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Examining research productivity of faculty in selected leading public universities in Kenya

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ABSTRACT

The purpose of this study was to examine research productivity of faculty at two leading Kenyan public universities. The analysis showed that the research productivity of faculty varied by gender, institution, terminal degree, rank, discipline, and years of work experience. Individual characteristics (gender, rank, terminal degree, and experience) and institutional characteristics (number of undergraduate students enrolled, percentage of Ph.D. students enrolled, and funding allocated for research function) are significantly associated with faculty research productivity. Faculty's experience was not a determinant factor of their research productivity. More experienced faculty were less productive. The study has significant implications to shift from performance contracts and self-reported instruments currently used in Kenyan public universities and enhance research productivity of faculty, in their pursuit of the stated institutional vision, mission and goals.

1. Introduction

The government of Kenya envisions 'a globally competitive education, training, research, and innovation system for sustainable development (Ministry of Education, 2016). In 2017/18 budget, the government invested $83.8 million, 1.01 percent of Gross Domestic Product (GDP) in higher education and set an investment target of at least 2 percent of the annual GDP for research, science, and technology development (Republic of Kenya, 2016a, c). However, the quality of research produced and performance of higher education institutions is low. For instance, a report by the Commission for University Education (2017) noted that universities are producing research of low impact that is not applicable even at the national level. One of the indicators of research productivity especially at institutional level is the ranking of universities based on national and international comparisons. In the case of public universities in Kenya; the focus of this study, the World University ranking that uses indicators of research productivity (publication of peer reviewed journal articles, refereed books, and refereed book chapters), and institutional performance, ranked the University of Nairobi, one of the largest universities in Kenya, as number 15,618 in the world and 532 in Africa. The other public universities including Moi University, Kenyatta University, Jomo Kenyatta University of Agriculture and Technology, Maseno University, Strathmore University, and Masinde Muliro University were ranked 1755, 1871, 2541, 2860, 3646, 4824, and 6168 respectively in 2017 (World University Rankings, 2016-2017). A further analysis of the world ranking report of top twenty universities in Africa showed South Africa, Egypt, and Nigeria took the first, second, and third positions with 12, 5, 1 respectively. Uganda and Kenya each had one university in the ranking (World University Rankings, 2016-2017). The University of Nairobi is the only Kenyan University, which featured, and was position 20.

Several studies have examined research productivity of faculty across the globe (Altbach, 2015; Ghabban et al., 2016; Toutkoushian et al., 2003). However, there are few studies like this focused on African universities and higher education systems as they get more integrated with global higher education systems. Further, limited empirical evidence pertaining to research productivity of faculty in Kenyan universities exists. The lack of attention to institutional research productivity and the lack of reliable data is astonishing given the considerable resources devoted to research (Republic of Kenya, 2016b). This study attempts to fill this gap by examining the influence of demographic and institutional factors on research productivity of faculty in two leading Kenyan public universities. The study addressed the following research questions: (a) What was the research productivity measured in h-index of faculty in two public universities selected for this study? (b) What was the individual characteristics (gender, experience, academic rank) influence on faculty research productivity? (c) Did the h-index of faculty vary with faculty's rank terminal degree, and discipline? (d) What was the interaction effect between the faculty' experience in years and their academic discipline? (e) What was the

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institutional characteristics (enrollment of undergraduate students, percentage of Ph.D. students enrolled, and funding allocated for research) of the two institutions studied and how did these factors influence faculty research productivity?

This pioneering study contributes to the literature on research faculty productivity in the two selected universities in Kenya. The h-index analysis of research productivity of faculty shades some light on the level of faculty engagement, and research performance of individual faculty at the of two leading public universities in Kenya studied in relation to gender, rank, experience, and area of specialisation or discipline. The h-index was created by Jorge Hirsch in 2005 to measure research productivity and citation impact in the area of theoretical physics. Over time its influence has spread to more academic disciplines and it is now widely used to measure research productivity in nearly all academic fields. It is a numerical indicator of how productive and influential a researcher is, as noted, "A scientist has index h if h of his or her Np papers have at least h citations each, and the other (Np-h) papers have no more than h citations each." (Hirsch, 2005, p. 1). This means that an h-index is given to a researcher on the basis of the number of papers (H) that have been cited at least H times. Google Scholar uses h-index to measure researcher productivity. For example, an h-index of 30 means the researcher has 30 papers that are cited at least 30 times by other researchers. Thus, the researcher is recognized for having a range of papers with good levels of citations rather than one or two outliers with very high citations.

