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Factors influencing research collaborations in Kenyan universities

Petronilla Muriithi[a,b,*], David Horner[a], Lyn Pemberton[a], Hesborn Wao[c]

[a] School of Computing, Engineering and Mathematics, University of Brighton, Brighton, BN2 4GJ, United Kingdom
[b] School of Computing and Information Technology (SCIT), Jomo Kenyatta University of Agriculture and Technology (JKUAT), P.O. Box 62000-00200, Nairobi, Kenya
[c] Division of Evidence-Based Medicine, USF Health Program for Comparative Effectiness Research (EBM − CER), Department of Internal Medicine and Health Outcomes, Morsani College of Medicine, University of South Florida, United States

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ABSTRACT

This paper presents the results of an exploration of factors influencing the organisation and conduct of academic research collaborations in Kenya. A mixed methods research design, involving 248 academics in four disciplines across four major public Kenyan universities, was employed. The study reveals a relatively high level of collaborative research which varies by disciplinary areas. Resource dependence emerged as having a strong influence on decisions to collaborate for this community. This was mainly attributed to low levels of investment in funding research, at both the institutional and national level. At the institutional level, inadequate policies, high levels of bureaucracy, competition among local institutions, weak links with industry, and a major focus on teaching as opposed to research, were reported as barriers to collaborative research. These contextual issues informed the resulting discussion of factors that affect collaborative research in Kenya.

1. Introduction

Past studies record a gradual increase in collaborative research over the years (Adams et al., 2010; NSF, 2012; Tijssen, 2007). Walsh and Maloney (2007) attribute this increase to attempts at solving global problems such as climate change that span disciplines and nations and advances in information and communication technology(ICT) that make remote collaborations easier. Gibbons et al. (1994) attribute it to attempts to solve practical problems affecting the society that call for expertise across disciplines and institutional boundaries.

The level and nature of collaborative research and attainment of associated benefits depend on the context within which research is conducted, and includes social, institutional, and technical environments. This differs between regions, countries, and even individual institutions. Although scientific collaboration is a multidisciplinary and widely researched area, majority of these studies have focused on research collaborations in the developed world. Reference to the issue in developing countries is mainly based on assumptions that need verification (Ynalvez and Shrum, 2011). Such reference includes generalisations made from bibliometric analysis in international databases, which point to low levels of research productivity (Adams et al., 2010; Adams et al., 2014; Mouton, 2008; Tijssen, 2007) and networking (Gaillard and Tullberg, 2001; Harle, 2009) from Africa. Bibliometric measures tend to under-represent research conducted in Africa (Mouton, 2008; Shrum, 1997). In developing countries, more priority may be towards research that addresses local needs such as poverty, food security, and disease control, resulting in much of the publications locally but not in international journals (Ynalvez and Shrum, 2011; Harle, 2010), hence reduced visibility.

This study sought to understand the nature and conduct of academic research collaborations in Kenya, leading to identification of influencing factors. It focused on collaboration at the individual level because, as Bozeman and Corley (2004) noted, 'many of the factors governing individual scientists collaboration choices remain very much within control of the individual, especially when the researcher works in an academic institution' (p. 600).

A number of studies refer to research collaboration as a form of interaction towards achieving a research goal (Laudel, 2002; Smith and Katz, 2000; Sonnenwald, 2007; Ynalvez and Shrum, 2011). However, differences arise in the definition of a collaborator. In this study, collaboration is defined as an interaction between two or more individuals, whether locally or remotely, within or across institutions or organisations, working closely together in a research project, to achieve a common goal(s). This definition differs from that of Ynalvez and Shrum (2011) who view collaboration as ties with individuals in organisation/institution outside the researcher's own.

* Corresponding author at: School of Computing and Information Technology (SCIT), Jomo Kenyatta University of Agriculture and Technology (JKUAT), P.O Box 62000-00200, Nairobi, Kenya.
E-mail addresses: pmuriithi@jkuat.ac.ke (P. Muriithi), D.S.Horner@brighton.ac.uk (D. Horner), Lyn.pemberton@brighton.ac.uk (L. Pemberton), hwao1@health.usf.edu (H. Wao).

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2. Related literature

Scientists collaborate for various reasons. Focusing on the individual/micro level, Melin's (2000) examination of reasons for, form and effects of collaboration established that most people view collaboration in terms of the gains, whether 'material, knowledge based, or social kind' (p.38). This view is supported by Sargent and Waters (2004) who break down motivating factors into 'instrumental' and 'intrinsic' factors. Instrumental motivation refers to resource based rationales including access to resources and special equipment (Beaver, 2001; Birnholtz, 2007; Duque et al., 2005; Katz and Martin, 1997) whereas intrinsic motivation refers to factors related to individual choic es and preferences such as boosting productivity(Beaver, 2001; Lee and Bozeman, 2005) and personal gains (Birnholtz, 2007; Katz and Martin, 1997). Knowledge based rationales include access to diversified expertise and special skills (Beaver, 2001; Hara et al., 2003; Sonnenwald, 2007)

The extent to which instrumental or intrinsic reasons influence collaboration decisions may depend on the existing conditions within the research environment. For example, Bozeman and Corley (2004) found that personal interest was a major determinant of American scientists' collaboration choices and strategies. However, with the majority of research systems in developing countries being constrained by limited resources (Gaillard and Tullberg, 2001; Harle, 2009), resource based and environmental constraints may outweigh personal interests in scientists' collaboration decisions in developing countries.

