

NATURE, PATTERNS AND TRENDS OF RESEARCH COLLABORATION AMONG ACADEMICS IN SELECTED UNIVERSITIES IN NIGERIA AND SOUTH AFRICA

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ABSTRACT

In this article, we argue that research collaboration, as an activity embarked upon by two or more individual researchers to attain common goals, is crucial in determining the breadth and depth of knowledge sharing among academics. The aim of the study was to investigate the nature, patterns and trends of research collaboration among academics in six universities in Nigeria and South Africa between 2003 and 2013. The study determined the level and extent of knowledge sharing among the actors by exploring several aspects of research collaboration. We targeted all the academic staff at the six universities whose

publications appeared in the SCOPUS database for the research period. The data was first extracted from SCOPUS by using affiliation search by university for the study period. Through descriptive and evaluative bibliometrics or publication count, domestically and internationally co-authored papers and major collaborating institutions between 2003 and 2013 were determined with the hope of finding co-authorship links for the six universities. The study revealed that research collaboration does occur among academics/researchers in the universities. The South African universities, namely, the University of KwaZulu-Natal (UKZN), Durban University of Technology (DUT) and University of Zululand (UZ) collaborated with each other. However, in Nigeria, there was only one collaborative tie between Ahmadu Bello University (ABU) and the Federal University of Technology (FUT), and no collaboration with Umaru Musa Yar'adua University (UMYU). South Africa also had a higher number of universities among the top 20 universities collaborating between the two countries within the study period.

Keywords: research collaboration, knowledge sharing, University of KwaZulu-Natal, Durban University of Technology, University of Zululand, Ahmadu Bello University, Federal University of Technology, Umaru Musa Yar'adua University, Nigeria, South Africa

1. INTRODUCTION AND BACKGROUND

While teaching and community outreach are important in a university, research is fundamental for enabling knowledge creation and dissemination and supporting teaching and learning in an academic environment. Research is increasingly being done through collaboration, a term that is often used interchangeably with terms like 'partnership'. It has become a popular concept in all areas of life where two or more individuals, organisations, institutions or nations embark upon a mutually agreed process. Collaboration can therefore be defined as a 'partnership, alliance or network, aimed at a mutually beneficial, clearly defined outcome' (Commonwealth of Australia 2004, 1). Sullivan and Skelcher (2002) assert that collaboration provides the opportunity for experts and researchers to work together towards achieving a common goal and for uniform practice through shared interests, objectives, and solving common problems. A lot of perspectives focus on the typology of collaboration. Smith and Katz (in Onyancha 2014, 87) categorise six levels of research collaboration, namely, individuals, groups, departments, institutions, sectors and countries. Such collaborations can also be inter-disciplinary and inter-regional. Roper (2002) highlights four categories, namely, scope, coverage, originators, and the extent of involvement of the individuals concerned. Two such typologies, in his view, are the 'expert-consultant model' and the 'expert-trainer model' where academics are poised to be role models whose functions are to identify

and promote the standard of the organisation through production, learning and sharing of skills and knowledge. Sullivan and Skelcher (2002) highlight three types of collaboration, namely, contracts, networks and partnerships. They explain that a contract is a collaborative initiative built upon a formal agreement that is based on a principal-contractor relationship which can be terminated in the event of the violation of contract terms. The network model begins with ordinary relationships driven by willingness, mutual trust, and common benefits (Sullivan and Skelcher 2002). These relationships go beyond organisational boundaries and objectives and are more advantageous in terms of individual participation. Unlike the contract or network types, the partnership model spells joint mutual agreement and emphasises joint decision making, processes and operations (Teisman 2000, 85–86). Thus, collaboration is regarded as a process of collective initiative, action and execution of an identified task based upon a predetermined framework aimed towards achieving a desired objective (such as a project, problem solving, business, administration, etc.). The typology of collaboration is likely to belong to one or more of the three paradigms discussed below.

Sullivan and Skelcher (2002) outline three theoretical viewpoints on collaboration, namely, optimist, pessimist and realist. The optimist viewpoint, they explain, places more emphasis on an affirmative and positive direction; the parties involved are regarded to be altruistic individuals with a long-time focus on benefits rather than immediate reward. From this perspective, academics and practitioners should stride side by side with mutual and shared responsibilities from the beginning (inception and design), through the struggle of sustainability and completion (production), and down to utilising the end products or services as output (consumption) and beyond (Sullivan and Skelcher 2002). Closely linked to the exchange theory, the two authors add, the optimist viewpoint advocates the partnership of different parties involved in carrying out a project aimed at solving a common problem through the implementation of shared responsibility and a mutually oriented initiative for continuous long-term benefits. Thus, a collaborative initiative can be embarked upon following the invitation of one individual by another with similar interests, known as collaborative advancement, and the setting of mutually agreed specifications and engagements for the conduct of a project, referred to as collaborative consent (Himmelman 1996). This type of collaboration focuses more on benefits than risks.