Based on the results of this study, public universities in Kenya should be able to compare their performance with their comparable institutions. Also, the study findings should guide university administrators on what they need to achieve a considerable growth in research output and increased faculty productivity. Moreover, the finding of this study offers valuable information for decision makers in higher education to set long term goals and allocate the limited resources efficiently (Huang, 2012). Aside from budgeting, the evaluation of faculty's research productivity provides vital information to guide the process of recruiting, developing, and retaining faculty (Huang, 2012); determining faculty promotions and transfers from one institution to another (Holosko and Barner, 2014). Given the increasing amount of funding allocated for research by the Kenyan government, foundations, and non-government institutions, it is necessary to critically examine the issue of faculty productivity hence the importance of this pioneering study. Results of this study should be of great significance to scholars with a focus on the development of higher education institutions in Kenya and Africa at large. Readers of the *International Journal of Educational Development* with a focus on universities in Africa should equally find the results of this study useful especially in guiding their own research in African universities. International funding agencies with a focus on Africa should also immensely benefit from the results of this study. Of great import to agencies that fund Kenyan public universities is the issue of faculty research productivity as measured by outcomes such as scholarly publications in to top tier refereed journals and the increased citation of the published work by researchers funded to conduct research in African universities. In addition, researchers with interest in the development of universities in Kenya may employ the research methods utilized in this study.

2. Literature review and conceptual framework

Research productivity is the extent to which faculty engage in research activities such as developing and conducting rigorous research studies, publishing in refereed journals, writing books and book chapters, presenting at peer refereed conferences, and producing artistic or creative works (Iqbal and Mahmood, 2011). Research activities also include gathering and analysing data, supervising postgraduate students and their class projects, seeking and getting research grants, performing editorial duties, and obtaining patents and licenses. Abramo and D'Angelo (2014) asserted, ''research activity is a production process in which the inputs consist of human, tangible, and intangible resources, and where output, in this case, the new knowledge, has a complex character of both tangible nature (publications, patents, conference presentations, databases, etc.) and intangible nature (tacit knowledge, consulting activity, etc'.)' (p. 1131).

This study is framed around a conceptual model that draws from research on faculty research productivity (Altbach, 2015; Chen et al., 2010; Cloete et al., 2011; Huang, 2012; Jung, 2012; McGill and Settle, 2012; Musiige and Maassen, 2015). From these strands of literature, two core factors appeared to account for research production among faculty and institutions of higher learning: Individual characteristics (gender, rank, discipline of the faculty, experience,) and institutional factors (type of institution, number of students enrolled, percentage of doctoral students enrolled and funding allocated for research activities). The next section presents a brief explanation of how these factors may influence research productivity.

2.1. Institutional factors

Universities are responsible for research, scholarship, and innovation and are depended on to serve as conduits for adoption and disseminating of knowledge generated across the globe (Commission for University education, 2017; Nafukho, and Muyia, 2014). However, in Kenya, there has been an increased focus on teaching related functions and absence of research related functions (Commission for University education, 2017; Wangenge-Ouma and Nafukho, 2011). The increased focus on teaching and learning as the institution's 'core business' at the expense of research is due to the adoption of corporate culture with increased accountability and outcomes, and the held notion that measuring research productivity is complicated and problematic especially due to lack of productivity data and information of performance indicators (Altbach, 2015; Toutkoushian et al., 2003). With the advancement in technology and based on the science of data analytics, information on academic faculty productivity is now readily available. In most higher education institutions, we now have advanced tools that assist institutions to measure productivity per faculty member. The fact that it is not done especially in Kenyan universities requires urgent attention. It is also no longer complex to do this but the process requires additional resources and the institutional/government willingness to put in place policies and regulations that require measuring faculty productivity using a variety of credible performance indicators.

Increase in undergraduate enrollment is likely to be associated with an increase in teaching workload, which may leave faculty with less time to engage in research activities (Porter and Umbach, 2001; Wangenge-Ouma and Nafukho, 2011). Responding to what counts for academic productivity in research universities, Altbach (2015) stated that it is crucial to include both measures of academic as well as research when calculating the productivity of institutions, individual researchers, and university systems.

Previous studies have pointed out the contribution of doctroal students towards an institution's research productivity (Holosko and Barner, 2016; Lodhi, 2009; Mayrath, 2008; Mullen, 2009; Webber, 2011). These researchers further noted that scholarly work begins at the graduate level and the mentoring one receives early in their career has a significant effect on their later professional scholarship productivity. Moreover, Holosko and Barner (2016); Lodhi (2009); Mayrath (2008), and Webber (2011), also pointed that the level of mentorship depends on the degree of interest and achievement of the mentor in research productivity. It is vital to examine the research productivity of faculty in Kenyan universities. However, the Kenyan higher education system seems to pay less attention to faculty development (Commission for University Education, 2017), and only 43 percent of university faculty have PhDs. The enrollment in Ph.D. programmes has remained flat. It is estimated that 4,394, a 1 percent of total population of the students enrolled for doctoral degrees and only 400 students graduate within five years (Commission for University Education, 2017). This study

therefore examines how enrollment of PhD students and supervision to graduation would contribute to research productivity.

A considerable body of literature has noted that funding allocated to research is positively associated with research outcomes (Barnett et al., 2015; Hottenrott, and Lawson, 2017; Jacob and Lefgren, 2011). Also, as noted earlier, the Kenyan government is devoting a lot of funding on research (Ministry of Education, 2016; Republic of Kenya, 2016a, 2016c). However, it is not obvious that such expenditures are effective. This study examines how funding allocated in two major institutions relate to research productivity.

