Scientometric Analysis of Research Performance of African Countries in selected subjects within the field of Science and Technology

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Abstract.
This paper assessed the performance of African countries in selected field of Science and Technology (S&T) over the last twenty years. The purpose was to determine the readiness of these countries in aligning to the strategic direction set by African Union (AU 2063) Agenda. The AU 2063 aims to emplace a paradigm shift from the current structure where its members’ dependents on natural resources to drive their economies to one that is knowledge-based. It thus set pillars for archiving this feat and they include; building and/or upgrading research infrastructures; enhancing professional and technical competencies; promoting entrepreneurship and innovation; and providing an enabling environment for STI development in the African continent. Data used for the study were retrieved from the SCImago database which comprises a total of Seven (7) subject areas cutting across one hundred and twenty-six (126) subject categories. In SCImago database, information was also searched on S&T performances with respect to publications in the World and Africa, over the last 20 years period starting from 1996-2015. Microsoft Excel was used to analyse the data collected. Results were presented in tables and figures on the top 10 most productive African countries in the field of S&T in all the seven selected subject areas. The paper suggested an intra-African collaborative effort between low and high performing countries in Africa as an option for developing the needed knowledge capacities for realising its regional developmental Agenda (AU 2063).

Keywords: Scientometrics, Performance, Science and Technology.

1 Introduction
African leaders have seen the need to emplace the continent on a pedestal aimed towards self-reliance capable of promoting economies of its member states that is more sustainable and in tune with what is obtainable in the developing world. In 2014, to re-affirm its vision of “an integrated, prosperous and peaceful Africa, an Africa driven and managed by its own citizens and representing a dynamic force in the international arena”, the African Union under its AU Agenda 2063 recognized Science, Technology and Innovation (STI) as multi-functional tools and enablers for achieving continen-
tal development goals, hence, initiated the Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024). The STISA-2024 is the first of the ten-year incremental phasing strategies to respond to the demand for science, technology and innovation to impact across critical sectors such as agriculture, energy, environment, health, infrastructure development, mining, security and water among others. The strategy is firmly anchored on six distinct priority areas that contribute to the achievement of the AU Vision. These priority areas are: Eradication of Hunger and Achieving Food Security; Prevention and Control of Diseases; Communication (Physical and Intellectual Mobility); Protection of our Space; Live Together- Build the Society; Wealth Creation. The strategy further defines four mutually reinforcing pillars which are considered as prerequisite conditions for its success. These pillars include: building and/or upgrading research infrastructures; enhancing professional and technical competencies; promoting entrepreneurship and innovation; and providing an enabling environment for STI development in the African continent. It anticipates that continental, regional and national programmes will be designed, implemented and synchronized to ensure that their strategic orientations and pillars are mutually reinforcing, and achieve the envisaged developmental impact as effectively as possible.

Every positive-oriented society today needs skilled and talented individuals to generate new ideas, products, processes and commercial enterprises. Therefore, existing studies have shown that accessing performance on the basis of STI, African countries performance is rated poorly if measured on indicators as tertiary education institutions, intellectual property and innovativeness and productivity and competitiveness [1]. This position was also supported and explained by the United Nations Economic Commission for Africa (UNECA) in its African Science, Technology and Innovation Review 2013 report document. The review was done to assess STI status and performance in the African context with a view to describing the innovation ecosystem in Africa. It looks at the innovation value chain from the perspective of training and research and development; technology development, acquisition, use and application.

In the last decade, Africa has recorded an annual growth rate of about 15 percent in terms of enrolment rate in tertiary institutions while in 2008, the figure for Sub-Saharan African countries on this same indicator was only 6 per cent which is lower when compared with statistics on other continents Asia (26%), Latin America and the Caribbean (38%). Furthermore, in terms of researchers involved in R&D, Africa performance is still relatively poor. For instance, in a survey conducted in 13 countries by African Science, Technology and Innovation Indicator Initiative (ASTII), the result shows that more than half of these countries have fewer than 1000 R&D researchers in total. However, only Gabon, Senegal and South Africa have more than 20 per cent of their total R&D personnel with PhD qualifications while Mozambique and Kenya reported less than 2 percent for this indicator [2].

