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Research Field Specialisation in Selected Universities in Kenya

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Abstract

The analysis of the subject representation of research outputs is a common occurrence in bibliometric studies, most probably because subject area analysis forms part of the indicators of ranking universities in some global ranking systems. However, the size, mission and vision of different universities seem to dictate their research niche areas, with some universities focusing on some subject areas or research fields more than others. The purpose of this study was to examine the research field specialisation in selected public universities in Kenya. The study targeted all public universities but only 17 met the threshold of 100 publications each for the period 2011-2020. The relevant data was obtained from the SCIVAL database. The findings show that Kenya produces the greatest number of publications in medicine and agriculture. The selected universities exhibited strong performance in the same fields, with four universities publishing in all research fields. In terms of field specialisation, 16 universities posted more than 10 specialisation fields, whereas only one registered fewer than 10 fields of specialisation, implying diversification of the fields of research across all the universities. Physics was the most common field of specialisation in the selected universities. The least common field of research in the selected universities was dentistry, which yielded papers in only four universities and a specialisation index greater than 1.0 in only two universities. The study makes several conclusions and recommendations for policymakers, university management and other stakeholders.

Keywords: *Research, Policymakers, Universities, Kenya*

Introduction

In today's society research performance is vital in moving countries towards an international and knowledge-based economy. As Marginson (2013) asserts, research is central to the mission of a university, and research performance is the primary factor that regulates university status and is seen to signify the innovation potency of global competitiveness. For a wide range of stakeholders, including state governments, academic organisations, the university education governance, researchers and students, this has created concerns about the effective judgement of academic research (López-Illescas, De Moya-Anegón and Moed 2011). University efficacy based on research rankings has become a popular way to assess a university's standing and excellence. One of the features used to evaluate institution ratings is the output of research in terms of articles, inventions and intellectual licences (Koto, Syukri and Sofyan Arief 2018). Similarly, prominent research outcomes in the field are articles, citations and, to a lesser degree, trademarks (Pastor and Serrano 2016). As a result, universities everywhere across the world strive for the opportunity to share scientific findings in periodicals, at conventions and elsewhere.

Universities are acknowledged as significant benefactors to the strengthening of a country's knowledge capital, as per Koto, Syukri and Sofyan Arief (2018). They are placing stronger focus on scientific output. University reputation in research excellence is considered one way of ranking excellence. Governments, researchers and the general public have taken a keen interest in university rankings, which are now used as tools in a variety of assessments, including institutional strategic positioning, research strategy development, evaluations of the integrity, applicability and effect of research effort, comparisons with network partners, identifying research partners and career opportunities. Vernon, Balas and Momani (2018) have listed a total of 24 ranking systems in the world with the following being the most visible or dominant:

Table 1: University ranking systems (Adapted from Vernon, Balas and Momani 2018: 6)

Ranking System (abbreviation)	Initial Year	Sponsoring Organisation	Total # of indicators	Website
Academic Ranking of World Universities (Shanghai)	2003	Shanghai Ranking Consultancy	6	http://www.shanghairanking.com/ARWU2016.html
Carnegie Classification (Carnegie)	1973	Carnegie Commission on Higher Education/ Indiana U.	8	http://carnegieclassifications.iu.edu/
Center for World University Ranking (CWUR)	2012	Center for World University Rankings	8	http://cwur.org/
Leiden Ranking (Leiden)	2011	Leiden University, Netherlands	18	http://www.leidenranking.com/
QSWorld University Ranking (QSWorld)	2013	Quacquarelli SymondsLimited	6	https://www.topuniversities.com/university-rankings
Round University Ranking (RUR)	2010	RUR Ranking Agency	20	http://roundranking.com/
SCImago Institutions Rankings World Report (SCImago)	2009	SCImago Lab	12	http://www.scimagoir.com/
The Times Higher Education World University Rankings (Times)	2004	TESGlobal Ltd	13	https://www.timeshighereducation.com/world-university-rankings
Clarivate Analytics Innovative University Ranking (CA) (formerly Thomson Reuters)	2015	Reuters	10	http://www.reuters.com/article/amers-reuters-ranking-innovative-univers-idUSL2N1C406D
U-Multirank (UMR)	2014	European Union and Advisory Board	30	http://www.umultirank.org/#!/home?name=nullandtrackType = home
USNews and World Report–Global Ranking (USNandW)	2014	USNewsand World Report	12	https://www.usnews.com/education/best-global-universities/rankings
University Ranking by Academic Performance (URAP)	2010	Middle East Technical University	6	http://www.urapcenter.org/2016/
Webometrics (Web)	2004	CybermetricsLab, Spanish National Research Council	4	http://www.webometrics.info/en

Each ranking system uses a variety of indicators to rank universities. The U-Multirank and Round University Ranking use the greatest number of indicators, that is 30 and 20, respectively. The least number of indicators is applied by Webometrics Ranking of World Universities (WRWU). Despite the widespread use of the ranking systems in the higher education sector, the systems have come under scrutiny and criticism for different reasons (see Bornmann, Wohlrabe, and de Moya Anegon 2017; Frenken, Heimeriks, and Hoekman 2017).

One of the areas of interest in bibliometric studies of university performance for purposes of ranking the universities is subject/research specialisation. It is therefore not surprising to note that universities are obliged to set up conducive infrastructure and environments to nurture and encourage researchers to be creative as they play a vital role in the establishment of niche areas of research (Yang, Morris and Barden 2009). According to Yang, Morris and Barden (2009: 421), ''research specialty is a self-organised social organisation, which is delineated by different facets namely, research paradigm, knowledge structure, personnel, institutions, specialised vocabulary, collaboration structure, research output, and domain journals''. In a university environment, field specialisation can refer to a course of study or major in an academic institution, as well as a body of knowledge that leads to a practice specialty. In this study, we have borrowed heavily from this definition. Research field specialisation is thus an organised body of knowledge delineated by and consisting of many factors, such as, but not confined to, research discourse, knowledge structure, personnel, institutions, thesaurus, collaboration structure, research output and domain journal commonality, that bring affiliated academics, practitioners and researchers together through research, technology, innovations and practices.