A number of models and frameworks have been developed to explain the process of scientific collaboration. Some focus on identification of stages and tasks associated with each phase of the collaboration (Kraut et al., 1987; Sargent and Waters, 2004; Sonnenwald, 2007), while others focus on factors that influence accomplishment of the tasks or performance (Amabile et al., 2001; Maglaughlin and Sonnenwald, 2005). Though some models address a range of factors across personal and process-specific issues, a single model may be insufficient to explain the process of scientific collaboration in the developing world. Kraut et al. (1987) and Vasileiadou (2009) models, for instance, mainly focus on the internal processes such as decision making, coordination and sharing information, thus falling short of explaining potential contextual factors influencing the internal processes. To encapsulate both internal and external environment factors, the variables identified for exploration in this study were mainly drawn from a synthesis of studies, models and frameworks in literature. We broadly classify them into personal, disciplinary, institutional, and resource availability factors (2.1–2.4) as presented next, forming the conceptual framework for this study.

2.1. Personal factors

Personal factors include the intrinsic motivating factors referenced by Sargent and Waters (2004), and factors relating to researcher characteristics and role of the individual in the conduct of collaboration tasks. Personal compatibility, an important ingredient of successful collaborative relationships, is influenced by individual work styles, approach to science, and personality (Hara et al., 2003). Personal differences may arise regarding perception and attitudes on various issues. These include information security issues (Walsh and Maloney, 2002), issues of trust (Olson and Olson, 2000), and differences in working styles of individuals from different cultural/disciplinary backgrounds (Sonnenwald, 2007; Amabile et al., 2001). Other personal factors include characteristics that define a person such as skills and capabilities, and prior collaboration experiences (Cummings and Kiesler, 2008; Sonnenwald, 2007; Hara et al., 2003).

2.2. Disciplinary factors

Disciplinary factors that may affect collaboration processes include the level of resource dependence, largely defined by the nature of the work in a discipline and the different disciplinary cultures and practices (Birnholtz, 2007; Melin, 2000; Lee and Bozeman, 2005; Whitley, 2000). The differences in the nature of intellectual fields mainly result from 'task uncertainty' and 'mutual dependence' with regard to both the field and scientists (Whitley, 2000). Work involving a higher level of interdependency may require more communication and coordination mechanisms (Cummings and Kiesler, 2005; Walsh and Maloney, 2007; Olson and Olson, 2000). No previous research in the region has examined differences in collaboration based on disciplines. This study sought to establish and seek explanations for possible differences between disciplines.

2.3. Institutional factors

The University plays a major role in the knowledge production process. Its role has continuously evolved, from the core function of teaching and training to creation of knowledge so as to contribute to the economy and meet societal needs (Martin and Etzkowitz, 2000). Thus, significant changes have been noted in the structures of university functions and external relationships, with more links with non-academic institutions and private organisations (Martin and Etzkowitz, 2000).

Prestige of an institution has been found to determine the kind of environment in which a scientist operates, for instance, in terms of research facilities, working with prominent scientists and contacts developed, thus affecting overall productivity (Crane, 1965; Long, 1978). In Kenya, older universities have much more established departments mainly in the traditional disciplines and enjoy such prestige. However, it is unclear if there are significant differences in volume of research and productivity between universities, a subject of exploration in this study.

2.4. Resource availability

Funding has been identified as a major constraint for research in Africa (Gaillard & Tullberg, 2001; Harle, 2009). Most African nations spend on average 0.4% of their GDP on research and development compared to a global average of 1.7% (UNESCO, 2012). Thus, research is highly underfunded, and mainly dependent on donor agencies and international organisations (Gaillard and Tullberg, 2001; Harle, 2009; Jowi and Obamba, 2013; Mouton, 2008; Shrum and Beggs, 1997). Overdependence on donor support may affect the type of research conducted and how it is conducted, as 'donors and international organisations continue to maintain a diversity of goals and interests in developmental issues.…S & T policy does not have its institutional locus 'within' the country' (Shrum & Beggs, 1997, p.1). Access to special equipment (Melin, 2000; Katz & Martin, 1997; Birnholtz, 2007; Beaver, 2001) and information resources (Harle, 2010; Duque et al., 2005) have been identified as being a hindrance to collaborative work. Though some studies involved scientists across African nations (Gaillard & Tullberg, 2001; Harle, 2009; Shrum and Beggs, 1997), the huge sampling frames used cast issues of representativeness and generalisation of results to a particular African nation. This study examined the extent and nature of resource based issues involving scientists in Kenya.

In sum, the above classification of factors formed the conceptual framework for this study. We examined the extent to which the factors determine involvement in collaboration and affect the levels and conduct of collaborative work. The following research questions were addressed:

1. What is the level of academic research collaboration in Kenya?
2. What factors influence the levels, motivation for, and conduct of academic research collaborations in Kenya?

3. Research method

3.1. Choice of the method

A sequential explanatory mixed methods research design involving the use of both quantitative and qualitative data was employed. The quantitative component included the use of questionnaires to investigate general trends in scientific research collaboration. Researchers across institutions were targeted to reduce potential bias associated with institutional cultures and structures. Inclusion of different disciplines had the potential to reveal the differences in collaboration structures, processes and practices across disciplines. In the qualitative component, interviews were used to seek a deeper understanding of collaborative relationships and behaviours, including issues perceived as important for successful research collaboration. In addition, the interviews facilitated exploration of emergent issues not included in the survey questionnaire.