To ascertain this claims, different tool for assessing performance and productivity of a system like Scientometrics can be employed. Though there are other tools for assessing scientific production, however, scientometric is very useful for this purpose.
In the field of Science and Technology Studies (STS), Scientometrics is a useful tool for measuring the scientific and technological performance of a knowledge system. Scientometrics is done as a measurement of scientific publications using a method referred to as Bibliometrics [3]. Scientometrics is restricted to the measurement of science communications, whereas Bibliometrics is designed to deal with more general information processes [4]. Scientometrics is for science what econometrics is for economics [5]. The advent of journal Scientometrics in 1978 from a research unit in the Hungarian Academy of Science and Scientific conferences, led to the development of Scientometrics as a discipline [6]. They stated that it was developed around one core notion (citations) though the discipline can study (to some extent) many aspects of the dynamics of science and technology. The citation is not only important in Scientometrics but provide a quantitative metrics for measuring research impact. Mingers and Leydesdorff further buttress this position and stated that “The act of citing another person’s research provides the necessary linkages between people, ideas, journals and institutions to constitute an empirical field or network that can be analyzed quantitatively”.

This paper seeks to use Scientometrics to analyze research performance of African countries in selected subjects within the field of S&T.

2 Methodology

The research was designed based on the need to find the best approach that could lead to a logical route to addressing the objectives of the research. The focal objective of this study was specifically to study how African countries perform in S&T over the last twenty years (1996-2015). To this end, the research design approach upon which this study was built, rests on the previous research works of [7] and [8] where in both cases, Scientometrics analysis of publication output on S&T in India between 1989-2014 and 1996-2011 respectively were carried out by these scholars. Therefore, in this study, the sample population from the SCImago database used in this study comprises a total of Seven (7) subject areas having a total of One Hundred and Twenty-six (126) subject categories. They include; Agricultural and Biological Sciences (14), Biochemistry, Genetics and Molecular Biology (17), Chemical Engineering (9), Computer Science (13), Engineering (17), Material Science (9), Medicine (47). On SCImago database at http://www.scimagojr.com, information was also searched on S&T performances with respect to publications in the World, Africa, Asia and Nigeria over the last 20 years period starting from 1996-2015. But for the purpose of this paper, only data on Africa was used for analysis. On the SCImago database, the search query used was (Search = “World”) AND (Year = 1996-2015); (Search = “Africa”) AND (Year = 1996-2015); (Search = “Asia”) AND (Year = 1996-2015); (Search = “Nigeria”) AND (Year = 1996-2015), each done separately. The Data was retrieved between the fourth Week of May and Second week of June 2017. To analyse the data retrieved, Microsoft Excel was used. Results obtained were presented in ta-
bles on the top 10 most productive African countries in the field of S&T in all the seven selected subject areas.

3 Data Analysis and Discussion

The ten most productive countries in Africa in the field of Science are shown in Table 1. Their corresponding ranking in the world is also shown to reflect their position beyond the continent. South Africa is ranked first in Africa and 34th position in the world having produced 188104 documents out of which 91.66% of it is citable. Ranked second in Africa is Nigeria with a world ranking of 52nd position, a wide margin from that of South Africa. Nigeria produced 59372 documents between the years under review out of which 95.38% of them is citable. Nigeria, including South Africa and Tunisia, records a high percentage of self-citation in the region having over 21%. Egypt supposed to stand at the second position in Africa considering its position of 42nd in the world, however, following the ranking list as obtained from the SCImago, the country was not included on the list. In terms of H-index, South Africa has the highest ranking followed by Kenya and Nigeria. Interestingly, in terms of citation per paper, Kenya recorded the highest score in this category despite its 6th position in Africa. This shows that despite the low volume of documents produced during the period under review, it was able to attract attention within the academic community. Overall, the Northern African countries prove to be very strong in the production of scientific knowledge in Africa having displayed more countries from the region according to the ranking. The performance of these North African countries may be as a result of their collaboration with their fellow countries in the Arab region like Saudi Arabia and the Emirates where they also receive grants to promote their research activities. The overall performance of Africa as ranked in the world calls for improvement and the need to address those challenges that researchers in this part of the world face which directly impact on the number and quality of publications from the region.