Casadevall and Fang (2014) have argued that specialisation in scientific fields advances and increases efficiency in prescriptive standards as well as scientific rigour, whereby scientists may, for example, form configuration groups and associations through which they define themselves as well as imitate practices and expectations of the groups. The positive side of specialisation is its aiding of individual scientists' proficiency in a subset of knowledge attainment and progression in competitive spheres. Knowledge specialisation in universities can produce pace setters in knowledge base/field specialisation, technological dexterity and research excellence, which imbues individuals with a sense of pride and self-distinctness as specialists. In the opinion of Small (1977), as it becomes obvious that specialist is the primary method of rational formation in modern science, field research specialisation is gaining popularity. According to Yang, Morris and Barden (2009), visualising institutional activities in a specialty is beneficial to policymakers and research funding organisations in creating resolutions.

According to Carnabuci and Jeroen (2009), field specialisation aids knowledge growth by boosting the efficiency of the knowledge generation process. As a result, as the study progresses, more research fields become specialised.

Kenya's Research Performance: A Brief Overview

Kenya is sub-Saharan Africa's second research engine, trailing only South Africa, according to the World Bank (2019). Kenya tops the category both in terms of statistical production, but also in terms of qualitative output. The study by Onyancha, Mwai and Kwanya (2021), who assessed the top papers produced in Kenya to gauge the country's research engine, reveals an increase in the publication of the top papers, largely in the form of journal articles; a heavy co-authorship of the papers; a favourable performance by Kenya when compared to the rest of the African countries; and the publication of the country's top papers in prestigious international journals. Kenya's research performance is partly dependent on the dissemination of its research in high-impact factor journals. In addition, the country's performance in research is heavily dependent on the performance of science fields such as internal medicine, environmental sciences and ecology, and public health and agriculture. In another study by Onyancha (2020) on the knowledge specialisation of the countries in sub-Saharan African countries, Kenya was found to specialise in 10 out of the Web

of Science's 22 knowledge fields, including immunology, multidisciplinary, environment/ ecology and agriculture. An examination of the published literature reveals that studies on the assessment of subject area specialisation within public universities are uncommon, even though public-financed universities contribute considerably to a country's economic growth and the world's research output. In Kenya, no study has looked at the specialised research index of state-funded universities. As a consequence, this study makes a significant contribution by examining field research specialisation at Kenyan public institutions.

Purpose and Objectives of the Study

The study aimed to investigate research field specialisation at selected Kenyan universities to create a knowledge specialisation index for the country. Specifically, the study sought to:

- Assess the trend and patterns of research outputs per university in different research fields
- Determine the public universities' research outputs contribution to the national research grid
- Examine the coverage and intensity of each public university's research in different research fields
- Determine the subject area of specialisation in each selected university

Research Methodology

Data for this study was obtained from the SCIVAL database, a tool that is used to assess the research performance of researchers, institutions and countries. The SCIVAL database draws its metrics from Scopus, one of the largest bibliographic and citation databases (Bar-Ilan 2007; Onyancha 2017). A basic search using the names of the universities, and limiting the year of publication to 2011-2020, yielded the relevant data that was needed for the study to achieve its objectives. The extracted data included:

1. Total number of papers published by Kenya
2. Total number of papers published by Kenya per subject area
3. Total number of papers published by each university
4. Total number of papers published by each university per subject area

The data was extracted for 17 out of the 29 universities that were targeted in the study. Twelve universities were excluded from the study because they yielded less than 100 papers each for the entire 10 years of the study, a criterion that was deemed to be sufficient for the computation of the specialisation index. The excluded universities and their corresponding number of papers indexed as reflected in SCIVAL are as follows: Kirinyaga University College (0), Rongo University College (0), Taita Taveta University College (0), Chuka University (95), Kibabii University (30), Laikipia University (37), Maasai Mara University (89), Machakos University (71), University of Kabianga (89), Murang'a University of Technology (0), Multimedia University of Kenya (0) and Cooperative University College of Kenya (0). The list of universities that were eventually included in the study, and their name abbreviations, are reflected in Table 2.

Table 2: Universities that were selected for study

No.	University	Abbreviation
1	Dedan Kimathi University of Technology	DU
2	Egerton University	EU
3	Jaramogi Oginga Odinga University of Science and Technology	JU
4	Jomo Kenyatta University of Agriculture and Technology	JKU
5	Karatina University	KAR
6	Kenyatta University	KU
7	Kisii University	KIS
8	Maseno University	MAS
9	Masinde Muliro University of Science and Technology	MUL
10	Meru University of Science and Technology	MER
11	Moi University	MU
12	Pwani University	PU
13	South Eastern Kenya University	SEK
14	Technical University of Kenya	TK
15	Technical University of Mombasa	TM
16	University of Eldoret	UE
17	University of Nairobi	UN

The data was extracted from SCIVAL so as to strategically align with the objectives and thematic areas of the study. The institutional and national outputs per subject area were critical in the generation of coefficients that could explain the subject specialisation, as well as the percentage contribution of each university to the national research output per subject area. Table 3 provides the total number of research papers per subject area, which is an indicator of the volume of research in Kenya per subject area.

Table 3: Distribution of publications according to subject areas

No.	Subject Area	Abbreviation	Papers	% of N
1	Agricultural and biological sciences	AGRI	8 066	16,52
2	Arts and humanities	ARTS	840	1,72
3	Biochemistry, genetics and molecular biology	BIOC	3 262	6,68
4	Business, management and accounting	BUSI	814	1,67
5	Chemical engineering	CENG	308	0,63
6	Chemistry	CHEM	587	1,20
7	Computer science	COMP	1 088	2,23
8	Decision sciences	DECI	263	0,54
9	Dentistry	DENT	55	0,11
10	Earth and planetary sciences	EART	1 280	2,62
11	Economics, econometrics and finance	ECON	959	1,96
12	Energy	ENER	692	1,42
13	Engineering	ENGI	1 521	3,11
14	Environmental science	ENVI	4 135	8,47
15	Health professions	HEAL	278	0,57
16	Immunology and microbiology	IMMU	2 722	5,57
17	Materials science	MATE	416	0,85
18	Mathematics	MATH	431	0,88
19	Medicine	MEDI	11 284	23,10
20	Multidisciplinary	MULT	1 734	3,55
21	Neuroscience	NEUR	283	0,58
22	Nursing	NURS	698	1,43
23	Pharmacology, toxicology and pharmaceutics	PHAR	538	1,10
24	Physics and astronomy	PHYS	508	1,04
25	Psychology	PSYC	588	1,20
26	Social sciences	SOCI	4 712	9,65
27	Veterinary	VETE	778	1,59