Elsewhere, previous studies have found faculty demographic characteristics, such as gender, rank, and years of experience to positively correlate with research outcome (Paik et al., 2014; Stack, 2004). For instance, Stack (2004) examined the relationship between gender, children and research using a sample of 11, 231 Ph.Ds. in sciences and Engineering. Stack found women published significantly less than men. The productivity was higher for women with children more than 11 years, whereas the productivity for women with young children was lower. In the discipline like social sciences, Stack found no relationship between gender and productivity. On the contrary, other scholars such as Kelchtermans and Veugelers (2013) used a panel data from 1992 to 2001 to examine gender and performance in research productivity. Kelchtermans and Veugelers (2013) found women had problems reaching the top performance but there was no evidence that women seemed to persist to top performance more easily than men. Other scholars found attributes such as the nature of the academic discipline, years of experience, time allocated to this type of work, and collaboration to be essential (Jung, 2012). It is therefore important that when examining research productivity, one should consider the institutional context, because of the critical influence it can have (McGill and Settle, 2012; Musiige and Maassen, 2015).

The conceptual model for this study draws on established literature on individual and institutional factors contributing to research productivity. This paper tests the framework that posits a relationship between individual and institutional factors on research productivity in two Kenyan public universities. The focus is on faculty research productivity in Kenya which has received less attention despite the increasing investment in research.

3. Measuring research productivity in Kenyan context

The role of research in Kenyan higher education is widely acknowledged through various government and higher education institutions' documents (Commission for University Education, 2017), but there is no specified criterion on how it should be measured. The Kenyan higher education institutions greatly depend on quality assurance reports as a means of ensuring research performance and productivity. This measure requires faculty to provide measurable output indicators and annual performance evaluation from their supervisors (the University of Nairobi, Quality assurance n.d). Beyond self-reported measures of research productivity, institutions through their research policy documents have focused more on how research should be conducted with little attention on how it should be measured (Krause, 2012). The need for a measure of research productivity is essential to guide policy and institution leaders on how they may enhance research productivity in their pursuit of the stated vision, mission, and goals.

4. Measures of research productivity

Although there is an increased emphasis on measuring research productivity, there is no objective concensus on what it constitutes, how it should be measured, or how it should be interpreted among scholars, and administrators across institutions of higher education (Altbach, 2015; Kumar, 2010; Toutkoushian et al., 2003; Webber, 2011). A wide range of indicators have been proposed to measure individual research productivity. The most commonly used measure is a summative index constructed from counts of conference papers, as well as journal publications in refereed journals, books, and book chapters (Altbach, 2015). An h-index consisting of publication and citation counts has also commonly been used to measure research productivity of faculty (Abramo and D'Angelo, 2014; Hirsch, 2005, 2010; Huang, 2012; Quimbo and Sulabo, 2014). Other researchers on this topic have pointed to factors such as; number and amount of research grants received by an academic member (Altbach, 2015; Porter and Umbach, 2001), educational outcomes (i.e. supervising students to graduation) of an academic member (Altbach, 2015), membership to National Academies (White et al., 2012), amount of funding allocated for research (Iqbal and Mahmood, 2011), and a supportive environment for scholarship (Walker and Fenton, 2013) should be considered while evaluating the research productivity of faculty. However, these measures cannot be easily quantified. Toutkoushian et al. (2003) observed that the significant variations among research productivity measures suggest that the developers did not rely on a theoretical framework when making their selections. For this study, the h- index as a measure of research productivity was utilised for the following reasons. First, publications of peer-reviewed journal articles, refereed books and refereed book chapters and citation counts are considered as the direct measures of research productivity (Capaldi et al., 2015). Second, the h-index has been proved to highly correlate with the Shanghai Ranking – Academic Ranking of World Universities, which uses five criteria: quality of education, quality of research (papers published in Nature and Science), output (SCI index), and size of the institution. Huang (2012) used data from 678 world universities' scientific performance over 11 years to extend the applicability of the h-index at an institutional level. The findings showed a high correlation ($r = 0.804$) existed between the h-index rankings generated by the study and the Shanghai Ranking. The results confirmed the validity of the h-index in the assessment of research performed at the university level. Also, it was noted that the h-index was one of the accurate measures of faculty research productivity.

5. Method

The target population for this study comprised of faculty in two public universities in Kenya. Kenya had 71 registered universities and other institutions offering degree programmes in 2016. An increase of 49 percent from 2012 academic year. This number consists of 30 public universities, 5 public university constituent colleges, 18 private universities, 5 private university constituent colleges, and 13 universities with interim authority (Commission for University Education, 2017; Republic of Kenya, 2017).