| Rank (Africa) | Rank (World) | Country   | Docs     | Citable docs | % citable docs | Citations | Self-citations | % self-citations | Citations per document | H index |
|--------------|--------------|-----------|----------|--------------|----------------|-----------|----------------|-------------------|------------------------|---------|
| 1            | 34           | South Africa | 188104   | 172424      | 91.66         | 2125927   | 454537        | 21.38             | 11.3                   | 320     |
| 2            | 52           | Nigeria    | 59372    | 56630       | 95.38         | 334059    | 72718         | 21.77             | 5.63                   | 131     |
| 3            | 53           | Tunisia    | 58769    | 55904       | 95.12         | 342429    | 73636         | 21.50             | 5.83                   | 123     |
| 4            | 55           | Algeria    | 42456    | 41544       | 97.85         | 215922    | 43297         | 20.05             | 5.09                   | 106     |
| 5            | 56           | Morocco    | 40737    | 38371       | 94.19         | 279731    | 51031         | 18.24             | 6.87                   | 129     |
| 6            | 67           | Kenya      | 24458    | 22347       | 91.37         | 379560    | 57594         | 15.17             | 15.52                  | 179     |
| 7            | 78           | Ethiopia   | 13363    | 12625       | 94.48         | 118656    | 24840         | 20.93             | 8.88                   | 101     |
| 8            | 84           | Tanzania   | 11964    | 11140       | 93.11         | 170144    | 25866         | 15.20             | 14.22                  | 122     |
| 9            | 86           | Ghana      | 11543    | 10578       | 91.64         | 111205    | 13874         | 12.48             | 9.63                   | 105     |
| 10           | 87           | Uganda     | 11528    | 10599       | 91.94         | 171367    | 26995         | 15.75             | 14.87                  | 128     |

*Egypt ranked 42 in the World but it was not included the ranking list in Africa as obtained from source.
In the field of Agricultural & Biological Science South Africa and Nigeria still maintained the top two positions in Africa. Nigeria has the highest percentage of citable document (99.51%) as shown in Table 2 and is closely followed by Ethiopia which records 99.10%. South Africa has the highest case of self-citation (28.75%) followed by Ethiopia (25.37%) and Nigeria (24.34%). In terms of citation per document, Kenya tops this section having recorded 13.9% citations per document produced. Kenya has also performed well as indicated by the H-index having 103 behind South Africa which is ranked the first position in the field of Agricultural & Biological Science.

| Rank | Country  | Documents | Citable documents | % citable documents | Citations | Self-citations | % Self citations | Citations per document | H-index |
|------|----------|-----------|-------------------|---------------------|-----------|----------------|-------------------|-----------------------|---------|
| 1    | South Africa | 34375     | 33575             | 97.67               | 444511    | 127778         | 28.75             | 12.93                 | 165     |
| 2    | Nigeria   | 14339     | 14269             | 99.51               | 82412     | 20055          | 24.34             | 5.75                  | 69      |
| 3    | Kenya     | 8053      | 7894              | 98.03               | 111942    | 20305          | 18.14             | 13.9                  | 103     |
| 4    | Tunisia   | 6427      | 6341              | 98.66               | 58160     | 13936          | 23.96             | 9.05                  | 76      |
| 5    | Ethiopia  | 4223      | 4185              | 99.10               | 34820     | 8834           | 25.37             | 8.25                  | 58      |
| 6    | Morocco   | 3392      | 3347              | 98.67               | 40130     | 5532           | 13.79             | 11.83                 | 67      |
| 7    | Tanzania  | 3029      | 2965              | 97.89               | 34235     | 5377           | 15.71             | 11.3                  | 65      |
| 8    | Algeria   | 2955      | 2914              | 98.61               | 17994     | 3433           | 19.08             | 6.09                  | 46      |
| 9    | Cameroon  | 2845      | 2818              | 99.05               | 27540     | 5451           | 19.79             | 9.68                  | 55      |
| 10   | Uganda    | 2646      | 2598              | 98.19               | 28944     | 5335           | 18.43             | 10.94                 | 59      |

Source: SCImago, Author analysis, 2017
Table 3. Top 10 most Productive countries in Africa in Biochemistry, Genetics and Molecular Biology