The following formula was used to compute the specialisation index for each university in each subject area:

$$SI = \frac{Us/Ut}{Ks/Kt}$$ or simply expressed as $$SI = \frac{Us \times Kt}{Ut \times Ks}$$

Where

- *Us* = Number of papers from University X in a given subject area (s) (e.g. publications on *Medicine* published by *University of Nairobi*)
- *Ut* = Total number of papers produced by a given university in time t (e.g. all University of Nairobi papers during 2011-2020 period)

- *Ks* = All papers published in a given subject area (corresponding to the *Us*) in the country, Kenya (e.g. all papers published in Kenya on *Medicine*)
- *Kt* = Total number of papers produced in Kenya in the period 2011-2020

For purposes of calculating the specialisation coefficient as outlined above, a whole count technique was used to assign a research publication to an individual institution or subject area. In his attempt to contrast adjusted count and whole/ complete count, Diodato (1994) explains that whereas in the adjusted count approach, every author is allotted an equal fraction of a unit, a complete (whole) count approach ensures that each author is fully counted wherever he/she appears in a publication, whether or not there is multiple authorship. Consequently, the aggregated number of publications for Kenya (Kt) was 48 840 (sum of the papers by subject area) instead of the actual 29 574 publications that Kenya published between 2011 and 2020. The same approach was used to determine the Ut (institutional output – sum of papers by subject area) figure for each university. The Ut and Kt aggregated outputs were deemed appropriate as an article could be classified in multiple subject areas in SCIVAL. This approach explains the percentage contribution of each subject area to the national outputs per subject in Table 3.

The same approach used in Table 3 was applied to calculate the percentage contributions of each field to the national research output in each subject area.

Results

This section presents the findings under five subheadings, namely:

- Research outputs per university in different research fields
- Public universities' research outputs contribution to the national research grid
- Coverage and intensity of each public university's research in different research fields
- Subject area of specialisation in each selected university

Research Outputs Per University in Different Research Fields

The total number of papers that each university produced between 2011 and 2020 per field is depicted in Table 4. The table reveals that UN yielded the most papers in all the fields except HEAL; there MU produced more papers (i.e. 49) than UN, which produced 44 papers. A summary of the two best performances for each university in terms of the highest number of papers produced in a field is as follows: DU (ENGI = 72; COMP = 37); EU (AGRI = 502; ENVI = 190); JU (AGRI = 60; MEDI = 57); JKU (AGRI = 569; MEDI = 505); KAR (AGRI = 57; ENVI = 42); KU (MEDI = 454; AGRI = 391); KIS (SOCI = 41; MEDI = 26); MAS (MEDI = 259; ENVI = 199); MUL (MEDI = 89; ENVI = 58); MER (AGRI = 29; IMMU = 24); MU (MEDI = 1 000; SOCI = 250); PU (MEDI = 110; AGRI = 84); SEK (AGRI = 95; ENVI = 57; TK (SOCI = 68; ENVI = 62); TM (MEDI = 56; ENGI = 24); UE (AGRI = 124; ENVI = 90) and UN (MEDI = 2 562; AGRI = 1 188). It follows therefore that AGRI and MEDI topped the list of the most researched fields in 7 universities each. The above indication of the most researched fields reveals that only 8 fields were the top 2 researched, with a total of 18 fields not featuring among the top 2 fields in each of the selected universities. The 8 fields are AGRI, COMP, EART, ENGI, ENVI, IMMU, MEDI and SOCI.

Table 4: University research output per field, 2011-2020

	DU	EU	JU	JKU	KAR	KU	KIS	MAS	MUL	MER	MU	PU	SEK	TK	TM	UE	UN
AGRI	19	502	60	569	57	391	23	139	49	29	143	84	95	48	23	124	1 188
ARTS	2	23	22	6	3	71	10	33	8	0	58	9	2	25	0	5	123
BIOC	10	106	45	233	8	172	16	70	40	8	125	68	22	24	11	33	571
BUSI	16	11	6	51	9	62	19	13	10	0	66	9	8	19	4	4	133
CENG	19	21	13	44	4	16	2	11	3	2	26	3	9	19	12	8	44
CHEM	8	60	16	38	0	45	4	50	12	5	27	4	9	32	2	18	121
COMP	37	17	16	117	2	69	15	102	23	5	60	10	11	46	14	18	266
DECI	14	4	1	17	5	21	11	3	6	1	13	2	3	13	2	6	53
DENT	0	0	0	1	0	1	0	0	0	0	7	0	0	0	0	0	37
EART	15	34	15	76	8	59	3	20	12	17	25	30	46	25	11	10	194
ECON	6	37	21	24	4	49	8	20	8	0	21	7	5	6	2	2	151
ENER	20	23	4	78	1	31	0	9	8	0	14	7	7	14	10	10	123
ENGI	72	55	15	212	6	95	14	29	24	10	102	24	22	56	24	24	303
ENVI	23	190	41	200	42	205	12	199	58	14	95	40	57	62	23	90	608
HEAL	0	1	0	8	2	38	1	1	2	0	49	0	3	0	0	0	44
IMMU	0	65	23	195	7	115	7	83	40	24	106	48	9	22	20	12	536
MATE	29	21	7	53	7	41	3	22	17	7	53	2	18	29	1	21	75
MATH	22	14	6	53	0	30	2	39	28	2	27	2	1	6	4	3	67
MEDI	10	184	57	505	14	454	26	259	89	21	1 000	110	25	49	56	35	2 562
MULT	7	27	10	81	2	60	6	31	13	8	69	17	12	17	10	9	273
NEUR	3	5	3	7	1	13	2	11	3	0	13	5	2	3	2	0	71
NURS	9	20	1	28	1	64	2	20	8	2	66	3	0	5	2	4	117
PHAR	0	41	6	39	1	31	3	36	14	2	37	4	9	11	1	10	194
PHYS	13	18	8	45	6	46	8	16	25	4	31	26	12	30	2	24	109
PSYC	0	8	1	15	1	30	2	46	5	0	51	13	1	1	2	0	98
SOCI	20	143	50	134	22	280	41	110	42	2	250	29	25	68	15	34	859
VETE	0	67	2	42	3	24	1	12	2	7	6	20	3	2	2	2	228