The pessimist perspective is the complete opposite of the optimist paradigm as it views the motive behind collaboration to be the influence and dominance of the parties involved. The theory is derived from the resource dependency theory (RDT) that was proposed by Pfeffer and Salancik in 1978 (known then as the 'resource dependence perspective'). The collaborative norms that are emphasised in this theory are competitive in nature, and the parties involved use their resources and influence to control the other and to manipulate or control their participation. This theory emphasises dominance and control (Boshoff 2009; Emerson in Charles,

Hayman and Mdee 2012). In his attempt to elaborate on this theory, Benson (in Charles et al. 2012) asserts that every organisation has pre-determined objectives to achieve and strictly strives to realise such objectives for its existence and survival. Thus, the theory views collaboration as an opportunistic venture; collaboration can be embarked upon at any stage of the project in as much as the perceived benefits of dominance and resource control are certain (Sullivan and Skelcher 2002, 41). Such collaboration has risks exceeding benefits (Pouris and Shan-Ho 2014, 2170) as the actors pursue global collaboration through 'self-interested strategies' (see Adams et al. 2014) and dependence with neo-colonial tendencies rather than inter-dependence (Boshoff 2009) where a mutually beneficial relationship of equals occurs.

The realist perspective focuses on the prevailing situation at the time of a collaborative project as the basis for making informed decisions about participation and level of involvement in the project. Alter and Hage's (1993) Evolutionary Theory provides a clearer interpretation of the realist perspective. The idea is that a number of factors influence the viability of a collaborative initiative, such as politics, economy, technological advancements and partners. They believe that experience and adaptation are very crucial in collaboration; it is not achieved instantly, rather it is a relative practice evolving through practice (Sullivan and Skelcher 2002). The realist perspective is similar to the pessimist perspective in some respects. The Social Capital Theory (see Putman 1995, 2000), which we have used in a broader study (Fari 2015a, 2015b; Fari and Ocholla 2015) seems to fit well in this paradigm and provides a broader perspective for understanding collaboration. For example, Adams et al. (2014) argue that the pattern of collaboration in Africa is not universal. Rather it exhibits both internal and external clusters that are defined by regional, historical, cultural and linguistic ties and influences. Related studies (e.g. Boshoff 2009, 2010; Onyanha 2011) concur with this paradigm in different ways. For example, Boshoff (2010, 500) reports, 'In SADC, about 81% of all papers and 78% of all intra-regional co-authored papers are produced by South Africa', creating a rather unbalanced partnership. In this case, the countries exhibit largely pessimistic and realistic paradigms.

Research collaboration is increasingly receiving attention in Africa. Studies in the last decade include: Onyanha and Ocholla's (2007) study on collaboration in HIV/AIDs research; Ocholla (2009) addressing challenges of collaboration in LIS; Boshoff (2009, 2010) regarding neo-colonialism and research collaboration in Central Africa; Onyanha's (2011) study on knowledge collaboration; Onyanha's (2014) study on partnership on HIV; Pouris and Ho (2014) determining research collaboration patterns and subject focus; Adams et al. (2014) identifying international collaboration clusters in Africa; Ngoepe, Maluleka and Onyanha's (2014) study on research collaboration in archives and records management; and Sooryamoorthy (2009a, 2009b), focusing on levels of collaboration and publications in South Africa as well as citation patterns (2009b). These sources provide useful related

citations for researchers in this field to pursue. We argue that the growing interest in research collaboration is driven by its benefits (see Katz and Martin 1997). Research collaboration promotes peer review; enables and supports sharing of knowledge, skills and techniques (Fari 2015a, 2015b); promotes knowledge transfer; enables the cross fertilisation of ideas; develops professional ties; increases visibility and recognition; and enables the benchmarking of research culture. The latter entails increasing the understanding of the value of knowledge and applied collaborative research; growing advocacy for shared responsibilities among experts towards achieving better results; an increase in funding for collaborative research processes and projects; and the desire to expand the provision of and access to higher education globally (Katz and Martin 1997; Sullivan and Skelcher 2002). Collaboration in research has become a global norm (Rao and Raghavan 2003, 230).

2. PURPOSE OF THE STUDY

The purpose of the study was to examine the trends of research collaboration among academics in South Africa and Nigeria from 2003 to 2013. We attempted to answer the following research questions:

1. Is there any research collaboration within, between and beyond the six universities?
2. What are the selected universities' contributions in terms of the number of co-authored papers from 2003 to 2013?
3. How do Nigerian and South African academics/researchers compare and perform in research collaboration?
4. What are the countries' and universities' extent of collaboration generally and with each other within the period of study?
5. What are the trends of research collaboration within the period from 2003 to 2013?
6. What is the influence of research collaboration/co-authorship on research impact?
7. Is there a relationship between research collaboration and knowledge sharing?

3. METHODOLOGY

Content analysis, through descriptive (publication count) and evaluative bibliometrics (citation analysis), was the primary research method in the study. The study targeted all the academic staff from six selected universities in Nigeria and South Africa whose publications appear in SCOPUS for the research period from 2003 to 2013. The universities were selected purposively. We used South Africa's categorisation of

universities, that is, comprehensive, traditional (research intensive) or technological, in our selection. The University of KwaZulu-Natal (UKZN, South Africa) and Ahmadu Bello University (ABU, Nigeria) are in the traditional university category; Durban University of Technology (DUT, South Africa) and the Federal University of Technology (FUT, Nigeria) are technological universities; while the University of Zululand (UZ, South Africa) and Umaru Musa Yar'adua University (UMYU, Nigeria) are in the comprehensive university category. The six universities also belong to the top 100 ranked universities in Africa, with UKZN among the top ten according to the 2013–2014 ranking web of world universities (<http://www.webometrics.info/en/Africa/Kenya%20>).