3.2. Sample selection

The study targeted 450 academic members of staff in four public Kenyan universities and four disciplinary areas. To reflect diversities in various disciplinary areas, the Field of Science and Technology (FOS) classification in the Frascati Manual (2007) was used. FOS classifies fields of science into six major categories: natural sciences, engineering and technology, medical and health sciences, agricultural sciences, social sciences and humanities. Purposive sampling was employed within the broader fields, based on significance of the research to the country, level of establishment of the discipline in the chosen institutions, and nature of the discipline, that would partly determine availability and accessibility of the data and participants.

Four disciplines (agriculture, engineering, public health, and computing) were sampled for the study. This reflects representation within each of the major categories in the classification, with the exception of humanities, which is assumed to have less collaborative research activities (Birnholtz, 2007; Whitley, 2000; Melin, 2000). This assumption was confirmed by a desk based survey of co-authorships, often used as an indicator of collaboration. The desk based survey involved retrieving publication records of individual researchers across a number of disciplines including the humanities, from CVs uploaded on the university websites and repositories, to identify co-authored publications.

At the time of data collection, there were seven public universities and 31 private universities. A preliminary study on establishment of the selected disciplines, staffing levels and volume of research undertaken in Kenyan universities found more research concentration in public universities as opposed to private ones. Unlike private universities, 'traditional' disciplines such as agriculture and engineering are mainly found in public universities. Public universities tend to attract trained researchers (PhD holders) as they have better research support infrastructures such as laboratories and equipment, and are mainly the target for funding by the government and international organisations. On the other hand, private universities tend to support newer market driven courses such as business education and information technology, thus smaller population of researchers in the chosen disciplines. They were therefore excluded from the sample.

Using purposive sampling, four out of the then existing seven public universities (University of Nairobi [UoN], Kenyatta University [KU], Moi University (MU), and Jomo Kenyatta University of Agriculture and Technology [JKUAT]) were selected for the study. These are the oldest Kenyan universities and have more established departments in terms of the number of courses offered under each disciplinary area and number of academic staff affiliated with the departments. A preliminary search of research and publication data through the staff profiles gave an indication of research activity across these institutions, thus boosting our confidence in the sampling process adopted.

A preliminary search on university websites identified the academic members of staff affiliated with departments in the disciplines under study, giving an initial estimate of the size of target population as 450. For more accurate identification of the levels of collaboration, and considering the size of the target population that could comfortably be accommodated within the time and budget constraints, further sampling within the selected disciplines and universities was found unnecessary.

Similarly, for the qualitative component, purposive sampling was used to select a subset of participants to participate in the interviews. The selection was based on the number of collaborations in which participants were involved (it was assumed that there was much more to learn from experiences of those in more collaborative work). In addition, it was assumed that ensuring representation across disciplines and institutions would capture variations important in understanding the nature of collaborative work. Each discipline was therefore represented across the four institutions, with the exemption of computing, in which established researchers were only found in two institutions. The need to follow up more on issues of funding made it necessary to interview one person external to the sampled population, an official from the funding arm of the government, the National Commission for Science, Technology and Innovation (NACOSTI).

3.3. Data and analysis

The quantitative survey included measures of level of collaborative work and productivity within the community, motivation for collaboration, challenges faced and demographic information. The interviews sought a deeper understanding of collaborations based on the participant's personal experiences. They included questions on management and organisation of the various activities in the collaboration and problems experienced.

As pointed out earlier, bibliometric studies that mainly derive data from international databases tend to under-represent research undertaken in Africa. Thus, to comprehensively capture collaboration and productivity data, this study employed self-reported measures. Level of involvement in collaboration in the last ten years was dichotomously coded (1 = Yes, 0 = No). Given the assumed low levels of collaboration (based on literature), 10 years was deemed as reasonable duration for respondents to remember the details of the collaborations. Productivity was measured by the number of publications one had over the last ten years.

Quantitative data were analysed using statistical analysis software, SPSS Version 21. Descriptive statistics provided general profiles of the respondents and basic indicators for research work environments, collaboration and productivity. A Kruskal Wallis test was used to show differences in levels of collaboration across common factors identified in literature as influencing research collaborations; disciplinary area, academic qualifications, country where highest degree was attained, institutional affiliation, age and gender. Logistic regression was performed using these factors as predictors of involvement in collaboration. In the regression model, disciplinary area, institution and age categories were dummy coded. For disciplinary area, agriculture was used as the reference category, because having the highest levels of collaboration, it was easier to compare the other categories against it, making interpretation of results easier. No particular criterion was used in selecting reference categories for age and institutions, as the Kruskal Wallis test revealed no significant differences in collaboration levels across these categories. A factor analysis on a list of problems identified as affecting collaborative research, and criteria of choice of collaborator, generated factor dimensions reflecting the major categories of problem areas and motivating factors respectively. Qualitative data analysis was guided by the broader themes examined in the quantitative survey, which were also explored in the interviews. Qualitative and quantitative findings were integrated into a coherent whole to illuminate our understanding of factors influencing research collaboration in Kenya.

Table 1
Basic demographic, collaboration and productivity indicators of respondents.