Public Universities' Research Outputs Contribution to the National Research Grid

In terms of the percentage contribution of each university to the national output in each field, Table 5 shows that UN contributed the most papers. The university's contribution surpasses 15% per field, with the highest contribution being in the field of DENT wherein the university contributed 67.3% of the nation's 55 papers that were published during the period under investigation. It is worth noting, however, that only four universities (JKU, KU, MU and UN) published papers in this subject area. The other fields in which UN contributed a substantial number of papers include PHAR (36.1%), VETE (29.3%) and NEUR (25.1%). Most of the universities' contributions to the national outputs accounted for less than 10% each per field. Besides UN, only the following universities contributed more than 10% to the national tally's output per field and only in a few fields each: EU (CHEM = 10.2%), JKU (CENG = 14.3%; COMP = 10.8%; ENER = 11.3%; ENGI = 13.9%; MATE = 12.7%; MATH = 12.3%), KU (HEAL = 13.7%) and MU (DENT = 12.7%; HEAL = 17.6%; MATE = 12.7%). Overall, UN contributed 20.9% to each field, and JKU occupies a distant second position with an average contribution of 6.6%, followed by KU (6.1%) and MU (6.2%), just to name the universities with an average contribution of 5% or above. The lowest average percentage contribution was registered by MER (0.4%), KAR (0.5%), TM (0.6%) and KIS (0.8%). These universities contributed an average of less than 1% to each field. In terms of the average contribution per university in each field, the mean of the 'means' in the last row in Table 5 would be x = 3.5%, implying that the selected universities' average percentage contribution per field is 3.5%. If this percentage contribution per the selected universities could be taken as the universities' benchmark, it

would imply that the selected universities' percentage contribution surpassed the overall contribution in 10 out of 27 fields. The 10 instances where the means, for each field, surpassed the 3.5% are CENG (x = 4.9%), CHEM (x = 4.5%), COMP (x = 4.5%), DECI (x = 3.9%), DENT (x = 4.9%), ENGI (x = 4.2%), MATE (x = 5.7%), MATH (x = 4.2%), PHAR (x = 4.8%) and PHYS (x = 4.9%).

Table 5: Institutional contribution to national research output per subject area

	DU	EU	JU	JKU	KAR	KU	KIS	MAS	MMU	MER	MU	PU	SEK	TK	TM	UE	UN
AGRI	0.2	6.2	0.7	7.1	0.7	4.8	0.3	1.7	0.6	0.4	1.8	1.0	1.2	0.6	0.3	1.5	14.7
ARTS	0.2	2.7	2.6	0.7	0.4	8.5	1.2	3.9	1.0	0.0	6.9	1.1	0.2	3.0	0.0	0.6	14.6
BIOC	0.3	3.2	1.4	7.1	0.2	5.3	0.5	2.1	1.2	0.2	3.8	2.1	0.7	0.7	0.3	1.0	17.5
BUSI	2.0	1.4	0.7	6.3	1.1	7.6	2.3	1.6	1.2	0.0	8.1	1.1	1.0	2.3	0.5	0.5	16.3
CENG	6.2	6.8	4.2	14.3	1.3	5.2	0.6	3.6	1.0	0.6	8.4	1.0	2.9	6.2	3.9	2.6	14.3
CHEM	1.4	10.2	2.7	6.5	0.0	7.7	0.7	8.5	2.0	0.9	4.6	0.7	1.5	5.5	0.3	3.1	20.6
COMP	3.4	1.6	1.5	10.8	0.2	6.3	1.4	9.4	2.1	0.5	5.5	0.9	1.0	4.2	1.3	1.7	24.4
DECI	5.3	1.5	0.4	6.5	1.9	8.0	4.2	1.1	2.3	0.4	4.9	0.8	1.1	4.9	0.8	2.3	20.2
DENT	0.0	0.0	0.0	1.8	0.0	1.8	0.0	0.0	0.0	0.0	12.7	0.0	0.0	0.0	0.0	0.0	67.3
EART	1.2	2.7	1.2	5.9	0.6	4.6	0.2	1.6	0.9	1.3	2.0	2.3	3.6	2.0	0.9	0.8	15.2
ECON	0.6	3.9	2.2	2.5	0.4	5.1	0.8	2.1	0.8	0.0	2.2	0.7	0.5	0.6	0.2	0.2	15.7
ENER	2.9	3.3	0.6	11.3	0.1	4.5	0.0	1.3	1.2	0.0	2.0	1.0	1.0	2.0	1.4	1.4	17.8
ENGI	4.7	3.6	1.0	13.9	0.4	6.2	0.9	1.9	1.6	0.7	6.7	1.6	1.4	3.7	1.6	1.6	19.9
ENVI	0.6	4.6	1.0	4.8	1.0	5.0	0.3	4.8	1.4	0.3	2.3	1.0	1.4	1.5	0.6	2.2	14.7
HEAL	0.0	0.4	0.0	2.9	0.7	13.7	0.4	0.4	0.7	0.0	17.6	0.0	1.1	0.0	0.0	0.0	15.8
IMMU	0.0	2.4	0.8	7.2	0.3	4.2	0.3	3.0	1.5	0.9	3.9	1.8	0.3	0.8	0.7	0.4	19.7
MATE	7.0	5.0	1.7	12.7	1.7	9.9	0.7	5.3	4.1	1.7	12.7	0.5	4.3	7.0	0.2	5.0	18.0
MATH	5.1	3.2	1.4	12.3	0.0	7.0	0.5	9.0	6.5	0.5	6.3	0.5	0.2	1.4	0.9	0.7	15.5
MEDI	0.1	1.6	0.5	4.5	0.1	4.0	0.2	2.3	0.8	0.2	8.9	1.0	0.2	0.4	0.5	0.3	22.7
MULT	0.4	1.6	0.6	4.7	0.1	3.5	0.3	1.8	0.7	0.5	4.0	1.0	0.7	1.0	0.6	0.5	15.7
NEUR	1.1	1.8	1.1	2.5	0.4	4.6	0.7	3.9	1.1	0.0	4.6	1.8	0.7	1.1	0.7	0.0	25.1
NURS	1.3	2.9	0.1	4.0	0.1	9.2	0.3	2.9	1.1	0.3	9.5	0.4	0.0	0.7	0.3	0.6	16.8
PHAR	0.0	7.6	1.1	7.2	0.2	5.8	0.6	6.7	2.6	0.4	6.9	0.7	1.7	2.0	0.2	1.9	36.1
PHYS	2.6	3.5	1.6	8.9	1.2	9.1	1.6	3.1	4.9	0.8	6.1	5.1	2.4	5.9	0.4	4.7	21.5
PSYC	0.0	1.4	0.2	2.6	0.2	5.1	0.3	7.8	0.9	0.0	8.7	2.2	0.2	0.2	0.3	0.0	16.7
SOCI	0.4	3.0	1.1	2.8	0.5	5.9	0.9	2.3	0.9	0.0	5.3	0.6	0.5	1.4	0.3	0.7	18.2
VETE	0.0	8.6	0.3	5.4	0.4	3.1	0.1	1.5	0.3	0.9	0.8	2.6	0.4	0.3	0.3	0.3	29.3
MEAN	**1.7**	**3.5**	**1.1**	**6.6**	**0.5**	**6.1**	**0.8**	**3.5**	**1.6**	**0.4**	**6.2**	**1.2**	**1.1**	**2.2**	**0.6**	**1.3**	**20.9**

