



How collaboration type, publication place, funding and author's role affect citations received by publications from Africa: A bibliometric study of LIS research from 1996 to 2015

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Abstract

This study investigated if collaboration type, publication place, funding and author's role affect citations received by publications from Africa. Library and Information Science (LIS) publication record of the 54 African countries was collected from the Web of Science. Five types of collaborations were analyzed; no, institutional, national, African and international collaborations. The result shows that only 4.43% of the research by LIS authors from Africa were funded while only 8.16% were published in Africa. The study further shows that the visibility of the articles was low as they attracted 0.67 citation per year. Single author papers declined by the year, while collaboration increased. Institutional collaboration was the most popular while intra-Africa collaboration was the least popular. Furthermore, articles that were funded, published outside Africa, and from intra-African and international collaborations were more cited. International collaborations where LIS authors from Africa were lead authors attracted less citations. The observable differences in citations received by different funding status, collaboration types, publication place and authors' role were statistically significant. Though higher visibility and funding through international collaboration as revealed in this study is a positive incentive for authors from Africa to participate in international collaboration, it is important to also improve intra-African collaboration. Through strong intra-African collaboration networks, innovative research could be driven to solve some of the problems facing Africa. It was also recommended that structures that will promote intra-African and international collaboration should be provided with funding opportunities.

Keywords Library and Information Science · Research collaboration · Africa · Research funding · Research visibility · Authors' role

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Introduction

Evaluations of research in Africa have shown certain peculiarities. Research has shown that the proportion of the contribution of Africa to global science is negligible compared to other continents (Confraria and Godinho 2015; Luukkonen et al. 1992). Studies such as Wagner and Leydesdorff (2005a, b), Glänzel (2001) have also shown that apart from South Africa, the role of other African countries in the global scientific production is insignificant. One of the challenges facing the scientific outlook of Africa in the global arena is the unavailability of most journals and other scientific publications that are published in Africa on the internet (Nwagwu 2005). Similarly, most of the journals that are published in Africa—(unlike their counterparts that are published in other parts of the world)—are not indexed in online scientific bibliographic databases such as the Web of Knowledge (WoS), Scopus and PubMed. Results of studies about assessment of global research outputs are based on these online databases that do not index most of the journals which are published in Africa. Nwagwu (2005) found that only 2.72% of medical publications from Nigerian publishers were indexed on PubMed between 1967 and 2002. The unavailability of the journals and articles that are published in Africa on the internet and in online bibliographic databases shows that researchers in Africa who value visibility need to publish in journals with an online presence and that are indexed in popular bibliographic databases; most of the journals in this category are published from outside Africa.

Another feature of science in Africa, which affects the ability of authors to publish high quality papers in highly visible and quality journals, is the underfunding of research. There is evidence in the literature that research funding in Africa faces many challenges. Identified challenges to research funding include: poor fiscal policy implementation and management on education, poor commitment from the governments of African countries to the funding of research, and poor planning by these governments to cater to increasing enrolments to higher education (Bakare et al. 2014; Teferra 2013; Teferra and Altbachl 2004; Whitworth et al. 2008). For instance, Teferra (2013) noted that while Africa allocated approximately 0.78 per cent of its GDP to higher education and research between 1991 and 2006, “during this period, the total number of students pursuing higher education tripled, climbing from 2.7 million in 1991 to 9.3 million in 2006 (an annual average increase rate of 16 per cent)”. United Nations Educational, Scientific and Cultural Organization (2015) also reported that the investment by Sub-Saharan Africa on research increased by 0.1% in 1996–2013, while its population increased by 12.5% during the same period.

Similarly, research has shown that most of the publications from Africa are products of single authorship and domestic collaborations with little inclination towards intra-African and international collaborations. Onyancha and Maluleka (2011) which focused on the contribution of African countries to each other’s knowledge production noted that the contribution of Sub-Saharan African countries to each other’s knowledge production was very little. Onyancha (2018) focused on LIS in Africa and showed that single-author papers had the highest proportion, followed by internal collaboration, with intra-African and international collaborations as the least popular. Narváez-Berthelemot et al. (2002) also studied research collaboration among mainstream scientists in Africa where it was observed that the least productive countries in Africa collaborate internationally more than the most productive countries like Egypt, South Africa and Nigeria. Onyancha’s (2011) investigation of South African author collaborations with other countries noted that South African researchers collaborated more with international peers than with peers in the continent of Africa. Sooryamoorthy (2009, 2017),

focused on the sciences and social sciences disciplines in South Africa in repeated studies, noted that international collaboration was less popular than domestic collaborations. Similarly, Asubiario (2018) observed that international collaboration among biomedical researchers from the University of Ibadan, Nigeria's biggest university, was the least popular.

It has also been observed that authors from Africa are characterized with marginal roles in collaboration with peers from other parts of the world. According to Owusu-Nimo and Boshoff (2017) and Boshoff (2009), researchers from Ghana and central Africa participated in research collaboration with peers from outside Africa in mundane roles such as data collection and fieldwork agents, in contrast to the important and more academic roles played by their collaborators from outside Africa that secured research funds and other resources. This relationship suggests that the quality of the contributions of researchers from Africa in collaboration is less important than their peers' from outside Africa. This further raises questions about the research capacity of researchers from Africa, relative to their peers from outside Africa. This co-authorship relationship between researchers from Africa and outside Africa was termed academic neo-colonialism by Boshoff (2009).

Though studies such as Nwagwu (2008) and Onyanha (2007, 2009, 2018) focused on the visibility of publications in Africa, none has investigated factors that predict the visibility of publications from the continent. However, there are relevant studies that have focused on certain countries or institutions in Africa. One of the most relevant articles is Sooryamoorthy (2009) which focused on investigating the collaboration types that attracted the most citations in science disciplines in South Africa. Similarly, Sooryamoorthy (2017) in a repeated study, focused on investigating the collaboration type that attracted the most citations in social science disciplines in South Africa. Onyanha (2011) investigated how South African researchers collaborated before and after the apartheid, it was concluded that international collaboration attracted more citations than intra-African collaboration. Asubiario (2018) on the other hand, focused on the biomedical research in University of Ibadan. The major objectives of Asubiario (2018) were to identify the types of collaboration and funding status that attracted most citations. This study is different from the earlier studies in that it considers the research outputs of the fifty-three countries of Africa. Secondly, beyond collaboration types, this study investigates how other features of scientific publishing in Africa such as place of publication (Africa and outside Africa), funding status, role of authors from Africa affect the visibility of publications from Africa by considering LIS publications over a period of 20 years (1996–2015). Publication data of 1996–2015 was considered for analysis so that the most recent 20-year publication could be analyzed alongside post-publication citation data of at least 3 years (2016, 2017 and 2018).

The main objective of this study is to find out how the highlighted peculiar features of Africa's research (funding, collaboration type, researchers' role and publication place) affect its citation counts over a 20-year period. This research aims at answering the following research questions:

1. What is the pattern of collaboration among researchers who are affiliated with institutions in Africa?
2. Which collaboration type among the researchers returns the highest number of citations?
3. What is the funding status of research from Africa and how does the funding status affect its citation number?

4. Which role does researchers who are affiliated with African institutions play when they co-author with peers from other parts of the world and how does their role affect the citations received?
5. How often do researchers who are affiliated with institutions in Africa publish in African journals and how does this affect the citations received by their publications?