We used the SCOPUS database to select research papers published from 2003 to 2013 for our analysis because it indexes quality research publications and balances between quality and comprehensiveness in its coverage of research in Africa (see Onyanha and Ocholla 2009). The data was first extracted from SCOPUS by using researchers' institutional affiliation as the search term. Through descriptive bibliometrics or publication count, domestically and internationally co-authored papers between 2003 and 2013 were identified for co-authorship analysis. A network link was attained by designing a matrix connecting the collaborating universities using Microsoft Excel and then copying the data into UCINET 6 software for processing. We counted the country-wise co-authorships and considered the co-occurrence of Nigeria or South Africa with another country in the address field of each record. A country and university was counted only once, irrespective of how many times it appeared with Nigeria or South Africa in the address field of the same record. We determined whether there was research collaboration among the universities and between the two countries over time and identified the main collaborators by using four approaches: determining co-authored papers domestically (within the countries), between the two countries, and beyond the two countries; determining the strength of association by using the co-word algorithm to determine the co-word and collaborative links; calculating the collaborative co-efficient to measure the degree of collaboration; and applying factor analysis to identify the major collaborating country/university as was done in a related study (Onyanha and Ocholla 2007). We report the findings in the next section.

4. FINDINGS

The findings are presented and discussed in sections 4.1 to 4.6.

4.1. Collaboration networks among the six selected universities in Nigeria and South Africa

Several studies (e.g. Boshoff 2009, 2010; Onyanha 2011; Sooryamoorthy 2009a) show that research collaboration in Africa is relatively low. Other studies (Adams et

al. 2014; Boshoff 2009) also acknowledge that collaboration is driven by geographical location/proximity, shared culture, history and language, and neo-colonial research dependence. The proximity/regional aspects of collaboration seem to prevail in the networks created in this collaboration.

Figure 1 depicts the collaborative network. The arrows connecting the universities indicate whether or not there was a two-way collaboration (each arrow indicates the direction of the collaboration). The figures on each side of the arrow indicate the number of times one university collaborated with the other and vice versa. For example, the number of times UKZN collaborated with DUT was 141.0 times altogether, while UKZN and UZ collaborated 55 times, and UKZN also collaborated with ABU three times during the study period. DUT and UZ collaborated five times, while ABU collaborated with FUT only once. As the graph indicates, the only university that collaborated both within and outside the home country was UKZN, even though most of the collaboration was with universities in South Africa. The only collaboration between UKZN and the selected universities in Nigeria was between UKZN and ABU, while UMYU did not collaborate with any of the selected universities in Nigeria and South Africa during the study period.

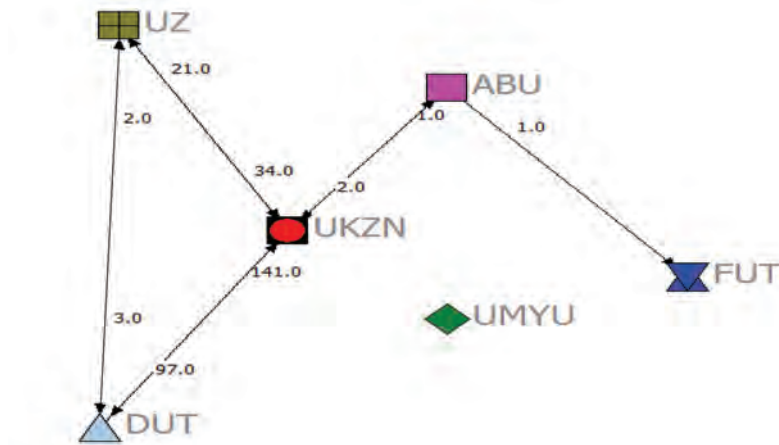


Figure 1: Collaboration trends among the selected universities

4.2. Number of co-authored researches per university (2003–2013)

Co-authorship is widely used to analyse and understand research collaboration, as reflected in several studies reported by Onyancha (2009, 88) and Sooryamoorthy (2009a). Citing Gauthier in particular, Onyancha (2009, 88) reports that, 'Co-authorship remains the most preferred indicator used to describe collaboration and cooperation in all areas of research'. Table 1 illustrates the contribution of academics from the six selected universities in Nigeria and South Africa with respect to co-authored papers from 2003 to 2013.

In the case of ABU, the number of co-authored papers was steadily growing with slight downward fluctuations in the years 2004 and 2009, respectively. There was a decline for two consecutive years from 2011 to 2013; the highest record of 343 co-authored publications was reached in 2011, but the output declined to 300 and 281 in 2012 and 2013, respectively. The trend was not encouraging for FUT throughout the study period, even though it showed some positive growth towards the end in 2012 and 2013, recording a total of eight and 11 co-authored papers, respectively. However, the change was not commendable compared to other universities in the study. The academics from UMYU provided no contributions from 2003 to 2009 and also in 2011, and only two, one and six publications were co-authored in 2010, 2012 and 2013, respectively. This was the poorest performance of all the sampled universities.

There was a steady increase in the number of papers published by two or more authors from UKZN. The output grew considerably and consecutively in 2011, 2012 and 2013 when 1 291, 1 440 and 1 556 co-authored papers were recorded, respectively. The contribution of academics from DUT throughout the study period was steadily increasing, with a few downward fluctuations of 11, 32 and 76 papers in the years 2004, 2008 and 2012, respectively. The trend for UZ was not steady, even though there were records right from 2003. The output kept fluctuating, with the highest record of 61, 62 and 63 publications per annum in the years 2009, 2010 and 2013, respectively, reflecting an insignificant growth.

Overall, in all six cases the growth of co-authored papers compared to single-authored papers during the study period showed significant growth except at FUT and UMYU where the growth of both single- and co-authored papers was quite low.