Variable	% Response	% involved in collaboration within each category	Mean (SD) of Current projects	Mean (SD) of publications
Involved in collaboration	65	65	1.80(1.40)	9.58 (7.40)
Not involved in collaboration	35	–	–	3.65(3.98)
Personal factors				
Age	N = 228			
25 − 30	7.5	47.1	1.71(1.04)	2.0(2.09)
31 − 40	28.9	54.5	1.75(1.56)	5.41(5.48)
41 − 50	30.7	72.9	1.82(1.21)	9.67(7.81)
51 − 60	25.4	69	2.05(1.52)	8.78(7.16)
Over 60	7.5	70.6	1.27(1.56)	7.38(6.55)
Gender	N = 248			
Male	79	64.9	1.89(1.44)	7.76(7.03)
Female	21	64.2	1.38(1.10)	5.66(6.54)
Academic qualification	N = 225			
Has a PhD	55	86.3	1.98(1.48)	10.93(7.43)
No PhD	45	37.6	1.39(1.08)	3.14(2.80)
Disciplinary factors	N = 248			
Agriculture	27.5	89.7	2.38(1.51)	11.57(7.60)
Engineering	49.4	51.6	1.50(1.32)	5.97(6.08)
Public Health	13.0	65.6	1.14(.96)	5.37(5.33)
Computing	10.0	60	1.62(.96)	6.09(7.12)
Institutional factors				
Institutional Affiliation	N = 248			
University of Nairobi (UoN)	31.1	66.2	1.72(1.28)	9.12(8.06)
Jomo Kenyatta University of Agriculture and Technology (JKUAT)	41.5	62.1	2.02(1.66)	7.02(7.09)
Kenyatta University (KU)	10.5	73.1	1.65(1.17)	6.69(5.66)
Moi University (MU)	16.9	64.3	1.56(1.05)	5.97(4.66)
Region of study				
Trained in developing country	48	52.9	1.50(1.06)	5.78(6.24)
Trained in developed country	52	70.6	2.12(1.60)	8.65(7.15)

Note: % response represents the percentage of participants who responded to the corresponding entries/list of variables under each category in column 1, whereas N is the total number of responses in each category. Questions regarding involvement in collaboration, disciplinary area and institutional affiliation were compulsory thus were answered by all respondents (N = 248). However, some respondents did not to answer all questions in the other categories.

4. Findings and discussion

The quantitative survey yielded 248 responses, representing a 55.1% response rate. Table 1 shows a summary of basic demographic and other indicators of research collaboration and productivity (publications).

About two-third (65%) of the participants were involved in collaborative research. A Kruskal Wallis test revealed significant differences in the distribution of number of current research projects across disciplines ($\chi^2 = 18.57$, $p < 0.001$), academic qualification ($\chi^2 = 4.29$, $p < 0.05$), and region where last degree was attained ($\chi^2 = 4.75$, $p < 0.05$). The test was not significant across institutions, age group and gender categories.

A positive link is seen between collaboration and publication productivity, whereby those involved in collaboration had a mean of 9.58 publications versus 3.65 publications for those not involved. Collaboration and productivity levels were highest for those in the 41–50 and 51–60 age brackets. Males had a higher mean number of projects (1.89 vs 1.38) and publications (7.76 vs 5.66) than females. Significant differences in collaboration and productivity were realised in levels of collaboration and productivity between PhD holders and non-PhD holders. Noteworthy, in Kenya universities individuals with Master's degree and/or those pursuing PhD may be allowed to teach. In this study, these individuals without PhD qualifications are referred to as non-PhD holders, and excludes other university personnel such as the non-academic staff. Notably, those who trained in developed countries were more collaborative and productive than those who studied in developing countries.

Some of the indicators in Table 1 are referenced in subsequent sections, especially in the discussion on factors influencing research collaborations in Section 4.3.

4.1. Motivation for collaboration

Motivation for collaboration may contribute to the number and nature of collaborations in which people get involved. Respondents were asked to indicate, using a 4-point Likert scale (1 = Not important, 2 = A little important, 3 = Important, 4 = Very important), how important each of a set of 11 variables (Column 1, Table 2) were in their choice of a collaborator. A factor analysis of the 11 variables, using Orthogonal (Varimax) Rotation, yielded a KMO statistic of 0.712 indicating the sample size was adequate to yield distinct and reliable factors. Because the KMO for individual variables were > 0.5, all were included in the analysis. Only factors with eigenvalues > 1 were retained. The resulting rotated component matrix grouped the motivating factors into three factor dimensions, classified as: social cultural, knowledge and resource based, and goal oriented factors (Table 2).

Social cultural factors scored lower as motivator for collaboration as compared to knowledge and resource and goal oriented factors (see means in Table 2, Column 2). A number of respondents indicated they consider reputation important in their choice of collaborator, thus seek collaborations with reputable individuals in particular research areas. This can be for a number of reasons, including that reputable individuals may be influential in attracting funding grants (Beaver and Rosen, 1979), have more experience in conducting research collaboratively, or have access to important networks (Crane, 1969). The

Table 2
Criteria for Choosing a Collaborator: Factor Loadings, Mean, and Standard Deviation.

Factor	Mean	SD	n	F1	F2	F3
Factor 1: Social-Cultural						
Friendship	1.86	0.91	144	0.823		
Strong reputation	2.99	0.89	147	0.678		
Nationality	1.54	0.88	148	0.567		
Value of previous collaboration with person	2.93	1.01	148	0.565		
Institutional/organizational affiliation	2.99	0.86	151	0.561		
Factor 2: Knowledge and Resource						
Access to funding	3.32	0.80	149		0.685	
Access to special equipment	3.07	0.89	147		0.677	
Mentoring junior colleagues	2.82	0.88	152		0.627	
Collaborator has special skills and expertise	3.55	0.67	151		0.591	
Factor 3: Goal-Oriented						
Sharing a common goal	3.66	0.53	147			0.779
Strong work ethics	3.22	0.79	144			0.638
Eigenvalue after rotation				2.162	1.939	1.518
Unique variance explained (%)				19.66	17.63	13.80

Note: Factors are listed in the order of size of their factor loadings, suppressing absolute values < 0.4 as recommended by Stevens (2002) in Field (2009); SD = Standard Deviation.

anticipation of receiving credit through collaborating with such individuals may thus act as a motivating factor for getting into research collaborations.

