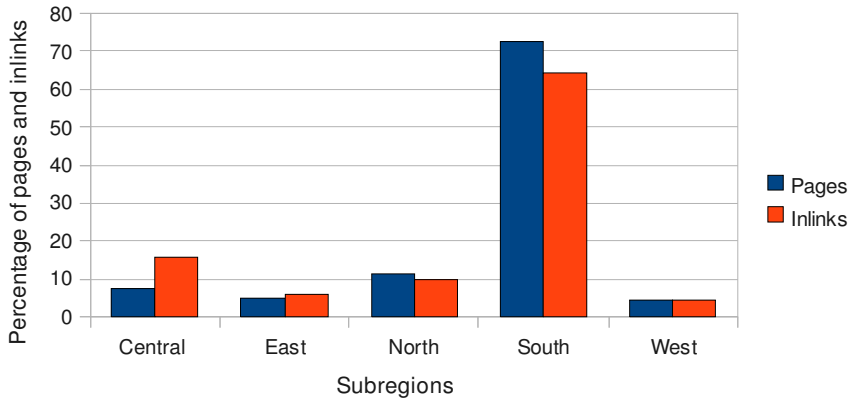

Figure 1: Percentage of Pages and Inlinks by Subregions

In the Central subregion, Sao Tome and Principe have the highest Internet penetration, the lowest number of Internet users, the highest number of web pages and inlinks, while Central African Republic and Chad have the lowest Internet penetration and number of web pages respectively. Angola has the highest number of Internet users. In the Eastern subregion, Seychelles has the highest Internet penetration as well as the highest number of inlinks; the lowest penetration is in Ethiopia while the lowest number of inlinks is from Eritrea. Sudan has the highest number of Internet users, while Djibouti has the lowest; Uganda is at the top in terms of web pages while Somalia closes the list.

In the Northern subregion, Morocco has the highest Internet penetration as well as the highest number of Internet users, web pages and inlinks while Western Sahara has the lowest penetration, the lowest number of pages and lowest number of inlinks. In the Southern subregion, the Reunion has the highest Internet penetration, while Mayotte trails the list in all the variables. South Africa tops the list in respect of number of Internet users, number of web pages and number inlinks. In West African subregion, the Internet has penetrated Benin more than it has other countries, the lowest being Liberia. Nigeria ranks topmost in terms of number of Internet users, while the lowest is also Liberia. Senegal has the highest number of web pages as well as the highest number of inlinks while Guinea Bissau has the lowest in of inlinks and web pages.

Size of the Web Space of Top Fifteen African Countries

Number of Internet Users and Penetration

Table 2 shows that the fifteen countries in the study have a total population of 435,378,711 and 36,087,740 Internet users, a ratio of about one Internet user for every 12 persons. In respect of their individual country populations, Seychelles, Morocco, Tunisia and South Africa have the highest penetration (>10%), while Congo and Cameroon have the lowest, 2 or less. But, Nigeria, Morocco, Egypt and South Africa present the highest number of Internet users (>10%) while Cape Verde, Seychelles, Congo, Gabon and Zambia have less than one percent number of their populations using the Internet. At the subregional level, the northern sub-region has the highest proportion of Internet users (10.30%) while the central has the lowest (0.4%); penetration is highest in the east (17.16%) and lowest in the central (3.16%).

Distribution of Web Pages

With regards to distribution of web pages**,** the 15 countries in the study, or 28% of all the countries in the region, generated 98,629,700 pages and 21,272,500 inlinks, an average of about 0.21 inlinks per page. Further, the sample covered 79.51% of the total African web pages and 69.64% of the inlinks. It is very significant that 15 of the 57 countries in the region accounted for about 8 out of every 10 Web pages. Table 3 shows that Southern Africa sub-region leads other sub-regions in the production of Web pages accounting for 83.14%, about five times the number of Web pages contributed by all other sub-regions in total. Within the Southern Africa sub region, South Africa is responsible for over 98% of the Web pages, while Zimbabwe and Zambia share less than 2%. In the whole sample, South Africa is the highest producer of Web pages in comparison with other countries, generating 80,600,000 Web pages or 81.72% of the total number of Web pages produced by the fifteen countries in the region. The Northern Africa sub-region namely Morocco, Egypt and Tunisia contributed 12.97%, with Morocco (5.70%) leading, followed by Egypt (5.04%) and Tunisia (2.21%). The three countries in the East African sub-region contributed only 2.40% of the Web pages: Kenya accounted for 1.32%, with Seychelles and Sudan making less than significant inputs (0.91% and 0.17%) each. Although Nigeria leads the rest of West African countries in terms of number Web pages produced, it contributed only 0.74% of the total web pages to the 1.28% made by the West Africa sub-region. The Central African countries contributed 0.26%, with Gabon leading; Cameroon (0.12%) and Congo (0.02%) ranked the