Table 1: Single- and co-authored researches of the six selected universities

YEAR	UKZN			DUT			UNIZULU			ABU			FUT			UMYU		
	Total	S	C	Total	S	C	Total	S	C	Total	S	C	Total	S	C	Total	S	C
2003	14	2	12	18	0	18	31	9	22	94	28	66	0	0	0	0	0	0
2004	378	82	296	11	0	11	28	3	25	78	15	63	0	0	0	0	0	0
2005	699	144	555	23	0	23	50	5	45	115	14	101	0	0	0	0	0	0
2006	831	155	676	33	3	30	40	5	35	170	19	151	1	0	1	0	0	0
2007	884	146	738	52	10	42	49	3	46	199	30	169	1	0	1	0	0	0
2008	1 038	184	854	39	7	32	60	6	54	229	16	213	4	1	3	0	0	0
2009	1 105	177	928	55	7	48	69	8	61	236	24	212	4	2	2	0	0	0
2010	1 133	187	946	76	17	59	74	12	62	298	16	282	4	0	4	2	0	2
2011	1 461	170	1 291	113	26	87	66	8	58	372	29	343	3	1	2	0	0	0
2012	1 684	244	1 440	87	11	76	52	6	46	317	17	300	8	0	8	1	0	1
2013	1 848	292	1 556	131	19	112	76	13	63	295	14	281	12	1	11	6	0	6
Grand Total	11 075	1 783	9 292	638	100	538	595	78	517	2 403	222	2 181	37	5	32	9	0	9

Key:

S = Single-authored

C = Co-authored

Total = Totals include duplicate researches (i.e. researches belonging to two or more than two universities counted as whole researches for each author)

4.2.1. Mode of authorship in Nigeria

The data presented in Figure 2 is the aggregate of the all the single-authored and co-authored publications for all three of the selected universities from Nigeria for the study period.

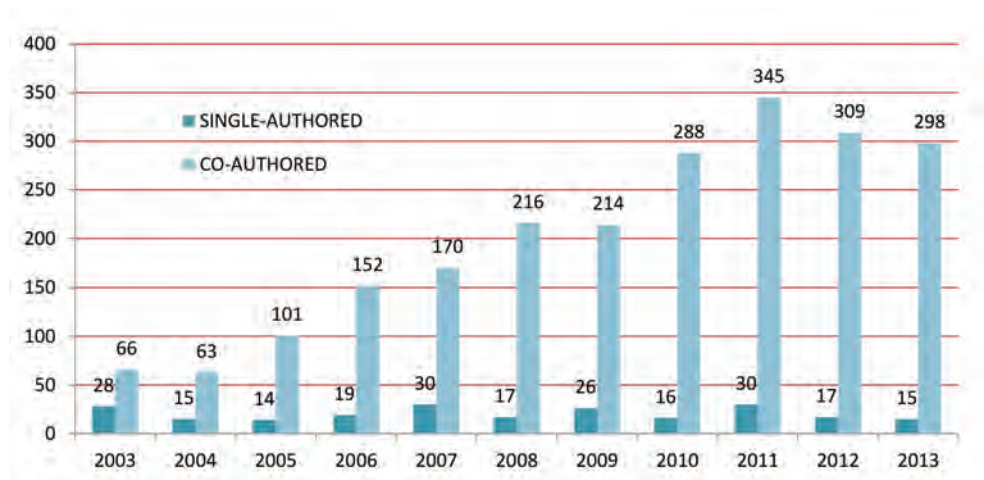


Figure 2: Mode of authorship in Nigeria

Figure 2 illustrates the total publication output by academics from the three universities in Nigeria and the trend in single- and co-authored papers during the period from 2003 to 2013. The trend shows that throughout the study period, there were a higher number of co-authored papers than single-authored papers. It also reveals that the output was increasing over the years, with the exception of the last two, 2012 and 2013, when the records dropped to 309 and 298 co-authored papers, respectively.

4.2.2. Mode of authorship in South Africa

The data presented in Figure 3 is the aggregate of all the single- and co-authored publications for the three selected universities from South Africa for the study period.

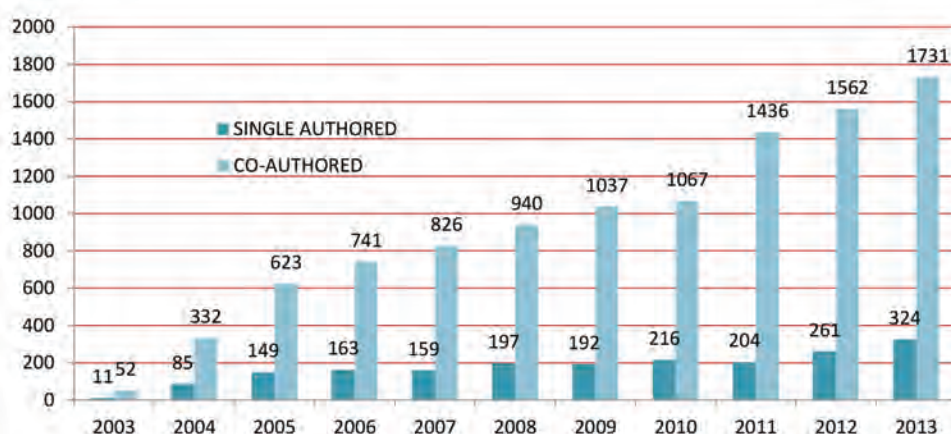


Figure 3: Mode of authorship in South Africa

Figure 3 shows the trend in single- and co-authored papers by academics from the three universities in South Africa. The publication output of both single- and co-authored papers was steadily increasing throughout the study period. The output reached 1 037 co-authored papers by the year 2009 and maintained that trend until 2013 when the highest peak of 1 731 was reached, which also marked the last year of the study period. Single-authored papers also reached their highest peak of 324 in the year 2013.