| Rank | Country      | Docs  | Citable documents | % Citable documents | Citations | Self-citations | % Self-citations | Citations per document | H-index |
|------|--------------|-------|-------------------|---------------------|-----------|----------------|------------------|------------------------|---------|
| 1    | South Africa | 18946 | 18297             | 96.57               | 327073    | 59190          | 18.10            | 17.26                  | 162     |
| 2    | Nigeria      | 6344  | 6264              | 98.74               | 48489     | 9728           | 20.06            | 7.64                   | 68      |
| 3    | Tunisia      | 6243  | 6113              | 97.92               | 70516     | 12936          | 18.34            | 11.3                   | 84      |
| 4    | Morocco      | 3104  | 3047              | 98.16               | 42632     | 4955           | 11.62            | 13.73                  | 78      |
| 5    | Kenya        | 2823  | 2764              | 97.91               | 47119     | 5915           | 12.55            | 16.69                  | 81      |
| 6    | Algeria      | 2168  | 2133              | 98.39               | 22552     | 2805           | 12.44            | 10.4                   | 57      |
| 7    | Cameroon     | 1477  | 1451              | 98.24               | 17555     | 3257           | 18.55            | 11.89                  | 49      |
| 8    | Ethiopia     | 1386  | 1371              | 98.92               | 14208     | 4956           | 17.27            | 11.14                  | 60      |
| 9    | Sudan        | 1105  | 1091              | 98.73               | 15126     | 1723           | 11.39            | 13.69                  | 54      |
| 10   | Ghana        | 115   | 112               | 98.40               | 15938     | 2537           | 15.92            | 13.39                  | 53      |

Source: SCImago, Author analysis, 2017

Research in the field of Chemical Engineering shows that South Africa tops the ranking list in the publication figure in Africa (Table 4). Unlike in the other subject categories considered earlier, there is a departure from the usual in the percentage of citable documents produced where Sudan has 100% of its documents citable. Cameroon recorded the highest percentage of self-citation of 19.65% followed by South Africa. In terms of citations per documents, Morocco recorded the highest figure in the region. Chemical Engineering is an important field that plays a significant role in the production of chemicals for industries alike, Africa’s research in this direction is commendable.

Table 4. Top 10 most Productive countries in Africa in Chemical Engineering

| Rank | Country   | Documents | Citable documents | % citable documents | Citations | Self-citations | % Self-citations | Citations per Document | H-index |
|------|-----------|-----------|-------------------|---------------------|-----------|----------------|------------------|------------------------|---------|
| 1    | South Africa | 4993      | 4928              | 98.70               | 69063     | 12622          | 18.28            | 13.83                  | 90      |
| 2    | Algeria   | 2649      | 2624              | 99.06               | 24591     | 3777           | 15.36            | 9.28                   | 58      |
| 3    | Tunisia   | 2576      | 2542              | 98.68               | 28698     | 4956           | 17.27            | 11.14                  | 60      |
| 4    | Nigeria   | 1635      | 1624              | 99.33               | 14886     | 2706           | 18.18            | 9.1                    | 57      |
| 5    | Morocco   | 1463      | 1453              | 99.32               | 25609     | 4210           | 16.44            | 17.5                   | 68      |
| 6    | Libya     | 288       | 286               | 99.31               | 1338      | 85             | 6.35             | 4.65                   | 17      |
| 7    | Cameroon  | 223       | 222               | 99.55               | 1588      | 312            | 19.65            | 7.12                   | 20      |
| 8    | Kenya     | 146       | 142               | 97.26               | 2789      | 95             | 3.41             | 19.1                   | 22      |
| 9    | Sudan     | 142       | 142               | 100.00              | 882       | 72             | 8.16             | 6.21                   | 17      |
| 10   | Ghana     | 131       | 125               | 95.42               | 951       | 66             | 6.94             | 7.26                   | 14      |

Source: SCImago, Author analysis, 2017
Table 5. Top 10 most Productive countries in Africa in Computer Science

| Rank | Country  | Documents | Citable documents | % citable documents | Citations | Self-citations | % self-citations | Citations per document | H-index |
|------|----------|-----------|------------------|--------------------|-----------|----------------|-------------------|-----------------------|---------|
| 1    | South Africa | 10644     | 10456            | 98.23              | 50791     | 15.46          | 4.77              | 77                    |
| 2    | Tunisia    | 9787      | 9666             | 98.76              | 23571     | 26.14          | 2.41              | 49                    |
| 3    | Algeria    | 8168      | 8091             | 99.06              | 21501     | 21.56          | 2.63              | 50                    |
| 4    | Morocco    | 4664      | 4618             | 99.01              | 10690     | 22.93          | 2.29              | 36                    |
| 5    | Nigeria    | 2597      | 2574             | 99.11              | 4528      | 25.62          | 1.74              | 24                    |
| 6    | Libya      | 492       | 487              | 98.98              | 1283      | 4.44           | 2.61              | 20                    |
| 7    | Ghana      | 375       | 370              | 98.67              | 747       | 12.58          | 1.99              | 15                    |
| 8    | Kenya      | 357       | 354              | 99.16              | 1280      | 12.97          | 3.59              | 19                    |
| 9    | Mauritius  | 335       | 330              | 98.51              | 635       | 11.97          | 1.9               | 12                    |
| 10   | Sudan      | 321       | 321              | 100.00             | 870       | 5.52           | 2.71              | 13                    |