The sample for this study comprised of faculty from the two leading public universities in Kenya. The two universities were purposively selected for the following reasons. (a) They are large universities with well-established systems and (b) have a higher number of faculty of over 1000. The first university, referred to as A had 2022 faculty, and the second university, referred to as B had 1138 faculty, a total of 3160, approximately 32 percent of the total faculty in Kenyan public universities, and (c) they have a wide range of postgraduate degree programmes (Commission for University Education, 2017).

According to Krejcie and Morgan (1970), when the population is 3,000, a sample size of 341 is recommended. The quantitative sample taken from the population of 3,160 was 612. The sample size calculator at 95 percent confidence level was applied to the population from two institutions to obtain the needed sample size. This is a strong indication that the sample for the study is representative. Systematic random sampling was then applied to the two samples where every n^{th} faculty from the list of the faculty was selected for inclusion.

5.1. Data source

Data for this study were generated from different sources that

include the institution's online databases, archive, prospectus, websites, and Google scholar website. The demographic information (i.e., gender, rank, experience, the field of specialization) of randomly sampled faculty members was retrieved from university prospectus/staff handbook. Google scholar database is one of the largest databases that gauge scholarly and scientific output of indexed works and citations each publication receives world over. The Google scholar provides reliable and reproducible h-index scores (Jascó, 2008) and has been used in other studies of faculty research productivity (e.g., Eloy et al., 2012; Svider et al., 2013). The h-index scores for all the 612 sampled faculty members was retrieved by searching the respondent names in Google scholar database.

5.2. Model and variables in the study

To examine the influence of individual characteristics (gender, rank, experience, terminal degree), discipline and type of institution on faculty research productivity, a linear regression was modelled as follows.

$$Y_I = X_I\beta + \varepsilon_I$$

Where Y_I is the faculty research productivity measured in h-index. The independent variables ($X_I\beta$), and ε_I the residual term, which represents the deviation from the observed values from their means. The $\varepsilon_I$is normally distributed with mean 0 and variance σ.

Faculty's h –index is the dependent variable and it measures the scholarly output based on the number of indexed works and citations for a period of 5 years (2012–2017). The independent variables included the teaching staff demographic information, such as gender, academic rank, terminal degree, and years of work experience used to determine the faculty's length of career. Academic rank was classified into six categories: as professors, associate professors, senior lecturers, lecturers, assistant lecturers and tutorial fellows.

Academic discipline was categorised into two groups based on colleges and schools in the institutions studied. This included (a) sciences, technology, engineering and mathematics (STEM) consisting of pure and applied sciences, Medicine, Public health, Health sciences, Technology, Veterinary Science) and (b) Non STEM consisting of Education, Agriculture and Life Sciences (Agriculture, land resource management, environmental sciences), and Humanities and Social Studies (consisting of creative Arts, Media studies, Geography and Environmental studies, Business and Economics, Law, and Africana studies).

Multi-factor Analysis of Variance was used to examine the difference in the faculty research productivity of the two institutions. Institutional variables, such as the percentage of Ph.D. students enrolled, funding allocated for research, and number of undergraduate students enrolled were used. The number and supervision of the students to graduation is believed to correlate with faculty productivity as well as that of the institution. It was therefore hypothesised that an institution with a high proportion of Ph.D. students was likely to be more productive. Table 1 presents a summary of the variables in the study.

Table 1 showed between 2012 and 2017, the two institutions under study had an average h -index of 1.913. With the standard deviation of 3.522, the h-index varied significantly among faculty members. The lowest h–index was 0, and the highest was 27.

On average, the two institutions had high student enrollment. The average enrollment at institution B between 2012 and 2017 was estimate 69,189 while that enrollment at institution A was 76,982. The two institutions differed in enrollment by about 3890. In both institutions, the percentage of Ph.D. students was extremely low. On average, the percentage of Ph.D. students in the two institutions was 0.62% with the standard deviation of 0.12%. The mean number of international students enrolled in the two institutions was 589.95 with the standard deviation of 270.02. The average funding for research was 1.89 million Kenya Shillings. The funding for research in the two institutions varied by about 1.55 million Kenya shillings.

Table 1 also provides a descriptive summary of categorical variables in the study. Of the 612 faculty in the study 32.84% were female, and 67.16% were male. Most of the faculty (59.31%) had Ph.D. as the terminal degree, 37.25% had masters while 3.43% were bachelor's degree holders. Regarding faculty rank, the majority of faculty members were lecturers (51.63%), followed by senior lecturers (17.32%), tutorial fellow (13.89%), while the percentage of faculty who were associate professors and full professors was small. The associate professors and full professors represented 9.31% and 7.84% respectively.

Table 1
Descriptive statistics of the variables in the study.