4.3. Countries' and universities' degree and strength of collaboration within the study period

The degree and strength of collaboration was determined in this analysis based on its successful application in related studies (Onyanha 2009; Onyanha and Ocholla 2007). While various methods of calculating the degree of collaboration have been used in research, we opted for the formula proposed by Subramanyam (1982), as follows:

$$\text{The degree of collaboration } C = \frac{Nc}{Nc + Ns}$$

Where,

C = Degree of collaboration

Nc = Number of co-authored papers

Ns = Number of single-authored papers

$$\text{Here, } C = \frac{2\ 222}{2\ 222 + 227} = 0.91 \quad \text{For Nigeria}$$

$$C = \frac{10\ 347}{10\ 347 + 1\ 961} = 0.84 \quad \text{For South Africa}$$

Table 2 reveals that there was a slight difference in the degree of collaboration when comparing Nigeria (0.91) and South Africa (0.84). Nigeria had a higher percentage of co-authored papers against single-authored papers than South Africa, even though the number of both single-authored and co-authored publications in South Africa was higher throughout the period of study. In essence, the percentage of co-authored research (2 222; 90.73%) against the number of single-authored (227; 9.27%) publications from the selected universities in Nigeria was higher than the number of co-authored research (10 347; 84.07%) against the single-authored (1 961; 15.93%) publications in South Africa. The higher the ratio of co-authored papers over single-authored papers in a particular university(s) within a particular period, the higher the degree of collaboration recorded.

Table 2: Degree of collaboration of the selected universities by country

Country	Total number of papers	Single- and co-authored paper percentage				Degree of collaboration
		S	%	C	%	
Nigeria	2 449	227	9.27	2 222	90.73	0.91
South Africa	12 308	1 961	15.93	10 347	84.07	0.84

Table 3 presents the data obtained with respect to the publications (within each university only) of the authors from the six selected universities for the period from 2003 to 2013, including the number and percentage of single- and co-authored articles.

Table 3: Degree of collaboration within each of the six selected universities

University	Total number of papers	Number of authors	Average authors per paper	Single- and co-authored paper percentages				Degree of collaboration
				S	%	C	%	
UKZN	1 554	7 539	4.85	8	0.51	1 546	99.49	0.99
DUT	206	711	3.45	25	12.14	181	87.86	0.88
UZ	344	1 193	3.47	28	8.14	316	91.86	0.92
ABU	456	1 797	3.94	24	5.26	432	94.74	0.95
FUT	137	478	3.49	15	10.95	122	89.05	0.89
UMYU	23	131	5.70	0	0.00	23	100.00	1.00

Table 3 reveals that in the case of South Africa, there were: eight single-authored (0.51%) and 1 546 co-authored (99.49%) publications for UKZN; 25 single-authored

(12.14%) and 181 co-authored (87.86%) publications for DUT; and 28 (8.14%) and 316 (91.86%) single-authored and co-authored publications for UZ, respectively. In Nigeria, there were 24 single-authored (5.26%) and 432 co-authored publications (94.74%) for ABU; 15 single-authored (10.95%) and 122 co-authored publications (94.74%) for FUT; and no single-authored (0.00%) and 23 co-authored (100%) papers for UMYU.

The average number of authors per paper revealed that South African universities were led by UKZN with the highest number of authors (4.85), followed by UZ (3.47) and DUT (3.45), while the Nigerian universities were led by UMYU (5.70), ABU (3.94) and FUT (3.49). The degree of collaboration within the universities was also calculated for the study period as shown in the table. The degree of collaboration in South Africa was 0.99, 0.88 and 0.92 for UKZN, DUT and UZ, respectively, while in Nigeria it was 0.95, 0.89 and 1.00 for ABU, FUT and UMYU, respectively.

4.4. Trends in research collaboration (2003–2013)

It is important to determine whether research collaboration is either growing or declining over time and the reasons behind this growth/decline trend in order to inform policy and decision making. In this section we analyse and present the collaboration trend, subject fields and frequency of collaboration, types and frequency of collaborative papers, universities and authors collaborating from the two countries, that is, between Nigeria and South Africa.

The data in Figure 4 represents the aggregate figures of the combined co-authored papers (2 authors or more) for the selected universities per country over the study period. The figures were compared country-wise in order to highlight the growth of the co-authored papers, which is the determinant/indicator of collaboration. The chart reveals a significant disparity in the number of co-authored papers over the years in favour of the South African universities; the number of co-authored publications in South Africa increased annually to 1 731 in the year 2013 against Nigeria's 345 in the year 2011.