Value of previous collaboration was seen as important in establishing a basis for future collaborations. Personal 'chemistry' was highlighted as an important ingredient for success as opposed to being forced to work on project:

> In some of these donor funded projects, you are forced to be bedfellows, and it's not always guaranteed that the chemistry will be there. Sometimes it could be a funded project, for instance and so what happens is that you simply get a letter on your desk telling you 'David, you have been nominated to represent this faculty in this new collaboration'. Then you find yourself in a meeting and well, without intent you find you just can't get out

Institutional/organizational affiliation was also considered important, scoring a mean of 2.99 (Table 2). This could be due to what researchers saw as competition between institutions. One researcher pointed out that local universities were 'making lots of MoUs with institutions outside and very far who don't seem to be a threat to them, and not within themselves. It could also be for resource based reasons, as discussed next.

Knowledge and resource based factors, including access to funding and special equipment, and collaborator having special skills and expertise were ranked highly as motivators for collaboration (Table 2, column 2). The need for relationships resulting in mutual gain for the participants was emphasised, with a number of respondents noting that they sought collaborators whose contribution complemented their own. A participant in agriculture, for example, narrated how they relied on Kenya Seed Company for mass production and marketing of the seeds they bred in their laboratories. While the university had the knowhow and laboratories, they did not have the capability to produce and market the seeds, making their collaboration complementary.

Funding emerged an important motivator for collaboration in two ways: Firstly, the requirements of funding bodies, whereby, for example, NACOSTI, the research financing arm of the Ministry of Higher Education, Science and Technology requires a research project to be multi-institutional to win a research grant. Secondly, researchers deliberately sought collaborations with organisations that could provide funding, leaving little room for inter university collaboration:

> … if for example Google is in partnership or is collaborating with JKUAT in the area of mobile application computing, and another multinational say yahoo is collaborating with Moi university in research about search engines. There's no way JKUAT is going to collaborate with Moi, because Moi is focusing on where they are getting the funds and they want to deliver that product, JKUAT is also committed to Google and they want to deliver that product. So this leaves very little room for collaboration between JKUAT and Moi

Goal-oriented factors were considered important in choice of collaborator. The importance of trustworthiness, work ethics and commitment was stressed:

> Sometimes you look at the CV of who are working with…the credentials, yes, truthfulness, because when you are doing a research that is problem solving, you want to get the actual result, not a cooked result. So it's not just the result, and of course as we say not just anybody. That's one, the degree of perfection. There are also people who put you on the program, because they want to use you. To get money, they have been told that they have to collaborate with someone. So I always ask … what is the background of this?

4.2. Problems in collaboration

To understand the nature of problems faced in collaborating, respondents were asked to indicate, the extent to which a list factors (Table 3, column 1) were viewed as a problem in their collaborations. The resulting means (Table 3, column 2) indicate that socio-cultural issues were considered less problematic in collaborative research as compared to resource based issues. A factor analysis of the 17 variables using Orthogonal (Varimax) Rotation yielded grouping of problems in collaboration into three dimensions relating to: problems of socio-cultural nature, problems of management and control, and problems of availability of resources (Table 3). Of the three problem areas, only availability of resources was significantly correlated with the number of collaborative projects ($r = 0.149$, $p < 0.05$), a possible indication that an increase in the availability of resources is associated with an increase in research collaboration.

Among the ***problems of social cultural nature***, information security did not emerge a major problem in collaborative research (Table 3, column 2). However, consistent with Amabile et al. (2001), issues of mistrust were pointed out, especially regarding collaborations involving industrial partners:

> There is just this suspicion that oh these people will steal my idea. So because of that, the industry tends to be much closed. They don't want to disclose anything they are doing. They will always be suspicious, even if let's say there is a processing line and you want to know the ingredients they add − you see it's good for you to know so that you can advise them on where there is weaknesses but sometimes they don't want to disclose

As exemplified by the experience of one participant, lack of research ethics, plagiarism, and lack of transparency in proposal review and grant awarding processes posed problems:

> … you submit a proposal to xx then you are told it cannot be funded. Then a few months later, you find somebody with the same proposal. Then you wonder but surely there's no way these people could have been thinking the same and writing the same as me. They definitely maybe had access….and see it's now very hard for you to prove that it was your idea

Similar observations were highlighted at a workshop on authorship, integrity and plagiarism organised by Linkage of Industry with Academia (LIWA), NCST and other collaborators (NCST, 2012). Lack of

Table 3
Problems in a collaboration.[1]

Problem Dimension	Mean	SD	n	F1	F2	F3
Factor 1: Problems of socio-cultural nature						
Scientific competition	1.57	0.77	150	0.854		
Cultural differences	1.38	0.67	149	0.739		
Information security	1.8	0.85	147	0.710		
Resolving conflicts	1.56	0.71	149	0.697		
Authorship inclusion and order	1.72	0.86	149	0.630		
Diverse disciplinary training of collaborators	1.72	0.87	149	0.587		
Selection of a publication forum	1.73	0.79	148	0.563		
Factor 2: Problems of Management and Control						
Coordination of member's activities	2.1	0.9	148		0.778	
Timely delivery of results	2.41	0.83	147		0.743	
Defining roles	1.7	0.78	148		0.711	
Availability of time to commit to research	2.66	0.93	150		0.674	
Leadership and control	1.91	0.86	148		0.638	
Availability of skilled personnel	1.85	0.89	149		0.503	
Administration of the funding	2.42	0.95	149		0.481	0.454
Factor 3: Problems of Availability of Resources						
Ease of getting funding	3.05	0.94	150			0.830
Amount of funding	2.99	0.89	148			0.794
Availability and access to special equipment	2.83	0.93	149			730
Eigenvalue after rotation				3.728	3.480	2.294
Unique variance explained (%)				21.93	20.47	13.50

Note: † = Factors are listed in the order of size of their factor loadings, suppressing absolute values < 0.4.
KMO statistic = 0.852.

ethics and dishonesty strains a collaborative relationship, and may affect an individual's perception towards collaborative work.