lowest in the number of web pages both at the sub-regional and national levels.

Table 3: Distribution of the Web pages by Countries (Percentage)

Country	Total pages	.edu	.gov	.org
Benin	0.07	0.00	0.22	0.01
Cameroon	0.12	0.00	0.33	0.00
Cape Verde	0.43	0.02	0.05	0.00
Congo	0.02	0.02	0.00	0.02
Egypt	5.04	8.27	17.63	19.69
Gabon	0.12	0.00	0.06	0.00
Kenya	1.32	1.76	2.02	1.29
Morocco	5.70	3.67	7.13	1.63
Nigeria	0.74	1.32	2.77	0.72
Seychelles	0.91	0.01	0.11	0.00
South Africa	81.72	83.77	66.03	74.07
Sudan	0.17	0.10	1.39	0.03
Tunisia	2.21	0.00	2.11	1.60
Zambia	0.62	0.02	0.00	0.00
Zimbabwe	0.81	1.03	0.16	0.95

At the sub-level domain, there were 6,401,162 pages in the .org, .gov and .edu sub-domains. The frequency distribution of the pages by sub-domains showed that 40.07% was organizational, 33.43% was educational while 26.50% was governmental pages. South Africa has the highest educational (83.77%), governmental (66.03%) and organizational (74.07%) web pages. Excluding Egypt, which has 8.27% of educational, 17.63% of governmental and 19.69% of organisational web pages, most of the countries had less than 10% of links to their educational, governmental and organizational web pages. Congo and Zambia have zero links to their governmental pages; the web pages of Gabon, Benin, Cameroon and Tunisia did not receive any links just as Gabon, Cameroon, Seychelles, Zambia and Cape Verde have no links to their web pages.

Distribution of Web Pages per Population

The study attempted to gain an understanding of the number of web pages that could be attributed to an individual in the region by constructing the ratios of web page per population. Generally, at the regional level, an African accounts for 0.28 web pages each. By sub-regions, Table 4 shows that South Africa has the highest number of Web pages. East Africa has the highest educational pages per population as well as the highest number of organizational pages per population. North Africa followed South Africa in terms of the magnitude of total Web pages, inlinks Web pages, organizational, government and educational Web pages. West Africa ranked third in terms of total web pages, but it has higher number of organisational pages per population than the North. The Central sub-region is the lowest in all terms, and has almost a zero number of government Web pages per population.

Table 4: Web Pages per Population (Percentage)

Country	Total Web pages	.edu	.gov	.org
Benin	0.01	0.00	0.01	0.04
Cameroon	1.44	0.00	0.00	0.01
Cape Verde	5.22	0.01	0.01	0.01
Congo	0.27	0.01	0.00	0.13
Egypt	61.52	3.38	0.01	134.67
Gabon	1.51	0.01	0.01	0.00
Kenya	16.09	0.72	0.01	8.83
Morocco	69.57	1.50	0.01	11.17
Nigeria	8.99	0.54	0.00	4.91
Seychelles	11.14	0.01	0.02	0.01
South Africa	997.73	34.21	0.03	506.67
Sudan	2.129	0.04	0.01	0.18
Tunisia	26.99	0.00	0.01	10.93
Zambia	7.51	0.01	0.00	0.00
Zimbabwe	9.94	0.42	0.00	6.48

By country Table 4 shows further that South Africa continues to lead in terms of the total Web pages, inlinks, educational, organizational and governmental Web pages per population. Morocco, Egypt and Tunisia, all North African countries, followed in terms of total number of Web pages per population although the difference with South Africa's figure is very high. In terms of inlinks, Seychelles ranked next to South Africa whereas Egypt followed South Africa in terms of Web pages found.