Coverage and Intensity of each Public University's Research in Different Research Fields

Figure 1 provides the total number of fields in which each university published at least one paper (Total fields), the number of papers that the institution produced between 2011 and 2020 (Total papers_1 = x) and the subject-aggregated sum of all the papers for each university (Total papers_2 = y). For example, whereas DU (Dedan Kimathi University) produced a total of 170 papers between 2011 and 2020, its aggregate when each subject area's papers are added together was 374. The latter figure constitutes papers that were counted multiple times despite belonging to multiple subject areas. Figure 1 shows that only four universities, namely JKU, KU, MU and UN, published papers in all the Scopus subject areas; the university with the least number of subject areas was MER, which registered 19 research fields. A similar pattern is replicated in terms of the number of papers for each university, where UN tops the list with x = 5 757 and y = 9 148, accounting for 19.5% and 18.7% of the national output (x = 29 574; y = 48 840). In the second and distant position is JKU (x = 5.8%; y = 5.9%), followed by MU (x = 5.6%; y = 5.2%), KU (x = 5.0%; y = 5.1%) and EU (x = 3.4%; y = 3.5%), just to name the universities with 1 000 or more publications in the first counting category.

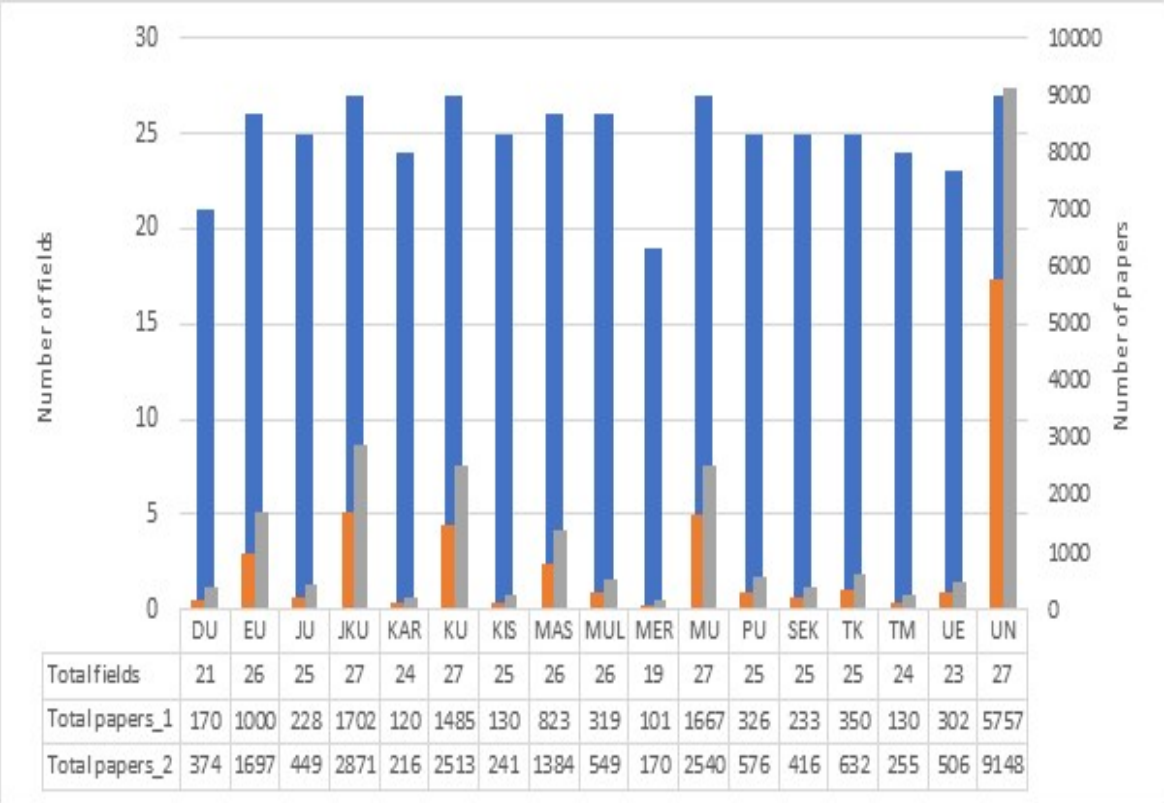

Figure 1: Number of research fields and papers per public university

Table 6: Number of papers per field in each university

	FIELDS		TOTAL PAPERS_1		TOTAL PAPERS_2	
	n	% of 27	n	Papers per field	n	Papers per field
DU	21	77.78	170	8.10	374	17.81
EU	26	96.30	1 000	38.46	1 697	65.27
JU	25	92.59	228	9.12	449	17.96
JKU	27	100.00	1 702	63.04	2 871	106.33
KAR	24	88.89	120	5.00	216	9.00
KU	27	100.00	1 485	55.00	2 513	93.07
KIS	25	92.59	130	5.20	241	9.64
MAS	26	96.30	823	31.65	1 384	53.23
MUL	26	96.30	319	12.27	549	21.12
MER	19	70.37	101	5.32	170	8.95
MU	27	100.00	1 667	61.74	2 540	94.07
PU	25	92.59	326	13.04	576	23.04
SEK	25	92.59	233	9.32	416	16.64
TK	25	92.59	350	14.00	632	25.28
TM	24	88.89	130	5.42	255	10.63
UE	23	85.19	302	13.13	506	22.00
UN	27	100.00	5 757	213.22	9 148	338.81