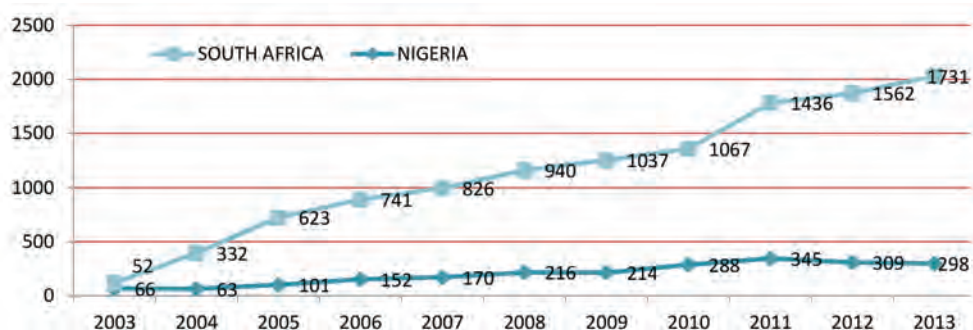


Figure 4: Co-authorship trends of the two countries during the study period

4.4.1. Some areas of research collaboration among all the universities from Nigeria and South Africa (2003–2013)

The data for the number and frequency of the areas/fields in which collaboration took place among all the universities from the two countries within the study period was extracted from the database and the results are presented in Figure 5.

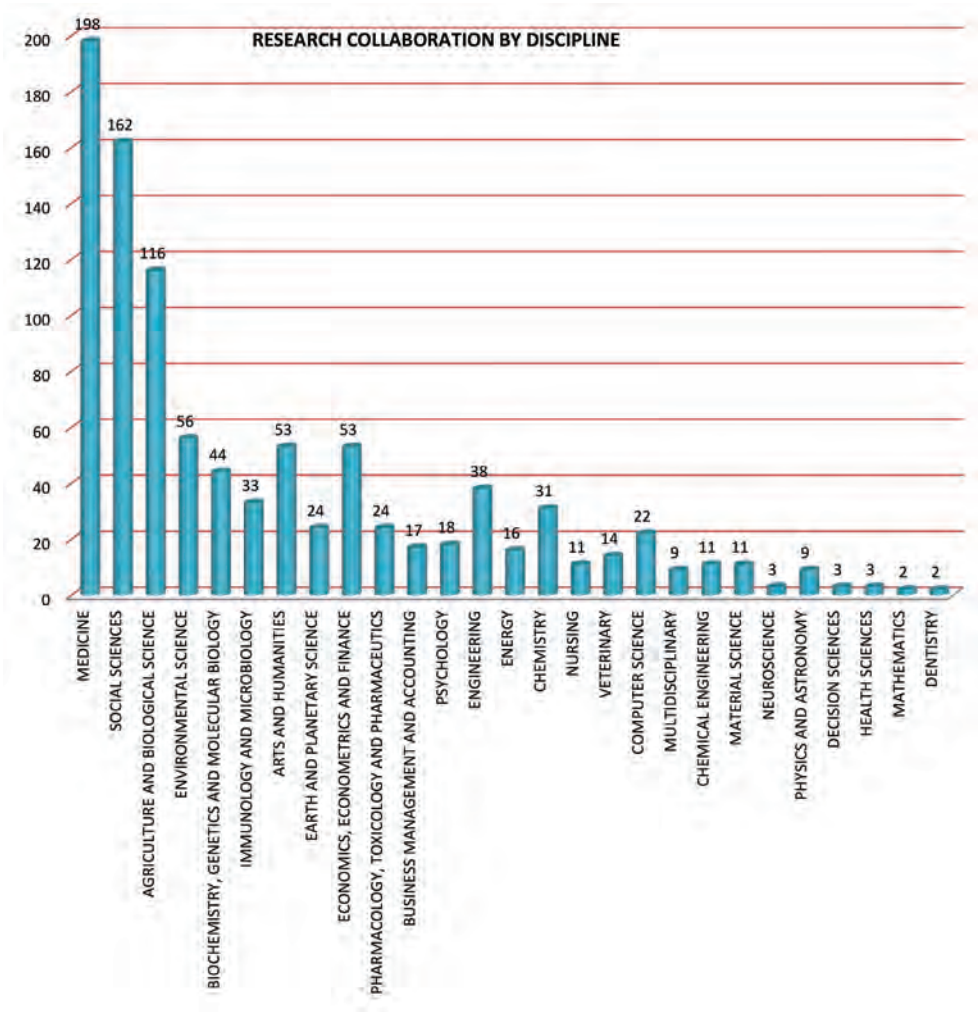


Figure 5: Some areas of collaboration and the frequency of collaboration

Figure 5 reveals some 27 areas of collaborative research among all the Nigerian and South African universities for the research period. The majority of collaborative publications were in the area of medicine (198), followed by the social sciences (162), agriculture and biological sciences (116), environmental sciences (56), biochemistry and genetics (44), and immunology and microbiology (33). The least number of collaborative publications were in the health sciences (3), mathematics (2) and dentistry (2). These results concur with Pouris and Ho's (2014, 2173) study which reported that research areas are dominated by 'medical and natural sciences fields' and related disciplines. The dominance of the 'natural resource' field of collaboration in Africa is also reported by Adams et al. (2014).

4.4.2. Types and frequency of collaborative documents among all the universities from Nigeria and South Africa (2003–2013)

The types and frequency of collaborative publications among all the Nigerian and South African universities over the period of study were also investigated. The majority of publications were journal articles (514), reviews (35), books (1), book chapters (18), conference papers (26), and editorials (3). The results obtained are presented in Figure 6. While we expected a lot of collaboration in journal articles, we did not expect the small number of co-authored conference papers and books.