Still on per population statistics, and respecting the sub-level domains, educational pages per population are generally very low. However, South Africa still outranked all other countries in Africa, having 211 educational pages per person. Apart from Egypt and Morocco, which have more than unit number of educational pages per person in their populations, Gabon, Benin, Cameroon and Tunisia have zero educational pages while the others have fractional number of Web pages. Although the pattern of proportion of government pages per population follows same trend across the region, these indices appear by far much lower than others. The highest government pages per person could be observed in South Africa which however has as negligible as about 4000 persons for one government web page. South Africa still has higher ratio of organizational than educational and government pages per population; organizational population page ratio in Egypt and Morocco followed; but Zambia, Gabon and Cape Verde have zero organizational Web pages per population.

Distribution of Inlinks

The distribution of inlinks to African countries' web pages was also investigated and shown in Table 5. The fifteen countries in the sample received a total of 21,272,500 inlinks. By sub-regions, Southern Africa received 81.20% of the total inlinks, Central Africa (15.70%), North Africa (9.8%), Eastern sub-region (6.08%) and West (4.20%). By country, South Africa also leads in the number of inlinks, compared to any other country, receiving 82.14% of the total 21,272,500 inlinks to Africa. This figure is three times higher than the number of inlinks

received by all other African countries added together. Apart from Morocco (5.95%), Egypt (4.50%), Tunisia (2.20%) and Kenya (1.33%), the rest of the countries received less than one percent of the total inlinks to Africa.

Table 5: Distribution of Inlinks by Country (Percentage)

Country	Inlinks	.edu	.gov	.org
Benin	0.08	0.00	0.71	0.01
Cameroon	0.11	0.01	0.24	0.00
Cape Verde	0.39	0.02	0.05	0.00
Congo	0.04	0.00	0.01	0.00
Egypt	4.50	3.44	14.50	19.07
Gabon	0.12	0.00	0.06	0.00
Kenya	1.33	1.32	3.00	1.50
Morocco	5.95	0.00	7.70	2.71
Nigeria	0.79	1.23	2.79	0.24
Seychelles	0.74	0.03	0.23	0.01
South Africa	82.14	93.47	65.81	73.01
Sudan	0.19	0.10	0.98	0.01
Tunisia	2.20	0.00	1.28	1.72
Zambia	0.60	0.04	1.24	0.74
Zimbabwe	0.82	0.34	1.41	

Of the inlinks received by the fifteen African countries, 6,511,625 (75.00%) of the inlinks were distributed to sub-level domain as follows: organizational 41.85%, governmental (27.53%) and educational (30.60%). Inlinks to South African educational pages (93.47%) were almost 100 times that of any other country. Benin, Congo, Morocco and Tunisia have zero educational inlinks, whereas Cameroon, Cape Verde and Congo also have zero government inlinks.

Distribution of Inlinks per Population

Seychelles has the largest number of percentage of number inlinks per person in comparison with other countries (Table 6). The rest of the countries have fractional percentage of inlinks per population. Egypt has the highest inlinks to its domains while Congo has the lowest (Table 7).

Table 6: Inlinks per Population (Percentage)

Country	Inlinks per population	Country	Inlinks per population
Benin	0.01	Nigeria	0.01
Cameroon	0.02	Seychelles	6.76
Cape Verde	0.14	South Africa	0.17
Congo	0.01	Sudan	0.01
Egypt	0.01	Tunisia	0.04
Gabon	0.02	Zambia	0.01
Kenya	0.01	Zimbabwe	0.02
Morocco	0.04		

Table 7: The Distribution of Self Links in the Selected Countries (Percentage).