Another indicator used to assess the universities' research intensity per field was the average number of papers per field. Table 6 reveals that the performance of the universities according to the number of papers per field followed a similar pattern as that reflected in Figure 1, albeit with minor variations. The UN yielded the highest average number of papers per field, followed by JKU, MU, KU and EU. The universities with the least number of papers per field were KAR (5.00; 9.00), KIS (5.20; 9.64), MER (5.32; 8.95) and TM (5.42; 10.63). These universities are among the youngest in the country, having been established and chartered after 2010. Not only did this category of universities produce the least number of papers, but also the least average number of papers per field. A relational comparison of the average number of papers per field for each institution against the national average indicates that each of the universities performed dismally. The national average number of papers per field between 2011 and 2020 is 1 095 (single counts) and 1 808 (multiple counts). It follows therefore that none of the universities' average was anywhere close, with the most productive university's averages accounting for approximately 19% of the national average.

Subject Area of Specialisation in Each Selected University

Table 7 provides the specialisation coefficients for each university per field as well as the number of fields in which each university is said to exhibit specialisation. Many universities registered coefficients that were equal to or higher than 1.0, thus exhibiting subject specialisation. The highest coefficient was registered by DU in MATE (*SI* = 9.1), followed by KIS in DECI (*SI* = 8.5), TM in CENG (*SI* = 7.5), MUL in MATE (*SI* = 5.8), TK in MATE (*SI* = 5.4) and SEK in MATE (*SI* = 5.1). An examination of the top two coefficients in each university identified the following subjects as the ones with the highest coefficients: DU (MATE, CENG), EU (CHEM, VETE), JU (CENG, CHEM), JKU (CENG, ENGI), KAR (DECI, MATE), KU (HEAL, MATE), KIS (DECI, BUSI), MAS (COMP, MATE), MUL (MATE, PHYS), MER (MATE, EART), MU (HEAL, MATE), PU (PHYS, VETE), SEK (MATE, EART), TK (MATE, CENG), TM (CENG, ENGI), UE (MATE, PHYS) and UN (DENT, PHAR). In terms of the number of subject areas that registered $SI \geq 1.0$, 5 universities posted 15 fields each. All the universities except PU posted a score of in 10 or more subject areas. An examination of the subject areas that scored values equal to or greater than 1.0 shows that PHYS posted the highest occurrences (16), followed by ENGI and MATE (15 each) and COMP (14), whereas CENG, CHEM, DECI and PHAR posted 13 scores that were equal to or above 1.0. ENVI (11) and MATH (10) rounded up the subject fields that posted a score of in 10 or more universities. The subject areas that scored a coefficient of but in the least number of universities included MULT (2), DENT (2), MEDI (3) and VETE, PSYC, HEAL and ECON which yielded a score of in 4 universities each.