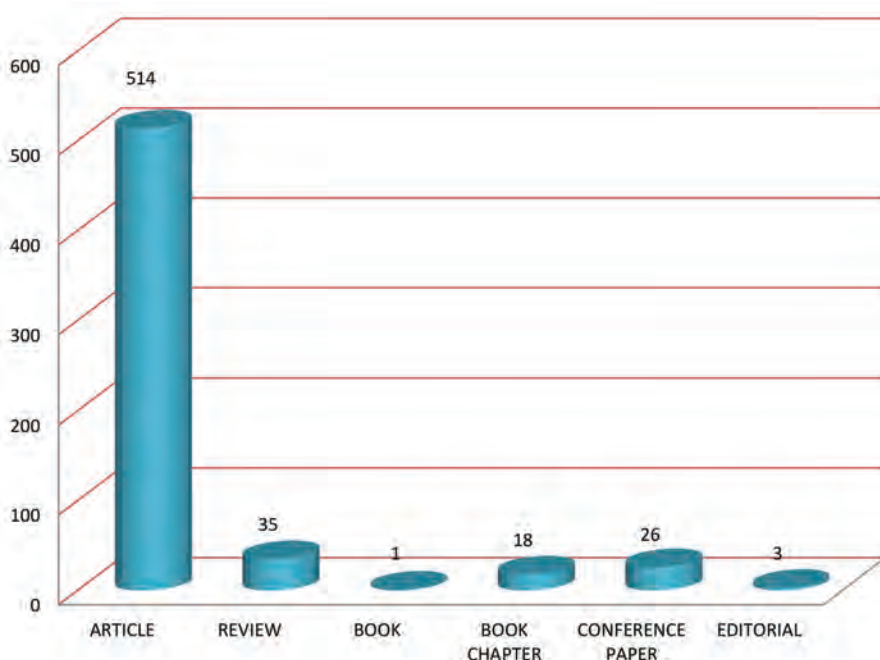


Figure 6: Types of publications used for collaboration

4.4.3. Top 20 authors collaborating among all the Nigerian and South African universities

Table 4: Top 20 collaborating authors

Name of author	University/ Institution	Country	Number of publications
Loto, C. A.	Tshwane	SA	8
Popoola, A. P. I.	Tshwane	SA	5
Afolayan, A. J.	Fort Hare	SA	5
Eloff, J. N.	Pretoria	SA	5
Van Staden, J.	UKZN	SA	5
Chigor, V. N.	Fort Hare	SA	4
Fatoki, O. S.	Cape Peninsula	SA	4
Ayede, A. J.	Ibadan	NIG	4
Mc Gaw, L. J.	Pretoria	SA	4
Okeniyi, J. O.	Covenant	NG	4
Kazeem, M. I.	Lagos	NIG	4
Okoh, A. I.	Fort Hare	SA	4
Oluwafemi, O. S.	Cape Peninsula	SA	4
Atilola, O.	Lagos	NIG	4
Adesokan, H. K.	Ibadan	NIG	3
Chigor, V. N.	Fort Hare	SA	3
Adeyemi, O. O.	Olabisi Onabanjo	NIG	3
Adedini, S. A.	Wits	SA	3
Akinwusi P. O.	Ladoke Akintola	NIG	3
Baro, E. E.	Abraka	NIG	3

Table 4 reveals that of the top 20 collaborating authors from the two countries for the research period, 12 were from South Africa and eight from Nigeria. C. A. Loto from South Africa was the highest overall collaborating author with eight co-authored publications.

4.4.4. Top 20 collaborating universities in Nigeria and South Africa

Table 5: Top 20 collaborating universities

University	Country	Number of publications
University of Ibadan	NIG	60
Obafemi Awolowo University	NIG	44
University of Witwatersrand	SA	34
University of KwaZulu-Natal	SA	31
University of Nigeria	NIG	31
University of Pretoria	SA	30
University of Cape Town	SA	27
University of Fort Hare	SA	27
University of Johannesburg	SA	22
University of Ilorin	NIG	22
University of Lagos	NIG	20
Tshwane	SA	19
Covenant University	NIG	18
University of Port-Harcourt	NIG	17
University of Calabar	NIG	15
Delta State University	NIG	14
University of Limpopo	SA	14
Ahmadu Bello University	NIG	13
University College Ibadan	NIG	13
Ladoke Akintola University	NIG	13

The highest number of collaborative research was recorded by Nigerian universities, specifically the University of Ibadan (60) and Obafemi Awolowo University (44). The top three collaborating South African universities were the University of Witwatersrand (34), followed by the University of KwaZulu-Natal (31) and the University of Pretoria (29).

4.5. Influence of research collaboration on research impact using co-authored papers from the six selected universities in Nigeria and South Africa (2003–2013)

The journal impact factor and author impact factor are based on citation analysis, often used to determine how influential a journal or an author's work is (Amin and Mabe 2000; Bar Illan 2011; Kumar and Fortunate 2014; Pendlebury 2008). Based on data obtained for all the publications from the six selected universities in the two countries, the cumulative number of citations received by each paper within the period of study was counted. In order to come up with the average citations per paper, the sum total of citations for all the papers was divided by the total number of papers which gave the average citations per single- or multiple-authored papers, respectively, as can be seen in Table 6.