Variables	Observations	Mean	SD	Minimum	maximum
H-index(5years)	610	1.913115	3.522481	0	27
Number of students enrolled	612	73,365.45	3889.795	69,188.6	76982
Percentage of Ph.D. students	612	.00622	.0012451	.0048707	.0074
Number of international students	612	589.948	270.021	300	841
Average funding for research	612	1.89e+07	1.55e+07	2258724	3.33e+07
Categorical Variables		**Coding**	**Frequency**	**(%)**	**Cumulative**
Institution	A	0	328	53.59	53.59
	B	1	284	46.41	100.00
Gender	Male	0	411	67.16	67.16
	Female	1	201	32.84	100.00
Terminal Degree	Bachelors	0	21	3.43	3.43
	Ph.D.	1	363	59.31	62.75
	Masters	2	228	37.25	100.00
Rank	Tutorial Fellow	0	85	13.89	13.89
	Professor	1	48	7.84	21.73
	Associate professor	2	57	9.31	31.05
	Senior lecturer	3	106	17.32	48.37
	Lecturer	4	316	51.63	100.00
Experience	Below 10yrs	0	181	29.72	29.72
	11 – 20yrs	1	167	27.42	57.14
	21 - 30 yrs.	2	158	25.94	83.09
	31- 40 yrs.	3	78	12.81	95.89
	Above 41 yrs.	4	25	4.11	100.00
Discipline	NON STEM	0	353	57.68	57.68
	STEM	1	259	42.32	100.00

Table 2
Correlation between Variables in the study and their Variance Inflation Factor.

Var		1	2	3	4	5	6	7	8	9	10	VIF
1	Institution	1.00										1.98
2	Gender	0.12	1.00									1.06
3	Rank	0.13	−0.02	1.00								1.02
4	TermD	0.11	0.06	−0.05	1.00							1.02
5	Discip	−0.26	−0.10	−0.03	−0.03	1.00						1.07
6	Expe_1	−0.25	−0.13	0.03	−0.24	0.08	1.00					1.12
7	Hindex	−0.19	−0.12	−0.13	−0.22	0.13	0.27	1.00				
8	Student	−1.00	−0.12	−0.13	−0.11	0.26	0.19	0.27	1.00			1.07
9	PerPhd	−1.00	−0.12	−0.13	−0.11	0.26	0.19	1.00	1.00	1.00		1.00
10	Fund	−1.00	−0.12	−0.13	−0.11	0.26	0.19	1.00	1.00	1.00	1.00	1.16

Note; Var = variable; TermD = Terminal degree, Discip = discipline; Expe_1 = Experience; Student = Number of student enrolled; PerPhd = percentage of pH.PhD. students; Fund = Funding allocated for research.

Regarding faculty experience, 57.14% of the faculty had less than 20 years of experience, 25.82% of faculty had between 21–30 years of experience, 12.72% of faculty had 31–40 years of experience, and only a small fraction (4.57%) of faculty had over 41 years of experience. The majority of the faculty (57.68%) were in STEM discipline, while the remaining 42.32% of the faculty were in non-STEM related disciplines.

5.3. Diagnostic tests

Prior to actual data analyses, several tests were conducted to determine the most appropriate estimation model for the data. The assumptions of normality of residuals, homoscedasticity, and linearity were tested. Three tests of normality: skewness and Kurtosis, Shapiro-Wilk test, and qq – plots, showed the normality assumption was violated. Similarly, the test of homoscedasticity was not reasonable. However, the test of linearity showed there is a relationship between the variables in the study and the dependent variable. Based on the findings, regression with standard errors was performed.

Correlation between the variables in the study was examined. Table 2 presents the correlation results. Most variables had correlation of less 0.5, indicating that they highly explained the dependent variables. Three variables: number of students enrolled, percentage of Ph.D. students, and average funding for research were highly correlated with other variables, implying the presence of multicolinearity. The variance inflation Factor (VIF) was used to detect multicolinearity. The VIF
results showed all the variables in the study had a VIF of less than 10. Since the highly correlated variables were institutional variables, multilevel analysis was conducted. Before that, power analysis was conducted to determine whether the sample was adequate for multilevel analysis. Power analysis showed the sample was not adequate for it fell below the 30 by 30 rule of thumb sample for conducting multilevel analysis. A multi-factor analysis of variance approach was used to test the effects the number of students enrolled, percentage of Ph.D. students enrolled, and funding allocated to research had on institutional research productivity.

Table 3
Regression Estimates for Faculty Research Productivity (H-index).

Predictors		Model 1	Model 2
Institution	a	−.3097 (.2454)	−.5925*(.2662)
Gender	Female	−.1917 (.2671)	−.3817 (.2853)
Terminal degree	Ph.D.	1.6932*** (.3399)	2.3276***(.4568)
	Masters	.6570* (.2983)	.5964 (.3997)
Rank	Professor	4.8259***(.9654)	
	Associate professor	2.2603***(.6212)	
	Senior lecturer	1.5669***(.4002)	
	Lecturer	.2040 (.16381)	
Discipline	STEM	.8095** (.2723)	.8145**(.2951)
Experience	11-20		.1149 (.2482)
	21-30		1.02843**(.3493)
	31-40		1.3811**(.5035)
	Above 41		1.6667 (1.0604)
Rank*Discipline	STEM* Professor	2.8638 (1.9556)	
	STEM* Ass professor	−.5006 (1.2340)	
	STEM* Senior lecturer	.8140 (.8007)	
	STEM* Lecturer	.15831 (.3456)	
Constant		−.4412(.3913)	−6.0398*(2.5687)
Model fit			
N		611	611
F(14,592)		14.61***	12.63***
R^2		0.2473	0.1527
RMSE		3.0788	3.2553