Methodology

Data was collected from the WoS by searching five of its citation indexes, namely, the Science Citation Index Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI), Arts and Humanities Citation Index (A&HCI), Conference Proceedings Citation Index-Science (CPCI-S), and Conference Proceedings Citation Index-Social Science and Humanities (CPCI-SSH). Data from the Information Science and Library Science WoS subject category that were published by authors that have affiliation with any of the fifty-three countries of Africa between 1996 and 2015 using this query: AD=(South Africa OR Nigeria OR Ghana OR Kenya OR Botswana OR Tanzania OR Uganda OR Ethiopia OR Senegal OR Zambia OR Benin OR Zimbabwe OR Malawi OR Namibia OR Guinea OR Mauritius OR Mozambique OR Niger OR Sierra Leone OR Mali OR Angola OR Lesotho OR Liberia OR Gambia OR Seychelles OR Algeria OR Burkina Faso OR Burundi OR Cape Verde OR Cameroon OR Cent Afr Republ OR Chad OR Comoros OR DR Congo OR Djibouti OR Cote Ivoire OR Congo OR Egypt OR Equatorial Guinea OR Eritrea OR Gabon OR Guinea-Bissau OR Madagascar OR Morocco OR Congo Republic OR Sao Tome and Principe OR Rwanda OR Somalia OR Swaziland OR Sudan OR Togo OR Tunisia OR Western Sahara) AND PY=(1996–2015) AND SU=(Information Science and Library Science). The author acknowledges the limitation of WoS as a data source as it does not exhaustively index publications from Africa. Nwagwu (2005), for example reported from observation that western countries' bibliographic databases such as Scopus, PUBMED, Web of Science are biased against Africa. Secondly, some records from WoS may be inaccurate, for instance funding status are sometimes not accurately recorded by the authors or during indexing. However, WoS was chosen because the field of Library and Information Science is clearly indicated as one of the subject "categories" and it provides a source for systematic collection of data for this study. The search was conducted on the 4th of January 2019, so that publication age could be set at years; the limitation of this assumption is that some papers are published early in the year of publication while others are published late. Distribution of the publication records of all the African countries is presented in "[Appendix 1](#)" with a total of 2331 LIS articles. Only journal articles and conference proceedings (1848) were considered for the first analysis which was obtained from WoS analytics. The analysis from WoS analytics include the distribution of the institutions and countries of affiliation.

The collected data were manually cleaned for further analysis by correcting incorrect affiliation addresses and filling in missing addresses. Missing addresses were traced manually by searching for the publications online; addresses of twenty-five records were recovered manually. Six records were removed because none of the authors were affiliated with African institutions; an additional fifteen records were also removed because the addresses were untraceable. After data cleaning, only 1827 records were left for the analysis.

Co-authorship was used as a basis for measuring research collaboration in this study. Researchers that are affiliated to more than one institution were recorded accordingly.

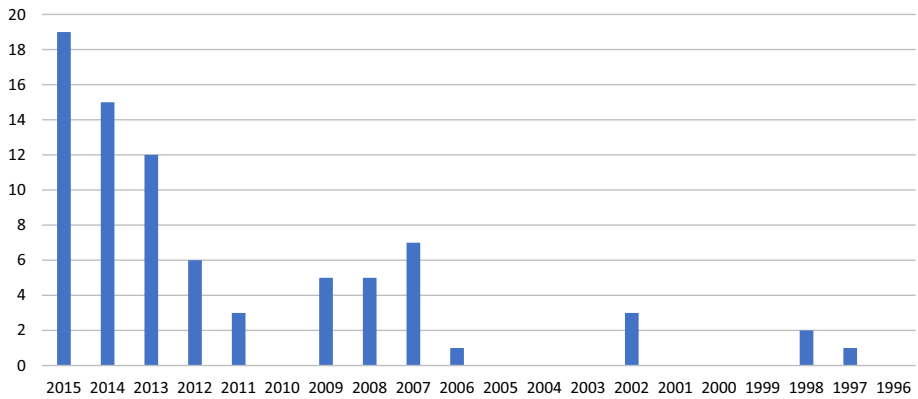


Fig. 1 Authors that are affiliated to more than one Institution

Data coding was done so that the number of authors was not greater than the number of institutions and countries. This was achieved by recording one institution for authors with more than one affiliation. Recording one affiliation address to one author is important because co-authorship as collaboration can only occur between at least two individuals. Therefore, this study does not misrepresent the affiliation of an author to two institutions as a form of collaboration. Only the first affiliation was assumed as the main affiliation and was recorded for authors if the first affiliation address was in Africa, otherwise the only African address of the author was recorded. The second or third affiliations were not recorded as part of the analysis. The number of authors with more than one affiliation is presented in Fig. 1.

The following were units of data analysis:

- Number of (collaborating) authors, institutions, and African and non-African countries to identify collaboration type,
- Publication place (Africa or outside Africa),
- Funding information (funded or not funded),
- Authors’ role was recorded as first author or others. This study assumes (based on the Sekercioglu (2008)) that authors’ rank in multi-authored articles mostly connote the role or contribution of co-authors. The first authors are usually the lead authors or principal investigators and the importance of the authors decline with rank. However, there are few exceptions to the assumption on ordering of authors’ names. First, some journals prefer that principal investigators/authors or corresponding authors are listed last while other authors are listed in alphabetical order (Tscharntke et al. 2007). Secondly, research initiators are sometimes listed as the first author, regardless of their overall contribution to the writing of the manuscript. Lastly, in cases where co-authors (report that they) contributed equally, ordering of authors’ name is inconsequential (Broderick and Casadevall 2019).
- Citation number and normalized citation number by publication age, where the publication age of articles that were published in 2015 and 1996 was three and twenty-three respectively.