Country	Total	Education	Government	Organisation
Benin	6760	375	452	1
Cameroon	9300	0	9,851	51
Cape Verde	33600	0	1,040	0
Congo	3600	12700	12,100	2250
Egypt	390000	339	14,120	9300
Gabon	10400	2	6	0
Kenya	115000	0	15,465	25904
Morocco	516000	2490	2,400	10000
Nigeria	68,700	180	3,110	29
Seychelles	64100	670	10,960	81
South Africa	7120000	1543890	1026000	997000
Sudan	16100	2	2,030	11
Tunisia	191000	72	78,000	42,800
Zambia	52000	13,800	23,200	12,901
Zimbabwe	71400	36,600	145,000	284,000
Total	8667960	1611120	1343734	1384328

Distribution of Self-inlinks and External Inlinks among the African Countries

We constructed a matrix to understand the nature of inlinks amongst the 15 countries. The result is shown in Table 8. Reading the table from rows to columns, the figures at the intersections signify the number of external inlinks from countries of origin of the external inlinks (rows) to the countries of destination of the external inlinks (columns). The figures in the diagonal represent the total number of self-inlinks received by the countries, with the indication that the fifteen countries created a total of 8,667,960 self-inlinks.

South Africa has the highest number of external inlinks (25,862) from all other African countries in the study. It is inlinked by Kenya the most (20,200) and by Congo the lowest (16). Zimbabwe has the next highest number of external inlinks (3,430) from other African countries, inlinked mainly by South Africa (3,290), but having no inlinks from Cape Verde, Benin, Sudan, Cameroon and Gabon. It received two or less inlinks from the other countries. In terms of total number of links, Kenya, with 20,401 links, has the highest number of inlinks to other African countries, followed by South Africa (5,000), Zimbabwe (3,096), Egypt (1,161), Morocco (1,029) and Zambia (1,017) while Cape Verde, Congo and Gabon sought for information from other African countries the lowest. However, over 99% of Kenya's links were to South Africa, while making zero links to Cameroon, Gabon and Zambia. In terms of consistency of links to all the countries in Africa, Morocco made at lowest one link to each of the Africa countries in the study although its total number of links is less than that of Kenya. Nigeria and South Africa are the only countries that received at lowest a single inlink from each of the countries; although Nigeria's inlinking magnitude is by far less than that of South Africa. Morocco was inlinked by all except Cape Verde. Cameroon (12) received the lowest number of inlinks from other countries while Cape Verde (30) made the lowest number inlinks to other countries.

Table 8: Distribution of Self-inlinks among African Countries

Country	.ng	.cv	.bj	.cg	.cm	.ga	.ke	.sd	.sc	.eg	.tn	.ma	.zm	.zw	.za	Total
.ng	68700	0	1	1	0	0	13	1	2	5	0	9	2	1	180	215
.cv	2	33600	0	0	0	0	0	0	0	1	0	0	0	0	27	30
.bj	1	0	6760	4	4	1	1	0	0	0	0	1	0	0	123	135
.cg	1	0	2	3600	4	0	2	0	1	2	0	8	1	1	16	38
.cm	1	0	2	5	9300	0	2	0	0	1	8	31	2	0	54	106
.ga	2	0	0	1	0	10400	0	0	0	1	0	10	0	0	73	87
.ke	11	1	1	1	0	0	115000	3	9	10	1	13	136	15	20200	20401
.sd	2	0	0	0	0	0	1	16100	0	13	0	3	0	0	131	150
.sc	4	0	0	1	0	0	4	2	64100	2	0	23	1	2	89	128
.eg	3	0	0	2	1	0	8	8	4	390000	49	234	1	1	850	1161
.tn	4	3	0	4	1	16	1	2	0	121	191000	293	1	2	58	506
.ma	8	5	2	11	1	13	9	4	13	149	466	516000	2	2	344	1029
.zm	3	0	0	1	0	0	22	3	2	2	2	9	52000	116	857	1017
.zw	2	0	0	1	0	0	20	1	9	2	1	8	192	71400	2860	3096
.za	59	7	6	9	1	0	538	8	138	239	24	199	482	3290	7120000	5000
Total	103	16	14	41	12	30	621	32	178	548	551	841	820	3430	25862	**33099**

Key: *.ng =Nigeria, .cv = Cape Verde, .bj = Benin, .cg = Congo, .cm =Cameroon, .ga = Gabon, .ke = Kenya, .sd = Sudan, .sc = Seychelles, .eg = Egypt, .Tn = Tunisia, .ma = Morocco, .zm = Zambia, .zw = Zimbabwe, .za = South Africa.*

External Links from the G8 Countries and China to Africa

The G8 countries and China altogether created 10,141,734 inlinks to Africa. Table 9 shows that the United States has the highest percentage of links to Africa, followed by UK, Germany, Canada and Italy. Four countries, Russia, France, Japan, and China, have very low number of links, which probably mirror the order of relationship that these countries have with Africa in comparison with the other countries. China had the lowest percentage of inlinks to the region, but has its highest linkage to Sudan, a country it recently shares so much in respect of oil exploration and other investments.