Standard error in parenthesis.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

6. Results

Table 3 presents the regression results of model 1 and model 2. Model 1 comprises of all the predictors in the model except for faculty work experience. Model 2 included all the predictors except the predictor faculty rank. Even though the two variables were neither correlated nor had issues with collinearity, the variables are assumed to be correlated and the two models were used to reduce the disturbances. Overall, model 1 regression with robust standard errors using gender, institution, terminal degree, faculty rank, and discipline to determine their influence on faculty research productivity as measured by h-index had a good fit. Approximately, 25% (R-Squared = 0.2473) of the variance in the faculty research productivity was accounted for by the predictors in the model, F (14,592 = 14.61., p = 0.000).

Further, the results showed that adjusting for other predictors in the model, the research productivity of faculty in institution B was less than that of institution A by 0.3097, however, the difference was not statistically different, (t = -1.26, p = 0.206) with the 95% Confidence interval of [-0.7916, 0.1722].

With regrad to research productivity by gender, the results determined that female faculty had lower h-index (research production) of 0.1917 compared to that of male faculty controlling for other predictors in the model. However, the difference was not statistically significant,(t= -0.72, p = 0.473). The results implied that the differences in the research productivity of male and female faculty in the two institutions did not vary from zero.

The results of analysis showed that faculty's terminal degree had a significant influence on their research productivity. In particular, the results showed that controlling for other predictors in the model, the faculty with a Ph.D. degree had a higher h- index 1.6932, on average, higher than those who only had bachelors degrees (t = 4.98,p = 0.000). Similarly, faculty who had a masters degree had an h–index of 0.6570, on average,higher than that of faculty with a bachelors degree, (t = 2.20, p = 0.028). The results suggested that

Table 4
Results of Multi-Factor Analysis of Variance test of effects of institutional factors on research productivity.

Predictor	Sum of Square	*df*	Mean Square	F	p	Eta-Squared	95% Coef interval
Intercept	259.84881	4	259.85	21.65	0.0001	.034	.011586 .0671916
Student enrolled	302.81888	1	302.82	25.23	0.0001	.04	.0149341 .0743828
Percentage PhD enrolled	302.81888	1	302.81	25.20	0.0001	.04	.011586 .0671916
Average Funding for Research	259.84881	1	259.85	21.65	0.0001	.034	.011586 .0671916
Residual	7296.5463	608	12.000898				
R-squared	0.0344						
Root MSE	3.46423						

Note: Eta-Squared values for individual model terms are partial.

faculty with a higher terminal degree were more likely to have more publications.

Regarding research productivity and faculty rank, the results of the analysis showed that controlling for other predictors in the model, professors had research productivity of 4.826 on average higher than tutorial fellows. The difference was statistically significant (t = 5.00, p = 0.000). associate professors had research productivity of 2.2603 on average, higher than tutorial fellows, which was considerably significant, (t = 3.64, p = 0.000). Senior lecturers, on average, had a research productivity of 1.5669 higher than that of tutorial fellows. This difference was statistically significant, (t = 3.92, p = 0.000). Although the research productivity of Lecturers was higher than that of tutorial fellows by 0.2040 on average, the difference was not statistically significant (t = 1.25, p = 0.214). The results suggested that controlling for other predictors in the model, the rank of the faculty: senior lecturer, associate professor, and professor, had a strong influence on research productivity.

The results in Table 4 showed that faculty in STEM disciplines had higher research productivity than faculty who were in non-STEM disciplines. On average, faculty in STEM disciplines had a research productivity of 0.8095 which was higher than that of non-STEM, faculty and was statistically different (t = 2.97, p = 0.003) with 95% Confidence Internal of [.2748, 1.3442].

Model 2 in Table 4 presents the results of the regression analysis with robust standard errors. Model 2 excluded the faculty rank and included faculty experience variable. Overall, model 2 had a good fit and an R-Squared = 0.1527, meaning that approximately, 15% of the variance in the faculty research productivity was accounted for by the predictors in the model, (F (9, 597) = 12.63., p = 0.000). The results of Model 2 showed that controlling for other predictors in the model, the research productivity of faculty in university B was less than that of the faculty in University A by 0.5925 on average. This difference was statistically positive and statistically significant, (t= −2.23, p = 0.026). Like the results of model 1, there was a difference in the research productivity of male and female faculty, although the productivity of the female faculty was much less than that of male by 0.3818 (t= −1.34, p = 0.181).