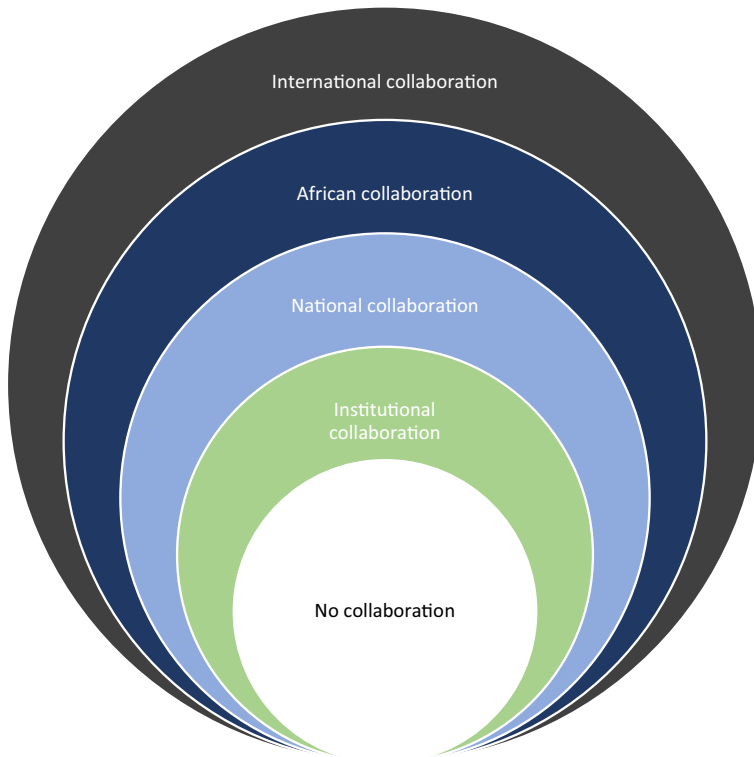


Fig. 2 Relationships Created between Collaboration Types

Five collaboration types were analyzed; international, African, national, institutional and no collaboration. The five collaboration types were mutually exclusive and ordinal; a record can be categorized as one of the five while no collaboration is the least and the international collaboration is the largest. No collaboration or single authorship occurs when the number of authors is one. Institutional collaboration, which is the least form of collaboration occurs when all the authors are affiliated to one institution; an institution can have different departments, sections, faculties, colleges or schools. National collaboration occurs when authors are affiliated with more than one institution, and all the institutions of affiliation are from one country. African collaboration occurs when all the institutions of affiliation in more than one African country and no countries outside Africa. International or intercontinental collaboration occurs when institutions of affiliation are in Africa and outside Africa. Mutually exclusive types of collaboration were created with relationship that is demonstrated in Fig. 2.

Results of descriptive statistics were displayed on tables and presented as frequencies and percentages. Descriptive statistics such as frequencies, averages and maximum value of records were reported for collaboration types, author numbers, publication numbers per country, year and authors. Number of citations per year was used as a measure of visibility so that effect of age of publication can be normalized. Age in years was obtained by calculating number of years from publication year to 2018. Citation data was collected on WoS on January 3, 2019 so that the age of latest publication was three. Inferential statistics were

used for hypothesis testing. Kruskal–Wallis’ one-way non-parametric ANOVA was used to find the difference in means of number of citations per year between the five collaboration types. Mann–Whitney mean test was used to investigate the significance of the difference in means of citation number per year between the funded and non-funded, published articles in Africa and outside Africa, African and non-African first author and single and multiple author publications.

Results

Productivity and collaboration performance of the African countries

The result of the productivity, collaboration performance and the contribution of LIS research to national research productivity of African countries between 1996 and 2015 is presented on Table 1 below. The result shows that South Africa is the most productive and cited African country, which accounted for 44.81% of all LIS papers from Africa and received a total of 5441 citations, five times more than the number of citations received by the second ranked country, Nigeria. Following South Africa as the most productive country in Africa are Nigeria, Morocco, Egypt and Botswana. The top five most productive countries in Africa accounted for more than 75% of the publications from Africa. Following South Africa as the most cited country in Africa are Nigeria, Kenya, Botswana and Egypt. South Africa, Nigeria, Kenya, Uganda and Tanzania had the strongest links and highest number of collaborations.

The citation to paper ratio of the LIS publications shows that only five of twenty-three countries received more than ten citations per paper. The top five countries with the highest citations per paper are not the top five most productive countries. Swaziland has the highest citation to paper ratio with 19.43 citations per paper, closely followed by Malawi, Ethiopia, Tanzania and Kenya.

Table 1 also shows that percentage of the contribution of LIS authors in Africa to national research productivity¹ is negligible (mean=0.51%, min=0.07%, max=2.51%). LIS research from only three (Botswana first, followed by Namibia and Swaziland in descending order) out of twenty-three countries in Africa contributed more than one percent to the national research productivity.

Countries that collaborated with the LIS authors in Africa

Countries that collaborated with the LIS authors from Africa is presented on Table 2 below. USA collaborated with LIS authors that are affiliated with institutions in Africa almost three times more than any other country. Following the USA in descending order are England, France, Canada, and Germany. Papers produced from collaboration with the USA authors received the highest number of citations, followed, in descending order, by England, Norway, Denmark, and the Netherlands. While considering the citations to paper ratio, the Scandinavian countries of Norway, Sweden and Finland had the highest returns. USA, England, France, Canada, and Germany have the highest and strongest collaboration links with LIS authors in Africa.

¹ National productivity was obtained as the number of articles published by a country from 1996 to 2015.

Table 1 Performance of African countries in LIS research collaboration and output between 1996 and 2015 with at least five publications (ordered by total link strength)

Rank	Country	LIS Papers	% LIS in Africa	Citations	Total link strength	Links	Citation/paper	% of LIS contribution to national productivity
1	South Africa	828	44.81	5441	205	29	6.67	0.72
2	Nigeria	306	16.56	1064	45	16	3.64	0.80
3	Kenya	54	2.92	554	41	11	10.45	0.26
4	Uganda	52	2.81	395	31	10	7.60	0.49
5	Tanzania	36	1.95	405	24	10	11.25	0.33
6	Egypt	104	5.63	451	22	6	4.47	0.10
7	Ghana	72	3.90	315	20	10	4.77	0.75
8	Botswana	93	5.03	461	19	8	5.36	2.51
9	Morocco	114	6.17	175	15	5	1.56	0.35
10	Zambia	22	1.19	98	15	5	4.67	0.61
11	Algeria	25	1.35	23	13	3	0.92	0.07
12	Malawi	20	1.08	235	12	7	11.75	0.40
13	Tunisia	60	3.25	154	12	3	2.57	0.12
14	Namibia	18	0.97	72	10	5	4	1.01
15	Ethiopia	23	1.24	232	9	5	11.6	0.22
16	Senegal	13	0.70	30	7	5	2.73	0.25
17	Swaziland	7	0.38	136	7	6	19.43	1.15
18	Zimbabwe	18	0.97	38	7	2	2.11	0.30
19	Benin	12	0.65	50	7	3	4.55	0.35
20	Cameroon	10	0.54	7	3	2	0.7	0.11
21	Mozambique	5	0.27	14	3	8	2.8	0.22
22	Papua and Guinea	7	0.38	12	2	1	2	0.36
23	Mauritius	5	0.27	15	1	1	3	0.29

Table 2 Foreign countries that collaborated at least 5 times with African countries in LIS research between 1996 and 2015 (ordered by total link Strength)

S/N	Country	Number of papers	Number of citations	Total link strength	Links	Citation/paper
1	USA	118	1667	156	31	10.69
2	England	44	362	56	19	6.46
3	France	40	140	46	14	3.04
4	Canada	16	131	32	19	4.09
5	Germany	13	140	28	13	5
6	Australia	10	153	25	13	6.12
7	Denmark	9	241	24	12	10.04
8	The Netherlands	19	223	24	10	9.29
9	Spain	6	59	20	12	2.95
10	Poland	5	55	19	12	2.90
11	Belgium	9	110	17	10	6.47
12	Norway	10	278	15	10	18.53
13	Sweden	8	141	11	6	12.82
14	Finland	5	121	8	5	15.13
15	India	5	44	8	5	5.5
16	Malaysia	14	45	8	4	5.63
17	New Zealand	6	22	8	4	2.75
18	Saudi Arabia	7	29	7	3	4.14

Trends in co-authorship

Table 3 presents data about the trends in co-authorship between 1996 and 2015. The results show that co-authorship was low among the LIS researchers with an average of 2.16 authors per paper. There is an upward trend in the average number of authors per paper with the increase from 1.28 to 2.43 in 20 years. The proportion of papers that were written by one author (37.60%) is greater than that of two (35.19%) and three (16.69%) authors. Only 2.96% of all papers were written by more than five authors. The trend in the average number of authors per paper reflects the decrease in the number of papers that were written by one author from 78.43% in 1996 to only 20.79% in 2014. The number of papers that were written by two and three authors also increased in the 20-year period. Most papers that were published in the first 10 years (1996–2005), were largely written by one author. This trend changed between 2006 and 2015 as most of the papers that were written between 2006 and 2015 were written by more than one author; most papers in this timeframe were written by two authors. Less than ten percent of the papers were written by three authors before 2004, this proportion increased to more than 10% in 2005. The highest number of authors per paper also increased to twenty-four in 2016 from four in 1996.