Among the ***problems of management and control***, and consistent with past studies (Harle, 2009; Ynalvez & Shrum, 2011), lack of time to do research was rated highly as a problem in collaborative research (see Table 3). Participants noted a lack of research culture in Kenyan universities, with more emphasis on teaching. With low budgetary allocations, universities find they need to survive and one of the ways they do this is through huge student intakes (Kashorda and Waema, 2014), which are not proportional to the teaching staff. This results in high teaching loads, resulting in the common complaint of lack of time to do research. Participants expressed a desire towards reduction of teaching loads for those in research. However, it also emerged that teaching was seen as holding more reliable financial benefits valued by many in academics as opposed to research:

> It takes long to get these collaborations working. For example it took us as a university long to get Google into some kind of collaboration with the university. And even then the conditions that comes with these collaborations they are so tight that you don't see yourself benefiting substantially or benefiting significantly as an individual from that kind of partnership. So what you do you say let me go and teach part time somewhere else, make my money because I have my financial obligations to fulfill

However, it should be noted that though availing more time may partly solve the problem of lack of time to do research, it may not be the magic solution to getting people to do research.

Problems of availability of resources included ease of funding, amount of funding, and availability and access to special equipment. It was noted that there was low investment in research by the government.

> … one of the most serious problem is funding. Collaboration is not just the science of what you want to do, those will become just dreams if you have nobody to support your work … the biggest problem so far is that investment within the country for research has been minimal. For years and years we have had to depend on donors to support our research. I think that's a challenge, a very big challenge…

Insufficient funds, identified by Sonnenwald (2007) as one of the emergent challenges at the 'sustainment stage', scored highly as a problem in some collaborations in this study(see Table 3, column 2). This was partly blamed on poor budgeting in the proposal, the length of time it takes for a proposal to be approved, within which fluctuations in money markets make equipment more expensive than was stated in the budget, and poor proposal review processes:

> More often than not, you find maybe because of lack of expertise, the people who review proposals don't really understand what needs to be done. For example, they may want something on value addition. But since they think value addition is making juice or jam, they don't know what it entails to put a juice on the shelf of supermarkets. There are so many costs involved that unless you are a food scientist, you may not really get. So you find that they don't know − they don't understand why you need a lot of money. So they chop the budget

When funding was available, respondents also cited the problem of administration of funds. Many participants faulted the bureaucratic processes at the universities in release of funds, which were seen as slowing down some processes and a cause for misunderstanding by collaborators who were unfamiliar with how the university systems operate.

> ..after your proposal gets funded, the money comes to the university. As soon as it comes to the university, it's the university's money and accessing it might be not be easy… So you find your collaborators do not understand why the money was transferred to you and you can't start the activities …. for us, we have to take imprest, which has to go through many processes. And then there's a fixed amount you can be given at a specific time. For instance the maximum is Ksh 300,000 − suppose I want to buy an equipment of Ksh 500,000, I need to justify, it needs to be approved and it's really a problem.

In some cases, funds meant for research were directed to other university projects that were considered 'more worthy'. Access to special equipment, emerged as one of the important factors in choice of collaborator and was indicated as a major challenge in collaborative research. Issues were raised about gaining access to equipment in other institutions. A participant expressed frustrations at the rigid bureaucratic processes involved in allowing collaborators from outside to use a particular university's equipment:

> I have to go and seek a lot of approvals yet it is a research that we are doing together. The fact that I am allowed or given the mandate to carry research and I am allowed to incorporate any person I think should just be a straight forward thing − that I want to work with this person…let's work with him then whatever equipment facilities are here they should be available to this person am working with

Though Harle (2010) argues that availability of scholarly literature is no longer much of a problem in the East and South African universities, a number of respondents in the current study reported problems with access to digital resources. Universities repositories mainly lack in content that is useful to the researchers. A study of the university repositories revealed that only one university at the time of data collection had made concerted efforts to compile a compendium of research activities, and was in the process of rolling out a research management system to organise all its present and past research.

[1] Respondents were asked to indicate to what extent each of the problems areas listed in Table 4 was a problem in their collaborations. The responses were measured on a four point Likert scale (1 = Not a problem, 2 = Minor problem, 3 = Problem, 4 = Major Problem)

Table 4
Predictors of involvement in collaboration in Kenya.