Source: SCImago, Author analysis, 2017

Computer Science as a field of Science is very important in the world today. Virtually all human activities are dependent on one form of technology or the other. Over the years, Asian countries have built capacities and enforce their superiority in the field of Information and Communication Technology (ICT) over other developing countries. A look at figures in Table 5 shows that Africa’s productivity in this subject area is still dominated by South Africa with a total of 10644 documents produced. The North African countries appear to be more formidable in this subject field having displaced Nigeria to the 5th position in the ranking. In terms of citations per paper, Kenya standing at the 8th position is closely ranked with South Africa having received 3.59 citations per document. Considering the total figure of documents produced, Africa researchers need to improve on their publication activity within this subject field since the relevance of Technology cross-cut all sectors of human endeavour today.

In today’s world, Engineering concepts and applications have continued to react to the dynamics of the society. Either in Construction, Design, Machine fabrication or Industrial input, Engineering is an important field that is as old as humanity itself. South Africa is still the dominant country in this field has produced a total of 19163 documents so far (Table 6). The North African countries (Tunisia and Algeria) are closely ranked after South Africa in terms of documents produced, citations per document and even in H-index received. Worthy of note here is that Tunisia and Algeria have more cases of self-citation in the region, an indication that is not favourable to the quality of publications.
## Table 6. Top 10 most Productive countries in Africa in Engineering

| Rank | Country   | Documents | Citable | % citable document | Citations | Self-citations | % self-citations | Citations per document | \(H\) index |
|------|-----------|-----------|---------|--------------------|-----------|----------------|--------------------|------------------------|-------------|
| 1    | South Africa | 19163 | 18819   | 98.20%          | 107903    | 19301          | 17.89%           | 5.63                   | 93          |
| 2    | Algeria   | 13678 | 13566   | 99.18%          | 58389     | 13228          | 22.65%           | 4.27                   | 69          |
| 3    | Tunisia   | 12038 | 11924   | 99.05%          | 52116     | 12671          | 24.31%           | 4.33                   | 63          |
| 4    | Nigeria   | 5586  | 5544    | 99.25%          | 16924     | 3737           | 22.08%           | 4.33                   | 48          |
| 5    | Morocco   | 5536  | 5465    | 98.72%          | 30741     | 6337           | 20.61%           | 5.55                   | 57          |
| 6    | Libya     | 956   | 950     | 99.37%          | 3362      | 153            | 4.55             | 3.52                   | 29          |
| 7    | Ghana     | 789   | 774     | 98.10%          | 2973      | 445            | 14.97%           | 3.77                   | 26          |
| 8    | Cameroon  | 680   | 677     | 99.56%          | 3233      | 771            | 23.85%           | 4.75                   | 25          |
| 9    | Sudan     | 642   | 638     | 99.38%          | 1502      | 151            | 10.05%           | 2.34                   | 21          |
| 10   | Kenya     | 574   | 566     | 98.61%          | 3249      | 239            | 7.36             | 5.66                   | 29          |

*Source: SCImago, Author analysis, 2017*

Research in the field of Material Science is also important to a nation’s technological development. It connects with the industries in terms of quality of material resources needed for production. Besides, the engineering field also relates with this field as a form of support for the production of technology-oriented outputs needed as inputs in other sectors of the economy. Table 7 shows South Africa still topping the chart in Africa having produced a total of 10956 documents. Algeria, Tunisia and Morocco are next ranked to South Africa. Notably in this field is the introduction of Cote d’Ivoire and Senegal to the table for the first time even though they occupy the bottom position in the ranks. West African countries are more engaged in research in this field of science. In terms of self-citation, the North African countries recorded the higher percentage in this.