More than 70% and 80% of the articles were written in one institution and one country respectively. Though a decrease in the number of papers that were written in one institution was observed from over 90% in 2006 to about 60% in 2015, collaboration between institutions was very low. Similarly, a decrease in the number of papers that were written in one country from 100% in 2007 and 2009 to 73.11% shows that collaboration with other countries among LIS authors in Africa was very low.

Table 3 Yearly number of authors, institutions and countries per paper

Year	No of authors										No of institutions					Countries		
	Mean	1 (%)	2 (%)	3 (%)	4	5	>5	Max	Mean	1	2	3	>3	Max	Mean	1	Max	
	2015	2.42	27.83	41.98	18.87	5.19	2.83	3.30	24	1.64	61.32	27.36	7.08	4.25	14	1.37	73.11	12
2014	1.56	20.79	29.70	29.21	14.36	2.97	2.97	13	1.55	61.88	27.72	7.43	2.97	8	1.23	79.21	4	
2013	2.34	35.44	36.08	16.46	4.43	2.53	5.06	14	1.5	70.89	20.25	4.43	4.43	14	1.32	78.48	9	
2012	2.37	30.59	34.71	23.53	5.29	0.59	5.29	11	1.45	69.41	21.18	5.88	3.53	5	1.26	81.77	5	
2011	2.21	29.03	38.71	24.19	4.03	0.81	3.23	8	1.47	62.90	29.84	4.84	2.42	4	1.26	75	3	
2010	2.06	39.04	40.00	12.38	2.86	1.90	3.81	11	1.47	69.52	23.81	4.76	1.90	10	1.24	79.05	4	
2009	2.03	38.2	37.08	15.73	5.62	0.00	3.37	9	1.52	62.92	28.1	5.62	3.37	6	1.25	75.28	3	
2008	2.06	37.93	38.51	16.09	4.02	1.15	2.30	14	1.41	72.99	20.69	4.60	1.72	12	1.26	83.33	12	
2007	2.13	33.61	38.66	15.97	8.40	2.52	0.84	9	1.34	73.11	21.01	5.04	0.84	4	1.17	84.88	2	
2006	2.13	33.33	39.13	15.94	7.25	2.90	1.45	7	1.33	75.36	21.74	1.45	1.45	7	1.23	81.16	2	
2005	1.77	54.72	24.53	13.21	5.66	0.00	1.89	6	1.21	86.79	0	0	3.77	4	1.13	90.57	4	
2004	1.89	41.67	44.44	5.56	2.78	2.78	2.78	6	1.31	69.44	30.56	0	0	2	1.14	86.11	2	
2003	2.1	41.18	35.29	9.80	9.80	1.96	1.96	10	1.49	70.59	19.61	1.96	7.84	5	1.30	78.43	3	
2002	1.8	52.5	35.00	2.50	7.50	0.00	2.50	8	1.15	87.5	10	2.5	0	3	1.05	95	2	
2001	1.17	50	30.00	10.00	5.00	0.00	5.00	8	1.30	75	20	5	0	3	1.03	85	2	
2000	1.53	61.23	28.57	6.12	4.08	0.00	0.00	4	1.22	81.63	16.33	0	2.04	4	1.10	89.80	2	
1999	1.22	81.25	15.63	3.13	0.00	0.00	0.00	3	1.03	96.88	3.13	0	0	2	1	100	1	
1998	1.74	64.1	23.08	2.56	2.56	2.56	5.13	7	1.23	79.49	17.95	2.56	0	3	1.13	87.18	2	
1997	1.44	61.77	32.35	5.88	0.00	0.00	0.00	3	1.03	97.06	2.94	0	0	2	1	100	1	
1996	1.28	78.43	17.65	1.96	1.96	0.00	0.00	4	1.06	94.12	5.88	0	0	2	1.06	94.12	2	
Total	2.16	37.60	35.19	16.69	5.91	1.64	2.96	24	1.42	71.10	21.89	4.38	2.63	14	1.23	81.49	12.00	

Table 4 Collaboration types in LIS publications by authors that are affiliated with institutions in Africa

Year	No collaboration	Institutional col- laboration	National col- laboration	African col- laboration	Intercontinen- tal collabora- tion
2015	27.83	33.5	11.79	6.6	20.28
2014	20.79	41.1	17.33	4.95	15.84
2013	35.44	35.44	7.6	6.96	14.56
2012	30.59	38.82	12.35	0.59	17.65
2011	29.03	33.87	12.1	4.03	20.98
2010	39.04	30.48	9.52	19.05	19.05
2009	38.2	24.72	12.36	4.5	20.22
2008	37.93	35.06	10.35	2.87	13.79
2007	33.61	39.5	11.77	16.81	13.45
2006	33.33	42.03	5.8	1.45	17.39
2005	54.72	32.08	3.77	1.89	7.55
2004	41.67	27.78	16.67	5.56	8.33
2003	41.18	29.41	7.84	3.92	17.65
2002	52.5	35	7.5	2.5	2.5
2001	50	25	10	0	15
2000	61.23	20.41	8.16	0	10.2
1999	81.25	15.63	3.13	0	0
1998	64.1	15.39	7.69	2.56	10.26
1997	61.77	35.29	2.94	0	0
1996	78.43	15.68	0	1.96	3.92
All	37.60	33.50	10.40	3.45	15.05

Trends in yearly collaboration types

The results of the five types of collaboration which were identified in this study are displayed on Table 4. The result also shows that about one in three papers (37.60%) were written by one author. On average, between 1996 and 2015, papers written by one author were more than papers written through institutional, intercontinental, national and African collaborations. Papers written by single authors declined by the year, accounting for an average of 69.36% in the first 5 years 1996–2000 and 28.74% in the last 5 years (2011–2015). On the other hand, collaboration increased by the year.

More than 70% of the articles were written in one institution ²while more than 90% of the articles were written in one country.³ Institutional collaboration was the most popular (33.50%), followed by international, national and African in descending order. The trend in the proportion of institutional collaboration was upward as it increased from the lowest range of 15.68% in 1996 to the highest range of 41.10% in 2014. National collaboration

² Number of articles written in one institution = No collaboration + Institutional collaboration.

³ Number of articles written in one country = No collaboration + Institutional collaboration + National collaboration.