	Model 1		Model 2		Model 3	
Variable	B	exp (B)	B	exp (B)	B	exp (*B*)
Personal factors						
Academic qualification (1 = Phd; 0 = No Phd)	2.434***	11.401	2.322***	10.196	2.242***	9.416
Gender(1 = Male;0 = Female)	−0.202	0.817	−0.164	0.848	−0.463	0.629
Age (Age > 60 as the reference category)						
25–40	0.251	1.285	0.651	1.918	0.620	1.859
41–50	0.293	1.341	0.649	1.914	0.700	2.013
51–60	0.417	1.517	0.788	2.198	0.685	1.984
Disciplinary factors						
Disciplinary field (Agriculture as the reference category)						
Engineering			−1.746***	0.175	−1.802***	0.165
Public Health			−0.852	0.428	−0.671	0.511
Computing			−0.841	0.431	−0.749	0.473
Institutional factors						
Region of study (not Africa as the reference category)					0.433	1.542
Institution (UoN as reference category)						
JKUAT					0.050	1.052
KU					0.171	1.187
MOI					0.065	1.067
Constant	−1.072	0.342	−0.690	0.502	−0.679	*0.507*
-2LL	231.928		216.733		204.752	
R^2(Nagelkerke)	0.326		0.392		0.399	
Model Chi Square	60.94***		75.254***		72.412***	

*P < 0.05, **P < 0.01, ***P < 0.001; ***B*** = regression coefficient; exp (***B***) = odds ratio; Dependent variable: involvement in collaboration; N = 245

Researchers felt centralised access to research information both at national and institutional levels would enhance searching for collaborators and networking and avoid duplication of research:

> The NACOSTI should be able to tell the scientific community, who is doing what and where they are, so that people can know where to go hunting for collaborators. Similarly, the universities should also be able to do the same, say we have this discipline, these people are working in this area, a way of getting the information around, of who is doing what and where they are and what they are working on, so that people can look them up

4.3. Factors influencing research collaborations

The results presented in the preceding sections point to a number of factors that affect research collaborations in Kenya. To illustrate the effects of some of the factors on predicting involvement in collaborative research, a logistic regression was performed. The dependent variable, *involvement in collaboration*, was captured by the question, Have you been involved in any collaborative research project(s) in the last ten years? The response was dichotomously coded (Yes or No). Table 4 presents the results of the logistic regression. Model 1 are the results of including *personal factors* (i.e., academic qualification, gender, and age) as predictors of involvement in collaboration. Model 2 shows the results of adding *disciplinary factors* (i.e., disciplinary field) to model 1 whereas model 3 shows the results of adding *institutional factors* (i.e. region of study and institution) to model 2.

The factor analysis indicate a strong influence of resource based factors on collaborations (Tables 2 and 3). However, these factors are not included in the logistic regression analysis as questions relating to this dimension were only answered by those who were involved in collaborations. For the same reason, the variables in the factor analysis were not used as predictor variables in the regression model, thus the regression is largely illustrative rather than a test of the model.

4.3.1. Personal factors

Personal factors are those of social and professional nature, influencing the scientists' attitude, preferences, and choices, level of commitment, interest and working styles. Academic qualification is positively associated with collaboration levels, results which are consistent with the findings by Duque et al. (2005) and Ynalvez and Shrum (2011). One with a PhD is approximately four to five times more likely to be involved in collaboration than one without (Table 4, Model 3: exp (*B*) = 9.416, P < 0.001).This may be an indication of the importance of postgraduate research training, especially at the PhD level, in building research related capabilities. However, levels of academic qualification differ significantly between disciplines. Agriculture has a relatively higher percentage of individuals with PhD qualifications (85%), compared to engineering (48%), public health (44%), and computing (23%). This points to a need for more focus on funding training in areas/disciplines with less trained research personnel.

A number of respondents noted a need for continued professional staff development support, especially, in proposal writing and grant awarding processes as well as specialised training in other areas relevant to conducting research. Provision of such support differs across institutions. For instance, only the University of Nairobi, among those studied had a clearly set out program of training in writing proposals at the time of data collection.

The results of this study indicate less commitment in supporting early career researchers who had just completed their PhDs into starting off and building a research career, as noted in the sentiments of a participant:

> You have been trained to become a researcher only to end up becoming the head of the department or the chairman. I don't think that was the plan, to be bogged down by administrative duties…. being a head of department in these public universities is just a nightmare − you get co-opted into all this committee for this, committee for that, things you don't need, so there's hardly time for research.

Harle (2011) notes that universities need to support early career researchers and devise strategies to address the problem.

Gender and surprisingly, age were not significant predictors of involvement in collaboration. However, those aged above 60 years were

less likely to be involved in collaborative research as compared to other categories (see Table 1). This corroborates Lee and Bozeman (2005) finding that research activity peaks at a certain timeline in one's career and gradually falls with age. Fewer women than men are involved in collaborative research (Table 1), possibly because there are fewer women in scientific disciplines. However, for those who are, the non-significant result could be an indication that they collaborate relatively at the same level with men.

4.3.2. Disciplinary factors

Levels of collaboration differ significantly between disciplinary areas. For example, those in engineering are approximately six times less likely to be involved in collaboration than those in agriculture (Table 4, Model 3: exp (B) = 0.165, $P < 0.001$). The differences in collaboration across disciplines are generally attributed to the factors discussed below.

4.3.2.1. Nature of the work. Nature of the work determines the level of dependence for resources, work and skills, and frequency of interaction between partners in performing the tasks (Hara et al., 2003; Olson and Olson, 2000; Whitley, 2000). Whitley (2000) sees differences in nature of intellectual fields as mainly resulting from their task uncertainty and mutual dependence. The nature of the work as described by a number of agriculturalists indicated awareness of problems that needed to be solved. This is evident in the disciplinary networks that exist to support work relating to particular issues, reflecting low levels of task uncertainty. In contrast, a participant observed research in computing as not being well structured and lacking in disciplinary networks, perhaps a reflection of less defined research problems and areas thus high task uncertainty:

> Computing research is still not very well structured. Even research areas sometimes are still not very well structured, like for example, some of the things I am doing simulations and thermo-smart systems, it's very hard to tell you who else is doing that around here so that I collaborate with him or her. So it's still not very well structured since this is an area that is fairly green in this part of the world…

This could be contributing to the relatively lower levels of collaborative work within computing seen in Table 1.