The results of the model showed that only faculty with Ph.D. degrees had a research productivity of 2.3276 higher than bachelor's degree holders. The difference was statistically significant, (t = 5.10, p = 0.000). Although, Faculty with master's degrees had a 0.5964 productivity higher than that of bachelor's degree holders, the results were not statistically significant. This results imply that the difference was not different from zero.

Regarding the influence of the years of experience of research productivity, the results of model 2 showed that only faculty with experience between 21 to 30 years, and 31 to 40 years, had a higher research productivity than those with the experience less than 10 years controlling for other predictors in the model. More specifically, the faculty with experience between 21–30 years, had a higher h-index of 1.0284 than those with less than 10 years of experience (t = 2.94, p = 0.003) and faculty between 31 to 40 years of experience had an h-index of 1.3811 and it was higher than that of experience with less than 10 years. The difference was statistically significant, (t = 2.74, p = 0.006). Although, faculty with the experience of between 11 and 20 years of work and above 40 years of work experience had a higher research productivity than those with the experience less than 10 years, the difference was not statistically significant from zero. The results suggested there was lower research productivity among newer or younger faculty when compared to more experienced faculty.

Regarding the effect of the interaction between the faculty rank and discipline, results in Table 4 showed that controlling for other predictors in the model, the interaction effect of faculty in STEM disciplines and faculty rank at all levels had no statistically significant effect on research productivity and the difference was not different from zero.

Results of Multi- factor ANOVA showed that the three factors have significant effects on the research productivity of faculty in the two universities studied. In particular, the effect of the number of undergraduate students enrolled was statistically significant [F (1,608) = 25.23, p < 0.0001], indicating that the number of undergraduate students enrolled was associated with research productivity. The results also showed that the percentage of Ph.D. students enrolled was statistically significant [F (1,608) = 23.2, P < 0.0001], indicating that the percentage of Ph.D. students enrolled was associated with faculty research productivity. Similarly, the funding allocated to research was statistically significant [F (1,608) = 21.65, P < 0.0001], indicating that there was a difference in faculty productivity based on whether they had funding or not.

7. Discussion and implications

From the descriptive statistics, research productivity of faculty at the two institutions studied was low. The minimum h-index was zero and the maximum was 27 for the 5 years under study. The study found that research productivity of faculty in University B was lower than that of University A controlling for other predictors in the model. Although unintended outcome, during the data collection it was noted that some of the faculty with 0 h-index had not been cited at all, some had published as reflected in Google scholar database but had not been cited. Some faculty either published non-refereed curricular and policy related documents, which are not counted as research or published in non-indexed journals without digital object identifier (doi) unrecognised by Google scholar. This study acknowledges there is need to consider other variables in measuring the research productivity of faculty, however, in the absence of bibliometric information which could have assisted in looking at other key indicators, the study relied on the "h-index" as that was the only information that researchers could readily access at the time. The h-index and Google scholar database used in this study are reliable sources recognised across the world. Thus, the findings of this study provide a true reflection of the research productivity of faculty in the two public universities studied.

The finding that research productivity of female faculty was less than that of male was not a surprise. This finding is similar to those of Musiige and Maassen (2015); Cloete et al. (2011); Stack (2004); Kelchtermans and Veugelers (2013), and Paik et al., 2014 who found

that research productivity of female faculty lagged behind that of male faculty, due to reasons related to child bearing, cultural pressures, and nature of discipline studied. Given the overall low research productivity across the faculty in Kenya, the results of this study have significant implications for early career development and mentoring for both male and female faculty. More attention should be paid to the mentoring of female faculty in order to narrow the disparities in academic productivity existing among male and female faculty. In addition, initiatives such as establishing of professional networks can enhance research skills and exchange of ideas among all faculty regardless of their gender.

The results of this study show that faculty with a doctoral degree had higher research productivity than those with a masters or bachelor's degrees. Moreover, the difference was considerably significant. Based on the findings, it can be concluded that obtaining a doctoral degree, as a terminal degree is crucial for improving research productivity of faculty in the two institutions studied. Arguably, faculty with a terminal degree have some rigorous research and scholarship training, which makes them productive in their academic careers. Like other comparable institutions, the Kenyan higher education system may consider setting policies that require all doctoral students to publish in indexed and credible refereed journals before graduating. Publishing in predatory journals should be discouraged. The emphases should be on quality as opposed to quantity of publications. This argument is based on previous literature that shows those who publish during their doctoral studies have greater research productivity and have a higher number of yearly citations as well as citations throughout their career compared to those who do not (Horta and Santos, 2016).

The results showed that full professors had a higher level of research productivity (4.8259) followed by associate professors (2.263), senior lecturers (1.5669), lecturers (.2040), than the tutorial fellows. Except for lecturers, the difference in the research productivity of professors, associate professors and senior lecturers was considerably significant. These findings are similar to those of Rachal et al. (2008), and White et al. (2012) who found highly ranked faculty had a higher research productivity. Since the rank of a professor is associated with higher research productivity, the low number of professors (7.84 percent) in the two institutions studied could partly be the cause for low research productivity. As unintended outcome, during data collection, it was noted that most of the professors with high h-index received their graduate degrees or some form of fellowship in universities abroad. The findings of this study have significant implications for recruiting, training and, retention of faculty with high research productivity. To increase faculty productivity, it is important to establish a mentoring programme where skilled and experienced professors should be engaged in mentoring and coaching junior faculty and graduate students.