Table 5 Productivity and visibility of publications of LIS authors that are affiliated with institutions in Africa

Year	Pub. no	Citations per year	Citations per year (max)	Percentage not cited (%)
2015	212	0.70	9.00	37.26
2014	202	0.72	9.00	40.59
2013	158	0.94	8.40	32.91
2012	170	0.82	9.17	31.18
2011	124	0.88	6.43	33.07
2010	105	0.78	7.50	26.67
2009	89	0.93	6.78	16.85
2008	174	0.45	10.10	48.28
2007	119	0.69	9.45	40.34
2006	69	0.65	5.00	31.88
2005	53	0.62	3.00	20.76
2004	36	0.74	4.43	19.44
2003	51	0.82	7.00	17.65
2002	40	0.40	5.50	37.50
2001	20	0.54	7.12	30.00
2000	49	0.43	6.72	40.82
1999	32	0.16	0.68	28.13
1998	39	0.18	2.15	33.33
1997	34	0.06	0.57	70.59
1996	51	0.07	0.73	66.67
All	1827	0.67	10.10	35.69

was largely unchanged, while African collaboration slightly increased over the years. International collaboration largely increased after the first 10 years.

Trends in yearly productivity and citations

Result of productivity, visibility in citation number and percentage of papers not cited are presented on Table 5. The table shows that productivity and citations received per year by the articles are low while the number of uncited articles is high. The result shows that an average of 91.35 articles (min=20 in 2001, max=212 in 2015) were written per year in Africa in the field of LIS. The result presented on Table 2 also shows that the average number of papers published per year in the first 11 years (1996–2006) was 43; it increased significantly in the 7 years (2007 to 2013) that followed to about 134; more than double. In the last 2 years (2014 and 2015), the average number of publications per year increased to 207, about quadruple of the average value in the first 11 years. Citations per year were low, with an average of 0.67 (max=0.94 in 2013, min=0.06 in 1997). There was a significant increase in citations per year after 1999. The highest citations per year received was 10.10 in 2008.

The result on Table 5 shows further that generally the number of uncited articles was very high; average of 35.69% (min=17.65% in 2003, max=70.59% in 1996) of LIS articles from Africa that were published between 1996 and 2015 were not cited. Looking at the yearly trend, the number of uncited articles reduced from more than an average of 65% between 1996 and 1997 to less than an average of 40% in 2014 and 2015.

Table 6 Authors' role, publication place and funding status of the LIS papers in WoS

	Publication place = Africa (%)	Funded (%)	African first author in international collaborations (%)
2015	18.40	2.10	9.43
2014	7.43	6.44	9.41
2013	6.96	10.13	8.86
2012	7.65	5.88	4.71
2011	10.48	4	3.23
2010	13.33	0.95	8.57
2009	16.85	7.87	7.87
2008	8.62	1.15	4.60
2007	10.92	3.36	4.20
2006	0	1.45	10.15
2005	0	0	0
2004	0	0	0
2003	0	1.96	5.88
2002	0	0	0
2001	0	0	10
2000	0	0	8.16
1999	0	0	0
1998	0	0	2.56
1997	0	0	0
1996	0	0	3.92
All	8.16	4.43	6.68

Yearly trends in role of African authors, place and funding status of publications

Number of articles in which LIS authors were listed as first author is displayed on Table 6. The table also contains data about the number of funded articles per year and articles which are published in Africa. In the first 10 years, none of the articles were published in Africa, from 2007 to 2015, an average of only 8.16% of the articles were published in Africa. Similarly, only 1.96% of all the articles that were published between 1996 and 2005 were funded. The result also shows that LIS authors that are affiliated with institutions in Africa were first authors in 6.68% (max = 10.15, min = 0) of all the published articles. A further analysis also showed that none of the papers that were written with intercontinental collaboration in which LIS authors from Africa are the first author were funded.

Collaboration types and number of funded articles

The result of the cross-tabulation of collaboration type versus funded articles is presented on Table 7 below. The result shows that though international collaboration accounts for only 15.05% of all the publications, it accounted for 55.56% of all funded articles.

Table 7 Collaboration types and funding status of the LIS articles in WoS

	Not funded	Funded	Total
Collaboration type			
No collaboration	38.77%	12.35%	37.60%
Institutional collaboration	33.85%	25.93%	33.50%
National collaboration	10.65%	4.94%	10.40%
African collaboration	3.55%	1.23%	3.45%
Intercontinental	13.17%	55.56%	15.05%
Total	1746	81	1827

Table 8 Citations received per year by funded and unfunded articles

	Funded	Not funded
<i>N</i>	81	1746
Citations per year	1.84	0.62

Table 9 Mann–Whitney *U* statistical test for funding status and citations received per year

Ranks					Test statistics	
	Funding	<i>N</i>	Mean Rank	Sum of Ranks	Mann–Whitney <i>U</i>	39440.000
Citation per year	Not funded	1746	896.09	1564571.00	Wilcoxon W	1564571.000
	Funded	81	1300.09	105307.00	Z	−6.897
	Total	1827			Asymp. Sig. (2-tailed)	0.000

Citations received by funded and unfunded articles

Table 8 below shows that funded articles received three times more citations per year than articles that were not funded. Funded articles only accounted for only 4.43% of all the LIS publications from Africa.

To find out if the observed difference in the citations received per year by funded and unfunded articles as shown in Table 8 is statistically significant, hypothesis H_{01} was tested using the Mann–Whitney *U* statistical tests.

Hypothesis H_{01} The difference in the citations received per year by funded and unfunded articles is statistically significant.

The result of the Mann–Whitney *U* statistical test for Hypothesis H_{01} is presented on Table 9 below. The result shows that funded articles with mean rank of 1300.09 have more citations than unfunded articles with mean rank of 896.09. The null hypothesis is rejected as ($Z = -6.897$, $U = 39440.00$, $p \approx 0.001$). Therefore, the difference in the means of the citations received by funded and funded articles is statistically significant.

Table 10 Citations received per year by Articles with First Authors from Africa and outside Africa

	First authors from Africa	First authors from outside Africa
<i>N</i>	1659	168
Citations per year	0.57	1.69

Table 11 Mann–Whitney *U* statistical test for first authors’ role and citations received per year

Ranks					Test Statistics	
	First author	<i>N</i>	Mean Rank	Sum of Ranks	Mann–Whitney <i>U</i>	
						79111.000
Citation per year	Non-African	168	1272.60	213797.00	Wilcoxon W	1456081.000
	African	1659	877.69	1456081.00	<i>Z</i>	−9.464
	Total	1827			Asymp. Sig. (2-tailed)	0.000

Citations received by African and non-African first authors

The result presented on Table 10 shows that papers with non-African affiliated first authors attracted citations per year three times more than papers African affiliated first authors.

To find out if the observed difference between the number of citations received per year by articles with first authors from Africa and those with first authors from outside Africa is statistically significant, hypothesis H_{02} was tested using the Mann–Whitney *U* statistical test.

Hypothesis H_{02} The difference between citations received per year by articles in which Africans were first authors and those in which Africans were not first authors is not statistically significant.

The result of the Mann–Whitney *U* statistical test for Hypothesis H_{02} is presented on Table 11. The result shows that articles with first from Africa had mean rank of 877.69 and are less cited than articles with non-African affiliated first authors with mean rank of 1272.60. The null hypothesis was rejected as ($Z = -9.464$, $U = 79111.00$, $p \approx 0.001$). Therefore, the difference in the means of the citations received per year by articles with African and non-African first authors is statistically significant.