Table 9: External links from the G8 countries and China (by percentage)

Country	USA	Canada	UK	France	Japan	Germany	Russia	Italy	China	Total
Benin	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.04
Cameroon	0.32	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.34
Cape Verde	0.09	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.11
Congo	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02
Egypt	2.45	0.02	0.00	0.01	0.01	0.03	0.01	0.01	0.01	2.55
Gabon	0.07	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.07
Kenya	1.33	0.01	0.08	0.01	0.01	0.02	0.01	0.01	0.01	1.47
Morocco	1.91	0.03	0.12	0.08	0.03	0.04	0.01	0.01	0.01	2.25
Nigeria	0.42	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.48
Seychelles	1.95	0.01	0.04	0.01	0.00	0.02	0.01	0.01	0.02	2.06
South Africa	81.54	3.32	2.47	0.17	0.26	0.01	0.16	0.01	0.01	87.96
Sudan	0.07	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.10
Tunisia	0.51	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.56
Zambia	0.53	0.01	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.57
Zimbabwe	1.12	0.01	0.26	0.01	0.01	0.01	0.01	0.01	0.01	1.42
Total	92.37	3.42	3.08	0.29	0.33	0.17	0.21	0.08	0.05	100

The distribution of external inlinks from each of the G8 and China to specific African countries can also be gleaned from Table 9. Apart from having the highest percentage of links to the region, the United States of America has percentage of links to any country in the region than any of the other G8 country. Except for the United Kingdom and Japan which had zero links to Egypt and Seychelles, other G8 countries, including China, consistently linked all the fifteen countries in our study.

Web Impact of the Links

The web impact factor of the links was calculated using the formula:

$$\textit{Web impact factor} = \frac{\textit{Number of links}}{\textit{Number of pages}}$$

The overall web impact factor for Africa is 0.25. For the fifteen countries in the study, the overall web impact factor = 0.22, self web impact factor =0.09 and external web impact factor=0.73. Table 10 shows the detail for each of the countries. Cameroon has the highest overall impact factor while Cape Verde has the lowest.

Table 10: Web Impact of African Countries

Country	Overall WIF	Self-inlink WIF	External inlink WIF
Benin	0.50	0.10	0.50
Cameroon	0.92	0.08	2.08
Cape Verde	0.15	0.08	0.06
Congo	0.52	0.17	0.31
Egypt	0.19	0.08	0.11
Gabon	0.21	0.09	0.10
Kenya	0.26	0.09	0.16
Morocco	0.25	0.09	0.15
Nigeria	0.20	0.10	0.09
Seychelles	0.62	0.07	0.54
South Africa	0.21	0.09	0.86
Sudan	0.21	0.09	0.11
Tunisia	0.17	0.09	0.09
Zambia	0.20	0.09	0.09
Zimbabwe	0.32	0.09	0.21
Overall	0.22	0.09	0.73

Self-inlink impact factor is generally very low among the countries, but is highest with Congo while the lowest is Seychelles. On its own, external inlink impact factor is highest with Cameroon while the lowest externally inlinked is Cape Verde. At the sub-regional levels, the central region has the highest impact factor 0.536 while the North had the lowest impact factor 0.213. The values for East, South and West Africa were 0.310, 0.218 and 0.323 respectively.

Further Statistical Analysis

Using Spearman rank correlation analysis, bivariate correlation was sought between pairs of population, Internet users in the countries, web pages, inlinks, self-inlinks, educational inlinks, government inlinks, organizational inlinks, educational self-inlinks, government self-

inlinks, organisational self-inlinks, African inlinks and Internet penetration. The lowest correlations are between penetration and population (0.02), penetration and educational links (0.029), and penetration and educational links (0.09).