Table 7: Subject specialisation index for the selected universities

	DU	EU	JU	JKU	KAR	KU	KIS	MAS	MUL	MER	MU	PU	SEK	TK	TM	UE	UN
AGRI	0.3	1.8	0.8	1.2	1.6	0.9	0.6	0.6	0.5	1.0	0.3	0.9	1.4	0.5	0.5	1.5	0.8
ARTS	0.3	0.8	2.8	0.1	0.8	1.6	2.4	1.4	0.8	0.0	1.3	0.9	0.3	2.3	0.0	0.6	0.8
BIOC	0.4	0.9	1.5	1.2	0.6	1.0	1.0	0.8	1.1	0.7	0.7	1.8	0.8	0.6	0.6	1.0	0.9
BUSI	2.6	0.4	0.8	1.1	2.5	1.5	4.7	0.6	1.1	0.0	1.6	0.9	1.2	1.8	0.9	0.5	0.9
CENG	8.1	2.0	4.6	2.4	2.9	1.0	1.3	1.3	0.9	1.9	1.6	0.8	3.4	4.8	7.5	2.5	0.8
CHEM	1.8	2.9	3.0	1.1	0.0	1.5	1.4	3.0	1.8	2.4	0.9	0.6	1.8	4.2	0.7	3.0	1.1
COMP	4.4	0.4	1.6	1.8	0.4	1.2	2.8	3.3	1.9	1.3	1.1	0.8	1.2	3.3	2.5	1.6	1.3
DECI	7.0	0.4	0.4	1.1	4.3	1.6	8.5	0.4	2.0	1.1	1.0	0.6	1.3	3.8	1.5	2.2	1.1
DENT	0.0	0.0	0.0	0.3	0.0	0.4	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	3.6
EART	1.5	0.8	1.3	1.0	1.4	0.9	0.5	0.6	0.8	3.8	0.4	2.0	4.2	1.5	1.6	0.8	0.8
ECON	0.8	1.1	2.4	0.4	0.9	1.0	1.7	0.7	0.7	0.0	0.4	0.6	0.6	0.5	0.4	0.2	0.8
ENER	3.8	1.0	0.6	1.9	0.3	0.9	0.0	0.5	1.0	0.0	0.4	0.9	1.2	1.6	2.8	1.4	0.9
ENGI	6.2	1.0	1.1	2.4	0.9	1.2	1.9	0.7	1.4	1.9	1.3	1.3	1.7	2.8	3.0	1.5	1.1
ENVI	0.7	1.3	1.1	0.8	2.3	1.0	0.6	1.7	1.2	1.0	0.4	0.8	1.6	1.2	1.1	2.1	0.8
HEAL	0.0	0.1	0.0	0.5	1.6	2.7	0.7	0.1	0.6	0.0	3.4	0.0	1.3	0.0	0.0	0.0	0.8
IMMU	0.0	0.7	0.9	1.2	0.6	0.8	0.5	1.1	1.3	2.5	0.7	1.5	0.4	0.6	1.4	0.4	1.1
MATE	9.1	1.5	1.8	2.2	3.8	1.9	1.5	1.9	3.6	4.8	2.4	0.4	5.1	5.4	0.5	4.9	1.0
MATH	6.7	0.9	1.5	2.1	0.0	1.4	0.9	3.2	5.8	1.3	1.2	0.4	0.3	1.1	1.8	0.7	0.8
MEDI	0.1	0.5	0.5	0.8	0.3	0.8	0.5	0.8	0.7	0.5	1.7	0.8	0.3	0.3	1.0	0.3	1.2
MULT	0.5	0.4	0.6	0.8	0.3	0.7	0.7	0.6	0.7	1.3	0.8	0.8	0.8	0.8	1.1	0.5	0.8
NEUR	1.4	0.5	1.2	0.4	0.8	0.9	1.4	1.4	0.9	0.0	0.9	1.5	0.8	0.8	1.4	0.0	1.3
NURS	1.7	0.8	0.2	0.7	0.3	1.8	0.6	1.0	1.0	0.8	1.8	0.4	0.0	0.6	0.5	0.6	0.9
PHAR	0.0	2.2	1.2	1.2	0.4	1.1	1.1	2.4	2.3	1.1	1.3	0.6	2.0	1.6	0.4	1.8	1.9
PHYS	3.3	1.0	1.7	1.5	2.7	1.8	3.2	1.1	4.4	2.3	1.2	4.3	2.8	4.6	0.8	4.6	1.1
PSYC	0.0	0.4	0.2	0.4	0.4	1.0	0.7	2.8	0.8	0.0	1.7	1.9	0.2	0.1	0.7	0.0	0.9
SOCI	0.6	0.9	1.2	0.5	1.1	1.2	1.8	0.8	0.8	0.1	1.0	0.5	0.6	1.1	0.6	0.7	1.0
VETE	0.0	2.5	0.3	0.9	0.9	0.6	0.3	0.5	0.2	2.6	0.1	2.2	0.5	0.2	0.5	0.2	1.6
SI > 1	**13**	**10**	**15**	**15**	**10**	**15**	**13**	**12**	**14**	**14**	**15**	**8**	**14**	**15**	**11**	**11**	**11**
% of 27	**48.1**	**37.0**	**55.6**	**55.6**	**37.0**	**55.6**	**48.1**	**44.4**	**51.9**	**51.9**	**55.6**	**29.6**	**51.9**	**55.6**	**40.7**	**40.7**	**40.7**

Discussion of the Findings

The results show that Kenya's strength in terms of the volume of research conducted in the country, as proxied through the number of published research outputs or publications, lies in medicine and agriculture, and biological sciences, which yielded 11 284 and 8 066 papers, respectively, thereby accounting for 40% of the country's subject-aggregated output. Onyancha, Mwai and Kwanya (2021), in their study entitled *Kenya's research excellence as indexed in the Web of Science: an informetrics' perspective,* found that the two fields were among the most researched and highly cited in Kenya. According to Onyancha, Mwai and Kwanya (2021), the top-cited fields in Kenya include medicine, environmental sciences and agriculture. The current study further reveals that the other subject areas or fields, besides medicine and agriculture, yielded less than 5 000 papers each. While the dominance of agriculture-specific papers can be attributed to the fact that Kenya is generally an agricultural country, and the country depends heavily on agriculture as the highest income earner not only for individual households but also as the largest contributor to the national gross domestic product (GDP) (World Bank 2021), medical research tops the list with the most papers due to the establishment of medical schools in almost all the universities in Kenya. The World Bank (2021) states that agriculture is the cornerstone of the Kenyan economy. Furthermore, agriculture and the health and medical sectors are among the most heavily funded sectors in the country. For example, in the 2021/2022 budget, the government of Kenya allocated a total of Kshs 3.6 trillion to agriculture and Kshs 47.7 billion to health.

An examination of the main grant donors in the Kenyan research ecosystem as reflected in the Scopus database reveals that medical research in

the country receives a financial boost from national and international organisations such as the Kenya Medical Research Institute, Bill and Melinda Gates Foundation, National Institute of Allergy and Infectious Diseases, National Institutes of Health and Wellcome Trust, among others. In fact, the aforementioned companies or institutions are the main research funders in the country, according to the data obtained from the Scopus database. The foreign research grants, which largely target the fields of agriculture and medicine, have led to a large number of co-authored papers in the two fields as observed by Onyancha, Mwai and Kwanya (2021).

The national outlook regarding the number of publications in each field is largely concurrent with the patterns of research production at university level. The two subject fields were ranked among the top 5 in the majority of the universities. Agriculture and medicine were ranked the first subject fields in 7 universities each, with exceptions being in 10 universities where these subject fields were mostly ranked in positions 2 or 3. Other subject fields that occasionally occupied position 1 in various universities include ENGI at DU, and SOCI at KIS and TK. It is illustrative therefore to note that agriculture and medicine occupied the top position in 14 out of 17 universities. The study also found that the least researched areas in Kenya are material sciences, which yielded 416, followed by chemical engineering (308), health professions (283), decision sciences (263) and dentistry (55). This pattern can be attributed to the low number of universities offering the courses as well as the student enrolment figures, especially in the postgraduate programmes (see Commission for University Education 2019).