Table 6: Number of citations per single- and multiple-authored papers

Number of authors	Total citations		Papers		Citations per paper	
	NIG	SA	NIG	SA	NIG	SA
1	823	7,142	227	1,961	3.63	3.64
2 and more	8,370	92,895	2,222	10,347	3.77	8.98
Total	9,193	100,037	2,449	12,308	3.75	8.13

Table 6 relays the data for the comparison of citations per paper and the nature of authorship (i.e. single or multiple) in Nigeria and South Africa. This comparison was done in order to establish the link between collaboration and research impact. It was established that Nigeria's 227 single-authored papers received a total of 823 citations with an average of 3.63 citations per paper, while South Africa's 1 961 single-authored papers received 7 142 citations, with an average of 3.64 citations per paper. Regarding co-authored papers, Nigeria's 2 222 co-authored papers received a total of 8 370 citations with an average of 3.77 citations per paper, while South Africa's 10 347 co-authored papers received a total of 92 895 citations with an average of 8.98 citations per paper. The widely held view that co-authored papers receive more citations is affirmed.

4.6. Implication of research collaboration for knowledge sharing

The trend in collaboration of the individual universities and countries at large correlated significantly with co-authorship, and this in turn influenced the number of times a particular article was cited. The average number of citations received by single-authored papers was significantly lower than the average number of citations

received by co-authored papers in the two countries. The benefits of collaboration and partnership, which include knowledge sharing alluded to at the beginning of the article, seem to prevail. We noticed a close link between co-authorship and research collaboration on the one hand, and research collaboration with knowledge sharing, on the other. The evidence suggests that knowledge is shared widely and more often through co-authored papers. Co-authored papers also determine the degree of collaboration (based on the average number of authors per paper), because the greater the number of authors collaborating, the more knowledge is shared. Therefore, it is deduced that there is a strong relationship between research collaboration and knowledge sharing.

5. CONCLUSION

At the beginning of the article, we highlighted three paradigms of collaboration as discussed by Sullivan and Skelcher (2002), namely, optimistic, pessimistic (see also Charles et al. 2012) and realistic. The realistic paradigm, which largely informs the study, recognises that multiple factors influence collaborative efforts, such as politics, economics, social and technological factors, and ‘adaptation’ (Alter and Hage 1993; Boshoff 2009, 2010; Sullivan and Skelcher 2002). Boshoff’s (2009, 413) study on neo-colonialism and collaboration in Africa, for example, determined that:

80% of Central Africa’s research papers are produced in collaboration with a partner from outside the region ... 46% of papers are produced in collaboration with European countries as the only partner, and 35% in collaboration with past colonial rulers. The top collaborating countries are France (32%), the USA (14%), and the UK and Germany (both 12%).

The realistic approach/paradigm to collaboration does not follow a ‘one shoe fits all’ approach. This approach to collaboration would be cognisant of factors influencing collaboration in Africa, such as history, culture and language (Adams et al. 2014); neo-colonialism (Boshoff 2009); natural resources (e.g. energy, agriculture); field/discipline on research collaboration (Adams et al. 2014; Pouris and Ho 2014); regional and international ties (Boshoff 2010; Onyanha 2011); and variability of the impact factor (Amin and Mabe 2000; Bar-Ilan 2008; Kumar and Furtunato 2014; Pendlebury 2008; Sooryamoorthy 2006b).

The study revealed that proximity/regional influences collaboration (see also Onyanha 2011). The results also revealed that research collaboration in terms of co-authored papers is increasing (see Table 1), thereby confirming a link between co-authorship and collaboration (Onyanha 2009; Sooryamoorthy 2009a), which in turn is linked to knowledge sharing (Fari 2015b). There was a higher number of co-authored papers than single-authored papers between 2003 and 2013 (see Figure 2 and Figure 3), which is positive growth in favour of collaboration. The collaborative growth was much lower in the Nigerian sample (see Figure. 4), but positive all the same. The leading research fields/disciplines of collaboration were the applied

sciences which are largely natural-resource based (see Figure 5). These results are confirmed by Pouris and Ho (2014) and Adams et al. (2014), but not so much in Boshoff's (2009) Central African study where collaboration in the natural sciences was most prevalent. While it is reasonable to expect research publications to appear in journal articles (see Figure 6), we expected conference papers and book chapters – which are popular sources of collaboration – to come after the journal articles, which was not the case. Furthermore, among the six universities that were sampled for the study only one, the University of KwaZulu-Natal, which is also the most established of them all, appeared in the top 20 universities collaborating between Nigeria and South Africa (see Table 5).

Evidence of collaboration among Nigerian and South African universities exists, though weak, and this does not seem to be unusual in Africa where collaboration among African countries is relatively low (Boshoff 2010; Sooryamoorthy 2009a). For example, Boshoff (2010, 500) determined that, 'In 2005–2008, 60% and 59% respectively of intra-regional and continental co-authored papers involved at least one high-income country'. Most of the publications reviewed for this study reveal that there is more existing research collaboration among African countries and developed 'high income' countries largely with long historical ties due to colonialism. There are realistic political, economic, and social technological factors used to explain this dependence rather than inter-dependence that need to be considered for future research.

The influence of research collaboration on research impact (Amin and Mabe 2000) was calculated using citation analysis. The average number of citations per paper for single-authored papers in Nigeria was 3.63 against the average citation of 3.77 per paper for co-authored papers, while the average number of citations for single-authored and co-authored papers in South Africa was 3.64 and 8.98, respectively. This suggests that research collaboration has an influence on research impact and that most scholars would prefer to cite papers that are co-authored. Such papers are increasingly associated with quality and influence (Amin and Mabe 2000; Kumar and Fortunato 2014). The evidence would suggest that research collaboration is growing, and collaboration through co-authorship is playing an important role that contributes to knowledge sharing.

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