## Table 7. Top 10 most Productive countries in Africa in Material Science

| Rank | Country   | Documents | Citable | % citable document | Citations | Self-citations | % self-citations | Citations per document | \(H\) index |
|------|-----------|-----------|---------|--------------------|-----------|----------------|--------------------|------------------------|-------------|
| 1    | South Africa | 10956 | 10816   | 98.72%          | 107086    | 18712          | 17.47%           | 9.77                   | 84          |
| 2    | Algeria   | 8254 | 8194    | 99.27%          | 57403     | 13266          | 23.11%           | 6.95                   | 69          |
| 3    | Tunisia   | 6944 | 6839    | 98.49%          | 48937     | 13668          | 27.93%           | 7.05                   | 59          |
| 4    | Morocco   | 5717 | 5675    | 99.27%          | 48726     | 10354          | 21.25%           | 8.52                   | 77          |
| 5    | Nigeria   | 2485 | 2462    | 99.07%          | 16032     | 3608           | 22.50%           | 6.45                   | 56          |
| 6    | Cameroon  | 466  | 463     | 99.36%          | 2819      | 613            | 21.75%           | 6.05                   | 24          |
| 7    | Libya     | 396  | 392     | 98.99%          | 2524      | 160            | 7.36             | 6.37                   | 27          |
In Africa, Medicine is a field that still needs improvement in terms of research and human capacity development. Africans are the most travelled for medical attention in the world presently, according to the statistics on Medical tourism. Mostly, the destination is to Asian countries especially India, and some other countries like Saudi Arabia, Germany, Israel etc. It can be deduced that in the field of medicine, as shown in Table 8, aside South Africa, research into this field is relatively low in West Africa countries. Considering the quality of publication among authors from these countries in the region, South Africa, Kenya, Nigeria and Uganda received higher H-index over all other countries.

4. Conclusion

The purpose of this paper which is to assess research performance of African countries in selected fields of S&T with respect to seven subject areas has been undertaken and with revealing inferences. Relating this outcome to realizing the AU 2063 Agenda by member countries, there is a ray of hope in its attainment. Although more commitment in the area of research and funding is needed. A particular case is that of the Medicine field where most of the citizens of countries like Nigeria and others still embark on medical tourism to Asia and other European countries. Although the case of South Africa is different from that of other Africa countries in this regard. The country has capacities and physical infrastructure to attend to medical issues of his citizens, hence record low figure in medical tourism. South Africa tops the chart of the most productive countries in Africa in all the S&T field and occupy a position of 34th in the world. A closer look on the country next to South Africa, which is Nigeria,

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| Rank | Country        | Documents | Citable documents | % citable documents | Citations | Self-citations | % self citations | Citations per document | H-index |
|------|----------------|-----------|-------------------|---------------------|-----------|----------------|-------------------|------------------------|---------|
| 1    | South Africa   | 46656     | 40847             | 87.55               | 744980    | 136527         | 18.33             | 15.97                  | 239     |
| 2    | Nigeria        | 19456     | 18421             | 94.68               | 134820    | 28891          | 21.43             | 6.93                   | 104     |
| 3    | Tunisia        | 15890     | 14211             | 89.43               | 101060    | 14291          | 14.14             | 6.36                   | 90      |
| 4    | Morocco        | 11773     | 10179             | 86.46               | 55312     | 6723           | 12.15             | 4.7                    | 79      |
| 5    | Kenya          | 9828      | 9225              | 93.86               | 191588    | 31385          | 16.38             | 19.49                  | 143     |
| 6    | Uganda         | 6522      | 6100              | 93.53               | 124757    | 20499          | 16.43             | 19.13                  | 119     |
| 7    | Tanzania       | 5899      | 5638              | 95.58               | 104297    | 17546          | 16.82             | 17.68                  | 106     |
| 8    | Ethiopia       | 4763      | 4582              | 96.20               | 47508     | 9552           | 20.11             | 9.97                   | 71      |
| 9    | Ghana          | 4248      | 4016              | 94.54               | 65276     | 7966           | 12.20             | 15.37                  | 90      |
| 10   | Cameroon       | 3850      | 3631              | 94.31               | 46576     | 7607           | 16.33             | 12.1                   | 75      |

Source: SCImago, Author analysis, 2017
occupy 52\textsuperscript{nd} position in the world. It can be deduced from the outcome that countries like South Africa, including some North African countries like Morocco, Tunisia, Algeria, etc., enjoy adequate funding and maintain a clear strategic direction towards aligning their national developmental priorities to their research orientation. Besides, they have been able to structure and functionalize their National Innovation Systems (NIS) such that industrial needs informs their research priorities and knowledge acquisition.

In conclusion, the overall performance of African countries as it concerns this paper is promising and could be said to align towards realizing the regional goal. However, there is need for more coordinated and collaborative effort across the regions where it seems to be more productive. To this end, intra-African collaboration that is geared towards promoting knowledge development between researchers from low and high performing countries in Africa should be encouraged.

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