Citations received by Articles that were published in and outside Africa

The result presented in Table 12 shows that articles that were published outside Africa received two times more citations per year than articles that were published in Africa. Articles that were published in Africa accounted for only 8.16% of all the LIS articles.

To find out if the observed difference as shown in Table 12, between citations received per year by articles that were published in and outside Africa is statistically significant, hypothesis H_{03} was tested using the Mann–Whitney *U* statistical test.

Table 12 Citations received per year for articles that were published in and outside Africa

	Published in Africa	Published outside Africa
N	149	1678
Citations per year	0.31	0.71

Table 13 Mann–Whitney U statistical test for publication place and citations received per year

Ranks				Test Statistics		
	Publication place	N	Mean Rank	Sum of Ranks	Mann–Whitney U	116802.00
Citation per year	Outside Africa	1678	918.89	1541901.00	Wilcoxon W	127977.00
	Africa	149	858.91	127977.00	Z	–1.362
	Total	1827			Asymp. Sig. (2-tailed)	0.173

Table 14 Collaboration types and citations received per year

	No collaboration	Institutional collaboration	National Collaboration	Intra-African Collaboration	Intercontinental Collaboration
N	687	612	190	63	275
Average citations/year	0.54	0.50	0.49	0.79	1.48

Hypothesis H₀₃ The difference in the citations received per year by articles that were published in African and those that were published outside Africa is not statistically significant.

The result of the Mann–Whitney U statistical test for Hypothesis H₀₃ is presented on Table 13. The null hypothesis was rejected as ($Z = -1.362$, $U = 127977.00$, $p \approx 0.001$). Therefore, the difference in the means of the citations received per year by articles that were published in and outside Africa is statistically significant.

Which collaboration type received the highest number of citations?

Table 14 shows that international collaboration received the highest number of citations per year, almost three time more than single author, institution and national collaborations. Surprisingly, national collaboration received the least number of citations per year. Intra-Africa collaboration, which is a type of international collaboration receive the second-highest number of citations per year though it accounted for the least number of papers.

The Kruskal–Wallis statistic test was performed to test for Hypothesis H₀₄ and investigate if the observed difference in the number of citations received per year between the collaboration types as displayed on Table 14 is statistically significant.

Table 15 Kruskal–Wallis Mean Ranks H test statistic

	Collaboration type	N	Mean Rank		Citation per year
Citation per year	No collaboration	687	883.16	Kruskal–Wallis H	115.758
	Institutional collaboration	612	837.42	Df	4
	National collaboration	190	798.70	Asymp. Sig.	0.000
	African collaboration	63	1159.32	a. Kruskal–Wallis Test	
	Intercontinental	275	1184.93	b. Grouping Variable: collaboration type	
		1827			

Hypothesis H₀₄ The difference in the citations received per year by at least two of the collaboration types (single author, institutional, national, African, and international) is not statistically significant.

The Kruskal–Wallis test that is displayed on Table 15 shows that there is a significant difference between the means of the citation per year of at least two collaboration types. Therefore, Hypothesis H₀₄ was rejected, $Z = 115.758$, $p \approx 0.0001$ with a mean rank score of 687 for no collaboration, 837.42 for institutional, 798.70 for national, 1159.32 for African and 1184.93 for international. There is a need therefore, to find out the pair(s) of collaboration types that have significantly different citations received per year.

To find out the pairs of variables that have significantly different means, ten Mann–Whitney *U* statistical tests were conducted for pairs of single author papers, institutional, national, African and international collaborations. The following hypotheses were tested:

Null hypothesis H₀₄₁: The difference in the averages between the number of citations per year for single author and institutional collaboration papers is not significant.

Null hypothesis H₀₄₂: The difference in the averages between the number of citations per year for single author papers and national collaboration is not significant.

Null hypothesis H₀₄₃: The difference in the averages between the number of citations per year for single author papers and African collaboration is not significant.

Null hypothesis H₀₄₄: The difference in the averages between the number of citations per year for single author papers and international collaboration is not significant.

Null hypothesis H₀₄₅: The difference in the averages between the number of citations per year for institutional and national collaboration is not significant.

Null hypothesis H₀₄₆: The difference in the averages between the number of citations per year for institutional and African collaboration is not significant.

Null hypothesis H₀₄₇: The difference in the averages between the number of citations per year for institutional and international collaboration is not significant.

Null hypothesis H₀₄₈: The difference in the averages between the number of citations per year for national and African collaboration is significant.

Null hypothesis H₀₄₉: The difference in the averages between the number of citations per year for national and international collaboration is not significant.

Null hypothesis H₀₄₁₀: The difference in the averages between the number of citations per year for African and international collaborations is not significant.

The results of the Whitney *U* statistical tests are presented on Table 16 below. The results show that three of the ten hypotheses were not rejected; hypothesis H₀₄₁ with

Table 16 Mann Whitney *U* Mean ranks and test statistics

	Collaboration type	Mean Rank	Sum of Ranks	Mann–Whitney <i>U</i>	<i>Z</i>	Asymp. Sig. (2-tailed)			
Citation per year	No collaboration	666.11	457620.00	199152.00	– 1.69	0.09			
	Institutional collaboration	631.91	386730.00						
	Total								
	No collaboration	448.22	307930.50				58927.50	– 2.11	0.04
	National collaboration	405.64	77072.50						
	Total								
	No collaboration	365.36	251004.50				14676.50	– 4.31	0.00
	African collaboration	486.04	30620.50						
	Total								
	No collaboration	435.46	299161.50				62833.50	– 8.25	0.00
	Intercontinental	596.51	164041.50						
	Total								
	Institutional collaboration	405.56	248204.00				55654.00	– 0.93	0.35
	National collaboration	388.42	73799.00						
	Total								
	Institutional collaboration	326.65	199910.50				12332.50	– 4.87	0.00
	African collaboration	448.25	28239.50						
	Total								
	Institutional collaboration	392.79	240388.50				52810.50	– 9.09	0.00
	Intercontinental	557.96	153439.50						
	Total								
	National collaboration	113.91	21642.50				3497.50	– 5.08	0.00
	African collaboration	166.48	10488.50						
	Total								
	National collaboration	177.23	33674.50				15529.50	– 7.55	0.00
	Intercontinental	271.53	74670.50						
	Total								
	African collaboration	154.55	9736.50				7720.50	– 1.35	0.18
Intercontinental	172.93	47554.50							
Total									

($Z = -1.69$, $U = 199152.00$, $p > 0.05$), hypothesis H_{045} with ($Z = -0.93$, $U = 55654.00$, $p > 0.05$) and hypothesis H_{0410} with ($Z = -1.35$, $U = 7720.50$, $p > 0.05$). This implies that the observed differences between the averages of citations received per year by papers that were written by single author and institutional collaboration, institutional and national collaboration, African and international collaborations are not statistically significant.