Also, population has a low correlation with number of web pages and with self-inlinks; Internet users also has a similar low correlation with educational self-inlinks just as self-inlinks with educational inlinks and educational self links. All other correlations are above 0.5. Internet users and population, inlinks and web pages, links from Africa to other African countries and web pages, inlinks and organisational inlinks, organisational self-inlinks and government inlinks have very high correlations. Inlinks to a country in Africa from all sources and total number of inlinks from countries in Africa to any African country shows a significant and high correlation. Self-inlinks have low correlations with population and with number of Internet users, and also with educational inlinks as well as educational self-inlinks. Correlation between self-inlinks and other variables is high. Correlations between educational inlinks, governmental inlinks, organizational inlinks, educational self-inlinks, governmental self-inlinks, organizational self-inlinks and Africa inlinks, and any other variable are high.

Table 11: Some Correlation Analysis

	Popula-tion	Internet users	Web pages	Inlinks	Self links	Edu. Inlinks	Gov. inlinks	Org. inlinks	Edu. self-inlinks	Gov. self-inlinks	Org. self-inlinks	Africa Inlinks	Penetra-tion
1	1.000	0.91	0.48	0.53	0.44	0.70	0.81	0.67	0.69	0.83	0.66	0.52	0.016
2		1.00	0.54	0.66	0.46	0.50	0.87	0.78	0.46	0.87	0.77	0.65	0.286
3			1.00	0.91	0.79	0.71	0.79	0.77	0.64	0.79	0.78	0.91	0.556
4				1.000	0.79	0.59	0.87	0.90	0.52	0.83	0.88	0.59	0.615
5					1.00	0.48	0.73	0.73	0.44	0.71	0.75	0.78	0.567
6						1.00	0.66	0.55	0.99	0.70	0.56	0.58	0.091
7							1.00	0.96	0.62	0.98	0.96	0.86	0.433
8								1.00	0.52	0.92	0.99	0.90	0.549
9									1.000	0.66	0.52	0.52	0.029
10										1.00	0.93	0.83	0.384
11											1.000	0.88	0.533
12												1.00	0.615
13													1.000

DISCUSSION AND CONCLUSION

Miniwatts Marketing Group reported that 3.5% of Africans had access to the Internet as at 2008, and that the continent achieved a penetration of 4.7. Our study shows that the top 15 countries achieved a penetration of 8.28 and about 9% of users. These figures could still be considered very low, considering that the countries where web pages or inlinks were either not discernible or very low such as Western Sahara, Mayotte, Somalia, Chad and Guinea Bissau were excluded from the study. Seychelles, Morocco, Tunisia and South Africa have the highest penetration, achieving a penetration greater than 10, while Congo and Cameroon have the lowest. In terms of proportion of Internet users, Nigeria, Morocco, Egypt and South Africa topped other countries, while Cape Verde, Seychelles, Congo, Gabon and Zambia have less than one percent of their populations using the Internet. The

Western sub-region has the highest number of Internet users, while the Central has the lowest number of Internet users and the lowest penetration; the East and North have the highest penetration.

South Africa accounts for a major proportion of web pages produced in Africa, posting almost five web pages for each web page developed in the whole of the region. Although most of the countries in the sample are French speaking, the English-speaking countries, led mainly by South Africa, accounts for much of the web pages in the region. At the sub-level domain, organizational pages accounted for much of the web pages, followed by governmental web pages. Ironically, educational web pages are the lowest in volume, and many of them come from South Africa. Benin, Cameroon, Gabon and Tunisia, all French speaking countries, did not provide any educational pages; all countries except Congo, had governmental web pages. Cape Verde, Zambia, Seychelles, Cameroon and Gabon had no organizational web pages.