Regarding consistency and sustainability in research productivity, the results showed that peak productivity was attained by faculty between 30–40 years of experience. Although faculty with over 41 years of experience had a higher research productivity than those with less than 10 years of experience the difference was not statistically significant. The findings contradict the results of previous studies by Potter et al. (2011), and Jacobs and Winslow (2004) who established that research productivity increased with experience. The findings could be due to the lower percentage (16%) of faculty who are experienced. The findings of this study have significant implications for those who aspire to become faculty. To unsure high faculty productivity, when faculty are hired, they should start their publications early in their careers, and publish persistently and consistently after gaining experience as tenured faculty. Institutional leaders and the Commission for University Education may consider policies that put more emphasis on the ability of the faculty to contribute to knowledge production when determining their hiring, tenure, and promotion as opposed to years of work experience. To keep faculty motivated in conducting research, universities may consider recognising faculty for their research productivity (Wang et al., 2011). In addition, institution leaders may also consider awarding financial support to researchers engaged in research related to the institution's priority areas since this has been established as an effective strategy to promote research outcome (Altbach, 2015).

The finding that faculty in STEM disciplines had a higher research productivity is in agreement with previous studies. For instance, Bonzi (1992) summarised some of the reasons as; faculty in STEM have greater collaboration, which takes a shorter time to produce one publication, the average length of an article in sciences is shorter than that of humanities and social studies articles, and there is a greater number of self-citation among pure scientists because they write a large number of briefer articles that build upon their previous research. In addition, about 67% of publications in science disciplines are journal articles, which are highly cited compared to publishing in books where professors in humanities and social studies excel. In the case of this study, since STEM had a higher representation of 57.68% faculty compared to non-STEM disciplines, the overall low research productivity of the two institutions should be a concern to the leaders. STEM disciplines are regarded as an important driver for innovation and economic growth. The disciplines have received much attention including financial investment in the recent past. These results have significant implication for institutional leaders and Commission for University Education who are focusing on developing research capacity especially in STEM disciplines. In Humanities and Social Studies departments, the findings show that researchers in these fields can still accomplish good and publishable research without external funding.

The finding that the number of undergraduate students enrolled, percentage of Ph.D. students enrolled, and funding allocated for research are positively associated with institutional research productivity has significant implications for institutional leaders and policymakers to reconsider policies that limit enrollment at university entry level and to increase the percentage enrollment for Ph.D. students. These findings support those of previous studies that mentorship has significant effect on research productivity and even for later professional scholarship (Holosko and Barner, 2016; Lodhi, 2009; Mayrath, 2008; Mullen, 2009; Webber, 2011). Similarly, like previous studies, the findings of this study stresses the need for investing more in research to increase research outcomes.

8. Limitations and suggestions for future studies

This study only examined research productivity of two institutions in Kenya. This may limit generalization of the findings to other public and private universities in Kenya as well as in developing countries. In addition, the data used were purely secondary. Futures studies using large sample data sets at institutional level including public and private universities are recommended. In addition, future studies on this important topic of faculty productivity should consider conducting surveys in addition to secondary data sources. Interviewing faculty to collect data on their perspectives on faculty research productivity is highly recommended.

Several measures of research productivity have been suggested, however, in the absence of bibliometric information which could have assisted in looking at other key indicators, this study mainly relied the "h-index" as that was the only information that researchers could readily access at the time. The h-index and Google scholar database used in this study are reliable sources recognised across the world. Future studies in this area should adopt a more robust measure of faculty research productivity.

8.1. Conclusion

In conclusion, knowing the faculty's research productivity is vital especially for a country that envisions to become competitive globally and dependents on higher education for its socioeconomic development. The study proposes a composite measure for faculty's research productivity that includes funding for research and awards received by

the faculty. Moreover, the authors acknowledge that h-index should not be the only measure of university faculty productivity. This means that the findings of this study should be interpreted with caution since other measures of faculty productivity especially in the areas of teaching and community engagement exist. This pioneering study however, should assist Kenyan universities in exploring additional measures of faculty productivity. Thus, universities need to adapt more robust measures of faculty productivity including grant and contract dollars, graduate students graduated, graduate students placed in jobs or higher education opportunities, undergraduate students taught and graduated, students mentored, faculty impact on policy making and policy implementation at county and national levels, faculty initiated community engagement projects aimed at promoting lifelong learning and addressing wealth generation among others. In addition, the universities should adopt a measure that counts all types of publications in credible outlets and other types of knowledge generated as well as develop criteria that can accurately measure faculty productivity including those in social sciences, humanities, education, and creative arts.

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