The results further show that seven of the ten hypotheses were rejected; hypothesis H_{042} with ($Z = -2.11$, $U = 58927.50$, $p = 0.04$), hypothesis H_{043} with ($Z = -4.31$, $U = 14676.50$, $p \approx 0.001$), hypothesis H_{044} with ($Z = -8.25$, $U = 62833.50$, $p \approx 0.001$), hypothesis H_{046} with ($Z = -4.87$, $U = 12332.50$, $p \approx 0.001$), hypothesis H_{047} with ($Z = -9.09$, $U = 52810.50$, $p \approx 0.001$), hypothesis H_{048} with ($Z = -5.08$, $U = 3497.50$, $p \approx 0.001$), and hypothesis H_{049} with ($Z = -7.55$, $U = 15529.50$, $p \approx 0.001$) were all rejected. This implies that single author papers (mean rank = 448.22) received more citations per year than national collaboration papers (mean rank = 405.64); African collaborations (mean rank = 486.04) received more citations per year than single author papers (mean rank = 365.36); international collaborations (mean rank = 596.51) received more citation per year than single author papers (mean rank = 435.46); African collaborations (mean rank = 448.25) received more citations per year than institutional collaboration (mean rank = 326.65); international collaboration (mean rank = 557.96) received more citations per year than institutional collaborations (mean rank = 392.79); African collaboration (mean rank = 166.48) received more citations per year than national collaboration (mean rank = 113.91); and international collaborations (mean rank = 271.53) received more citations than national collaborations (mean rank = 177.23).

Discussion of findings

One of the preliminary findings shows that South Africa is the most productive and cited African country, it accounted for 44.81% of all LIS papers from Africa and received a total of 5441 citations, five times more than the number of citations received by the second ranked country, Nigeria. Similarly, the top five most productive countries are South Africa, Nigeria, Morocco, Egypt and Botswana and they accounted for more than 75% of the publication from Africa. Following South Africa as the most cited country in Africa are Nigeria, Kenya, Botswana and Egypt. South Africa, Nigeria, Kenya, Uganda and Tanzania have the strongest links and highest number of collaborations. South Africa has consistently been identified as the most significant research hub in Africa by earlier studies such as Onyancha (2009), Onyancha and Maluleka (2011), Wagner and Leydesdorff (2005b) and Pouris and Ho (2014) that focused on research productivity and collaborations in Africa. These studies have also reported the rankings of Nigeria, Morocco and Egypt in different orders in the second to fifth place in research productivity in Africa.

As revealed that averagely LIS research contributed only 0.51% of national research outputs of African countries shows the contribution of LIS in Africa is negligible. Commenting on this finding at face value without considering the proportion of LIS researchers to all researchers in Africa is difficult. Similar trend of very insignificant proportion of LIS contribution to national research output was reported in Onyancha (2007), which focused on the citation analyses of Africa's LIS research from 1986 to 2006. It has also been reported that LIS in Africa is a relatively new discipline, this could explain why its contribution is insignificant since LIS has to compete with older and more popular disciplines (Ocholla and Bothma 2007; Onyancha and Minishi-Majanja 2009). It was also found that about 4% of all the LIS articles were funded. This result suggests that LIS research in Africa received

less funding than biomedical research considering the bibliometric study of biomedical research in the University of Ibadan, the biggest Nigerian University, between 2006 and 2015 by Asubiaro (2018) which showed that 30% of the biomedical research was funded.

The observable increase in research output of LIS researchers from Africa and the inclination towards collaboration as observed in this study is a pointer to the development of research in Africa. Earlier studies that adopted other methods of studying LIS in Africa have noted that LIS in Africa is young and developing. Some of these studies observed that there is an increase in the number of new LIS schools in some regions, while there is a decline in others because some traditional LIS schools have redesigned their curricula and have changed name, others have created new qualifications to realign themselves with the demands of the information profession (Aina 1994; Ocholla and Bothma 2007). Studies have suggested that collaboration is a measure of quality as it is believed that collaborative works are of better quality, are more cited and complex real-life problems are often solved through interprofessional or interdisciplinary collaborations (Bozeman et al. 2013; Katz and Martin 1997; Luukkonen et al. 1992; Subramanyam 1983). It was observed that institutional collaboration is the most popular as interaction with researchers through research collaboration outside the authors' institution and country is very low. This is consistent with the result of Onyancha and Maluleka (2011) which noted that Africa contributes insignificantly to each other's knowledge production. Similarly, Boshoff (2009) reported that 85% of international collaborations in the central African region are with authors from outside Africa. This trend shows signs of in-breeding; in-breeding occurs when researchers are employed in the same institutions or similar institutions in which they were trained. As noted by Asubiaro (2018), in-breeding is synonymous with intra-institutional or national collaboration, encourage research and disciplinary "*status quo*" and discourage global scholarly development in universities. The result also shows that collaboration among African countries is very low while a relatively more international collaborations was found, though there is an upward trend in international collaboration. An inclination over the years has also been reported in the literature about international collaboration in some countries in Africa (Narváez-Berthelemot et al. 2002; Asubiaro 2018). Though there is a need to discourage in-breeding and encourage international collaboration, there is also a need to increase intra-Africa collaboration. Barriers to research collaboration in Africa include lack of common value and trust, limited funding and infrastructure and absence of national and Africa-wide structure for such activities (Mensah et al. 2017; Maluleka et al. 2016).

Another key finding of this study is the very low visibility of the LIS research in Africa as reflected in the proportion of uncited LIS articles (35.65%) and average of 0.67 citation per year received by the papers. Though the uncitedness of LIS research in Africa is high, there are signs of improvement from the results of Onyancha (2007) where over 60% of LIS papers were uncited. It was also shown that LIS authors that are affiliated with institutions in Africa were first authors in less than 10% of all the international collaboration articles. This shows that LIS researchers from African institutions mostly do not participate in international collaborations as lead authors. This agrees with the finding of Owusu-Nimo and Boshoff (2017) about the role played by researchers that are affiliated with institutions from Ghana in international collaboration, which included data collection and field work. This is an evidence to speculate that researchers from Africa do not have the right expertise to lead international collaborations that are funded. A further analysis also showed that none of the international collaboration papers in which LIS authors from Africa are the first author were funded; the funding came from outside Africa. Therefore, foreigners were the first authors of all funded articles while LIS authors from Africa served as supporting authors. With this finding, it could be speculated that one of the reasons for the affinity for

international collaboration among researchers from Africa is visibility and funding. This corroborates the finding of Owusu-Nimo and Boshoff (2017) on research collaboration in Ghana, that access to expertise and enhanced productivity were the most important reasons why researchers from Ghana collaborate with international peers. Owusu-Nimo and Boshoff (2017) further stated that “collaborators from outside Africa played instrumental roles in providing resources and securing research funds”

The first hypothesis which was tested shows that funded articles received more citations than unfunded articles. This corroborates Asubiaro (2018) which observed that funded biomedical studies from the University of Ibadan received more citations. The result of the second hypothesis shows that articles whose first authors are affiliated with institutions in Africa were less cited than articles whose first authors are from outside Africa. This result provides some worrying indications about the role of researchers from Africa and their capacity to lead high profile research. This finding also raises further questions about research evaluation in Africa, it is however important to investigate what the situation is in other fields. The result of the third tested hypothesis shows that articles that are published outside Africa received more citations than articles that were published in Africa. This is an evidence to show that publications from African journals are less visible on the internet and the popular scholarly databases.