South Africa has such a huge number of web pages that outstrips its population by more than 900 times. South Africa also has a huge number of organizational pages per population, probably signifying a high level of deployment of the infrastructure for organizational activities. Zimbabwe, South Africa and to a lesser extent Congo have higher inlinks from other African countries than the inlinks they made to other African countries. Although all the countries received inlinks to their web pages, South Africa also dominated the inlinks to the region accounting for more than 82% of the whole, and this is the situation at educational, governmental and organizational domain levels. Organizational inlinks outnumbered both educational and governmental inlinks. The study showed that countries from the Southern sub-region have higher number of links to countries close to them compared to countries from the West region which have very few links to countries from the same subregion. The study also showed that the education sub-domain has a higher number of links originating and terminating in the same domain than the two other sub-domains while the government sub-domain had the lowest number of self-inlinks. The government probably creates web pages in anticipation that other people than the government would use them.

The study also investigated the nature of inlinks to African countries from other African countries. Comparing the total self-inlinks with the links to the individual countries from African countries only shows that African countries seldom link other African countries as much as each country links itself. By implication, electronic information produced by African countries are seldom consumed by countries in Africa, except, to some extent, by the individual countries creating the links. South Africa and Zimbabwe appear to be exceptions to this observation being major recipients of inlinks from other African countries. Kenya and South Africa also stand out somehow, because they made substantial inlinks to other African countries more than the other countries. In terms of consistency in inlinks, Nigeria and South Africa were the only countries that received inlinks from all the countries in the study, although the volume of inlinks to Nigeria is by far less than that of South Africa. Generally African countries made inlinks to other African countries more than they received from other African countries.

On the inlinks from the G8 and China, USA inlinked the region and the individual countries the most; but a huge proportion of these links go to South Africa. Inlinks from the G8 countries are, by far, higher than inlinks to African countries from other African countries. A significant inference from this result is the possibility that African information may achieve a very wide patronage if the information is adequately organized and marketed.

Generally, Africa has fractional web impact factors, a result that has implication that the web pages produced by Africa are either redundant or hardly ever accessed by anyone. By further implication, the information contained in the pages are not accessed and used by those for whom they are created. This result corroborates Nwagwu and Agarin (2006) which showed in a study on web link analysis of Nigerian universities that the universities do not link themselves, and are also seldom linked by anyone at all. This situation is repeated at country levels, except that Congo appears to be more inward looking in terms of self-inlinks than the other countries. The first four countries with the highest overall impact factors: Cameroon, Seychelles and Congo, and the two with highest self inlink impact factors: Congo and Benin are French speaking, while the highest external impact factor is recorded by bilingual Cameroon. Generally the low web impact has great significance in view of several observations and projects aimed at enhancing South-North information flow (Nwagwu 2008; Arunachallam 2007). The low impact factors suggest low Internet use of the web resources created by African countries.

The correlation analysis shows that large population does not necessarily result to a large number of web pages, self-inlinks, and inlinks from African countries or Internet penetration. A country with large population, for instance, will not necessarily be guaranteed of the Internet users in that country creating web pages of their own or linking web pages created in their countries. In the same way a large size of Internet users in a country will not suggest that the users use the Internet for educational purposes, neither does heavy self-linking necessarily suggest that linkers are using the facility for educational purposes.

However, there is high likelihood that higher population will lead to higher number of Internet users. The low correlation between educational links and number of Internet users might imply that high number of Internet users does not amount to use of the Internet for educational purposes, or production of educational information. Number of Internet users also has a low correlation with penetration, because Internet users relate to absolute number of persons using the Internet whereas penetration relates this number to the population of the country.

Generally our result suggests low web page creation and low use of the resources in the web pages that are created. The low or non-use of African pages raises several issues? For instance, Nwagwu (2008) has suggested that merely embarking on projects that put African information online will not guarantee that the information will be used by anyone, not even by people at home. There is need therefore to examine reasons for non-use of African electronic information on the web, including quality of resources that are deposited in the websites and the content of the websites. It is also appropriate for scholars to start

engaging on studies that address the nature of the new forms of digital divide engendered by the use characteristics of the Internet in view of many speculations that Internet may be of immense benefit to the developing regions. It is also appropriate to start examining how Africans, their countries and institutions themselves account for the low status accorded to the region in international information production and the pattern of information creation and consumption in the web. The high correlation between inlinks to an African country from all sources and the total number of inlinks from countries in Africa would suggest that African countries that are inlinked by other African countries are most likely to also be inlinked by other than African countries.

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