Figure 1 and Tables 4 and 6 further reveal that the most productive universities were UN, JKU, MU, KU and EU. The same universities contributed a high percentage of papers in each field at national level when compared to the rest of the universities. Firstly, the performance of the aforementioned universities in terms of the total number of research publications mirrors their performance in the global ranking systems, where the most productive universities in this study have emerged top among the Kenyan universities (see Nafukho Wekullo and Muyia 2019). For example, World University Rankings placed UN in position 1 in Kenya, followed by MU, KU and JKU (Nafukho Wekullo and Muyia 2019). Secondly, the four universities that published in all the Scopus fields of research are among the oldest and largest universities in the country and have a long history of research. As explained by Frenken, Heimeriks and Hoekman (2017), the size of the institution is one of the characteristics impacting university research achievement and performance. These universities not only produced the highest number of publications but, with the exception of EU which published papers in 26 fields, they conducted research and published papers in all the 27 Scopus subject areas. UN, for example, was chartered in 1970, whereas KU, MU and JKU were chartered in 1985, 1984 and 1994, respectively. In contrast, the study found that the lowest average percentage contribution was registered by MER (0.4%), KAR (0.5%), TM (0.6%) and KIS (0.8%). These universities that have published in fewer subject areas were established or chartered after 2010. In fact, as Ogot and Onyango (2022) explain, the majority of the universities in Kenya are very young, having been chartered after 2013, and therefore they are yet to make their mark in the Kenyan and global research landscape. It follows that these universities are at their formative stages in terms of research development and identity. In addition, an examination of the number of subjects approved by Kenya's Commission of University Education (CUE) reveals that the older universities offer more academic courses than the less productive universities regarding research. For instance, the number of programmes or courses offered in the old universities is as follows: UN (571), KU (318), MU (256), JKU (250), MU (248), whereas the newly established universities in Kenya offer fewer courses (CUE 2019). In addition, we believe that the established universities' incentivizing research and researchers may be among the factors contributing to their dominance at the top of the most productive universities (see McCowan 2018).

Regarding the subject specialisation in the selected universities, Onyancha (2020) conducted a similar study and noted that Kenya specialised in the following 10 knowledge fields: Immunology (SI = 1.693), multidisciplinary (SI = 1.614), environment/ecology (SI = 1.588), agriculture (1.552), molecular biology and genetics (SI = 1.447), microbiology (SI = 1.413), plant and animal sciences (SI = 1.306), clinical medicine (S = 1.085), neuroscience and

behaviour (SI = 1.048) and social sciences (SI = 1.043). The study used the Web of Science data as obtained from the Clarivate Analytics (formerly Thomson Reuters) Essential Science Indicators (ESI). The ESI categorises the knowledge fields into 22 groups, as opposed to the 27 fields in Scopus. It is worth noting that the fields do not have similar names in the two databases, but can be distinctively identified as defining a given field. The current study found that many universities specialised in up to 15 fields (out of 27 Scopus fields). The subject fields that were the most common as fields of specialisation (i.e. field with $SI \geq 1.0$) in the selected universities included physics, engineering, material science, computer science, chemical engineering, chemistry, decision sciences, pharmacology, environmental sciences and mathematics. The least common fields included multidisciplinary, dentistry, medicine, veterinary sciences, psychology, health professionals and economics. Evidently, the universities specialise in a variety of fields, with some fields posting higher coefficients than others. The variety of fields of specialisation that each university posted in the study as well as the publication of research papers in almost all the Scopus classification fields for each university reflects the preference of diversification of subject areas. This is in line with the CUE (2019) analysis of the courses offered in different universities in Kenya regarding diversification. McCowan (2018) has associated diversification of courses in institutions of higher learning, and more so universities, to the growth of the education sector over the last 10 years, leading to stiff competition in student enrolment and staff recruitment. Many universities have deviated from their core fields to embrace new fields for financial stability and sustainability, especially in view of the fact that government funding for public universities has continued to decline over time. In that regard, for example, KU, which was originally an institution that was meant to offer education courses, now offers science courses including medicine. JKU's core mandate was agriculture, but now has 250 courses in almost all the Scopus classification systems (see CUE 2019). The new universities have followed in the footsteps of the old universities concerning the diversification of programmes, which, we believe, has led to the trend and pattern of publication of research in multiple fields as witnessed in this study.

Conclusions

In conclusion, the research outputs in the selected universities mirror Kenya's research strength in terms of the number of publications, which proxy the volume of research. The most researched areas, both at national and university levels, are in the fields of agriculture and medicine. However, it was noted that, just as was the case at national level, several universities produced a substantial number of papers in fields other than medicine and agriculture, thereby implying diversification of the fields of research. This diversification in the selected universities is largely reflective of the status of the course offerings in many universities in Kenya. The lowest number of subject fields in which the universities conducted research was 8, whereas 4 universities conducted research in all 27 subject fields in the Scopus classification scheme. The majority of the papers were published in the fields of medicine and agriculture, whereas the least researched areas were dentistry, neurology, health professions and decision sciences. Dentistry was the least common research area or subject/course of study in the selected universities. Nevertheless, diversification of subject areas of research was visible across all universities, with the universities specializing in as many as 15 subject areas. The least number of specialisation fields was recorded at Pwani University, one of the newly established universities in Kenya. While the old universities dominated the research ecosystem in the country in terms of the number of publications produced per year, the low coefficients of subject area specialisation coefficients show that their extent of specialisation is weaker than that of the newly established universities, which yielded relatively higher specialisation index values, thereby implying the preference of diversification in big universities as opposed to specialisation. It was interesting to note that the poorly researched fields such as material science and decision sciences yielded higher specialisation index values than the most researched fields, implying that few universities consider these fields as their core areas of teaching and research.

Recommendations

The findings of this study seem to support the Ministry of Education's proposal to merge disciplines,

especially the disciplines or fields that are rarely researched in public universities. Oftentimes, teaching departments at universities are established and named according to given fields of research. As a result, we recommend that universities review their academic administrative units (e.g. departments, schools and faculties/colleges) in view of the findings of this study. Furthermore, the study has identified the fields of research specialisation for each selected university, implying that some universities are stronger in certain fields than in others. Consequently, each university may wish to reconsider its research niches with a view to strengthening the core fields while reconsidering the fields that do not constitute the nucleus. We believe that reorganising the fields of research focus in universities can help to reduce the costs of servicing disciplines and maintaining universities, and more time can be devoted to a core niche of each university, thereby strengthening the research specialty.

We recommend consideration of a future study that will expand the scope to include private universities in the country for comparison purposes, especially in view of the standing of private universities in global ranking systems. We further recommend a replication of this study in other geographic regions in sub-Saharan Africa.

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