International collaboration accounted for only 15.05% of all the publications, it nevertheless accounted for 55.56% of all funded articles. Similarly, international and intra-African collaborations attracted the highest number of citations per year. A further analysis through hypothesis testing showed that the differences in the number of citations received by single authorship and institutional collaboration, institutional and national collaborations, African and international collaborations are not statistically significant. On the other hand, intra-African and international collaborations received more citations than papers that were written by single authors, institutional and national collaborations and the differences were found to be statistically significant. This finding further confirms other studies in South Africa and Nigeria (Asubiaro 2018; Onyancha 2011; Sooryamoorthy 2009, 2017) which noted that international collaboration attracts more citations than institutional or national collaboration in Africa. As noted earlier, funded research was statistically more visible than unfunded papers and international collaboration accounts for only 15.05% of all the publications, it nevertheless accounted for 55.56% of all funded articles, this certainly further confirms that international collaboration is important to the visibility of research in Africa. Also, African collaboration received more citations than institutional collaboration and single author papers. National collaboration received more citations than single author papers.

Recommendations and conclusion

Recommendations for governments to provide funding for research in Africa is commonplace. One of the implications of this study on research policy and administration in Africa is that intra-Africa and international collaborations should be encouraged given its potential to increase the visibility of research in Africa. Government agencies, universities and research administrators have a role to play in making policies and creating structures that will promote intra-Africa and international collaborations. Research funders in and outside Africa are also stakeholders that can make policies that will facilitate and influence intra-African and international collaborations. These research funders can create structures that will include researchers from Africa in research

projects outside Africa while intra-Africa and international collaborations are incorporated into conditions for research projects' funding in Africa. Another implication of this study on research policy and administration in Africa is the need to improve the quality of journals (in terms of their presence online and publishing quality research) that are published in Africa. Research funders can also include disseminating research outputs in African journals as a criterion for research funding, this will potentially encourage the publication of high-quality papers in journals published in Africa and increase the visibility of these journals. Another implication of this study is that the capacity of LIS researchers in Africa to lead high profile research is called into question because they hardly collaborate with their peers outside Africa as first authors. Therefore, it is recommended that creating structures that can facilitate international collaboration may also include building research capacity of LIS researchers in Africa so that they can lead high profile research. One of the means of achieving such capacity building is through the employment of prolific and influential researchers from other parts of the world on permanent or visiting capacities. Other means include institutional collaboration that will entail research staff exchange.

It is also recommended that databases that index and house research from Africa should be created. One of the challenges that research journals' publishing houses in Africa face is poor return on investment because of the small market for these journals. With the proliferation of the open access model for research output dissemination, publishing journals in Africa becomes more difficult. It is as important to ensure these journals are published both online and offline, as it is to develop research in Africa. One of the solutions to this is the intervention of funding agencies in the publication of research journals from Africa. One of such initiatives is the Africa Citation Index (ACI) which is funded by the Council for the Development of Social Science Research in Africa (CODESRIA), another is the African Journals Online (AJOL) which is largest collection of African journals online with over five hundred journals from Africa. It is recommended that AJOL includes the indexing services to the publishing it is already doing, this can complement the ACI.

In conclusion, higher visibility and funding through international collaboration as revealed in this study is a positive incentive to researchers in Africa to engage in international collaboration. However, there is a need to also increase intra-Africa collaborations as this study has revealed that intra-African collaboration attracted more citations than other types of collaboration and single authorship. Besides, most of the African countries face similar problems, therefore engaging in intra-African collaboration can potentially drive research on innovative solutions to the problems facing Africa. Also, intra-African collaborations can encourage investment in journals that are published in Africa and help bring more improve their reputation, recognition and visibility to research.

Higher visibility of the articles that were published outside Africa is also a positive incentive for researchers in Africa to publish in journals that are published outside Africa. However, journals that are published in Africa will continue to receive less quality articles, less recognition for indexing in major databases and less development if this trend continues. The limitations of WoS as the data source for Africa's research publication data is acknowledged and future research using data from other citation databases is suggested.

Appendix 1

See Table 17.

Table 17 LIS and research outputs of African countries between 1996 and 2015 in the Web of Science

S/N	Countries/regions	LIS national research output	% of national LIS research output to Africa's LIS research output	Total national research output	% of LIS national contribution to total national output
1	South Africa	1269	54.44	176896	0.72
2	Nigeria	310	13.30	39013	0.80
3	Morocco	116	4.98	33452	0.35
4	Egypt	110	4.72	115289	0.10
5	Botswana	103	4.42	4097	2.51
6	Ghana	73	3.13	9678	0.75
7	Tunisia	61	2.62	49793	0.12
8	Kenya	59	2.53	22461	0.26
9	Uganda	54	2.32	11123	0.49
10	Tanzania	37	1.59	11184	0.33
11	Algeria	25	1.07	34519	0.07
12	Ethiopia	24	1.03	10994	0.22
13	Zambia	24	1.03	3928	0.61
14	Malawi	20	0.86	5027	0.40
15	Namibia	20	0.86	1983	1.01
16	Zimbabwe	19	0.82	6278	0.30
17	Senegal	16	0.69	6439	0.25
18	Benin	12	0.52	3408	0.35
19	Cameroon	11	0.47	10047	0.11
20	Papua and Guinea	8	0.34	2221	0.36
21	Swaziland	7	0.3	609	1.15
22	Mauritius	5	0.22	1754	0.29
23	Mozambique	5	0.22	2276	0.22
24	Burkina Faso	4	0.17	4290	0.09
25	Cote d'Ivoire	4	0.17	4047	0.10

Table 17 (continued)

S/N	Countries/regions	LIS national research output	% of national LIS research output to Africa's LIS research output	Total national research output	% of LIS national contribution to total national output
26	Sierra Leone	4	0.17	542	0.74
27	Sudan	4	0.17	4871	0.08
28	Lesotho	3	0.13	387	0.78
29	Rwanda	3	0.13	1642	0.18
30	Guinea	2	0.09	637	0.31
31	Mali	2	0.09	2656	0.08
32	Niger	2	0.09	1593	0.13
33	Angola	1	0.04	580	0.17
34	Burundi	1	0.04	366	0.27
35	Democratic Republic of Congo	1	0.04	962	0.10
36	Liberia	1	0.04	217	0.46
37	Mauritania	1	0.04	200	0.5
38	Republic of Congo	1	0.04	1166	0.09
39	Seychelles	1	0.04	472	0.21
40	Madagascar	0		2666	0
41	Gambia	0		2142	0
42	Gabon	0		1936	0
43	Togo	0		1083	0
44	Guinea Bissau	0		502	0
45	Central Africa Republic	0		475	0
46	Eritrea	0		438	0
47	Zaire	0		386	0
48	Libya	0		380	0
49	Chad	0		329	0

Table 17 (continued)

S/N	Countries/regions	LIS national research output	% of national LIS research output to Africa's LIS research output	Total national research output	% of LIS national contribution to total national output
50	Djibouti	0		101	0
51	Equatorial Guinea	0		85	0
52	Comoros	0		69	0
53	Reunion	0		69	0
54	Somalia	0		67	0
55	^a Congo	0		41	0
56	South Sudan	0		15	0
57	Sao Tome and Principe	0		11	0
58	Western Sahara	0		4	0
59	Somaliland	0		1	0
		2331	Total	567916	0.41

^aMay refer to Democratic Republic of Congo or Republic of Congo. This is believed to be a product of wrong indexing by the Web of Science

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