4.3.2.2. Disciplinary backgrounds and cultures. It has been noted in past studies (Sonnenwald, 2007; Walsh and Maloney, 2007) that differences in work organisation and cultures of different disciplines may affect collaboration processes. Agriculture, being one of the oldest and most established disciplines in the universities sampled, has over the years built a culture of research mostly done collectively, and has more than 80% of agriculturalists involved in collaborative work (Table 1). Years of doing research in agriculture have seen the departments and individuals establish links with other university departments, research institutes and private organisations engaging in similar research, thus the likelihood of more collaborations taking place. This may not be the case with 'newer' disciplines such as computing.

4.3.2.3. Perceived relevance of the research in the field. Differences in level of collaboration between disciplines was also partly attributed to funding sources that favored some disciplines more than others, probably a reflection of interest in the kind of research done. There was an indication that priority is given to research addressing local needs such as food security, consistent with the views of Duque et al. (2005) and Harle (2009). However, others viewed this differently. With much of the funding originating from international organisations, one participant claimed that there was a general perception that those from developing countries are supposed to be 'consumers' not 'producers' of technology, thus less interest in funding technological projects, such as those in engineering. This can be seen as a reflection of the effects of too much dependence on donor support, which Shrum and Beggs (1997) and Mouton (2008) noted, determine what research is done and how it is done.

4.3.3. Institutional factors

A Kruskal Wallis test found no significant differences in levels of collaboration between institutions (also see Table 4). This could be a reflection that the universities are faced with similar kind of contextual situations thus none emerges superior to the other in research performance. It is noted that those who studied outside Africa are more likely to be involved in collaborative research than those who studied in Africa (Table 4, Model 3: exp (B) = 1.542). This could be a result of prior exposure to active research environments, as argued out by Crane (1965) and Long (1978). They are possibly presented more opportunities for making ties with research active individuals and being incorporated into active research networks, thus more opportunities for engaging in collaborative research.

The following issues emerged as important for institutions towards promoting not only collaborative research but also research in general.

4.3.3.1. Motivation and rewards. Poor remuneration packages, motivation and reward mechanisms were identified as affecting research work. Motivation is viewed in different ways by various individuals. While a number indicated preferring financial gains, others look at recognition and promotion as their source of motivation. One was specific that the kind of recognition she was interested in was promotion, which was not forthcoming 'even after making the university that much money'. Others expressed dissatisfaction at the financial gains they accrued from their innovations as individuals, with the university being seen as the major beneficiary. A participant noted that he'd rather collaborate with private organisations, associated with much more financial gains.

Lack of implementation of research findings in commissioned research, in the words of one participant, robbed them of the morale to do more research if the previous reports or findings had not been acted on. Harris (2013) notes the different view of research output and impact between researchers and practitioners, whereby researchers are more worried about publications and citation counts, while practitioners are interested in actionable advice. Placing more emphasis on practical impact in reward mechanisms as opposed to publication counts could probably encourage research that is of interest to the community, increasing its chances for implementation and impact.

4.3.3.2. Leadership structures. Leadership and management structures influence processes such as access to resources, decision making and communication processes. University leadership structures were indicated as being characterised by stiff bureaucratic processes with decisions and approvals having to pass through many hands. Such are the processes involved in processing and release of project funds, and getting collaborators from outside of the universities utilise university resources:

> If I want to collaborate with somebody from a company or industry, and he comes here, he has to be known by the administration. He has to be allowed to do this and that, and seek a lot of approvals yet it is a research that we are doing together. The process is just so cumbersome because it's not an employee of this institution

Participants reported that those in management at times did not seem to understand the urgency of some of the work or requests made by the researcher. This reflects a conflict in interest between management and researcher interests, also observed by Muinde (2009) and Melin (2000).

4.3.3.3. Institutional policies and strategies. Some universities had better policies and structures in place to support and encourage research. Differences were noted in policies regarding research training, visibility

of researchers, accessibility of research information, and issues regarding research ethics. For example, though research ethics emerged an issue affecting conduct of research, only one university had a plagiarism policy, first introduced in 2013. Lack of proper guiding policies on issues such as intellectual property (IP) rights in some cases resulted in conflicts in collaborations involving the university and industrial partners. To illustrate this, a participant gave an example of a project that had to be stopped because the industrial collaborators and the university could not agree on the share of IP rights:

> … the main problem was that after sometime we were told that we had to come up with an IP document so that we sign the IP, but the company wanted a bigger share of the IP. So the university collaboration department, the DVC RPE's office was of the stand how come we even appear to be giving away the entire IP. So that one became quite rocky and we just ended the collaboration.

4.3.3.4. Facilitating links with industries. A number of participants noted that weak links existed between universities and industry. A participant from engineering felt that industries do not trust local researchers with solutions or designs:

> We are supposed to be consumers according to them … even if we go to the industry, they don't allow local designs to come in. They are industries yes, manufacturing industries, but the designs come from elsewhere, they just implement them here

Participants observed that partnering with industrial partners would lead to benefits of funding and sharing equipment, widely cited as barriers to collaboration in Table 3. The need to do research that was of interest to industry was seen as important in improving integration with the industry. It was noted that universities needed to proactively publicise and showcase what they do:

> It's us the academia to show the industry what we can do. But if you do not show them what you can do, then they'll never invite you to solve their problems. I'll give you an example. It is a recent case. Kenya Power consulted some people from South Africa to solve a certain problem in the power industry. Those people came, they provided their solution, and it failed. The same Kenya Power engaged JKUAT staff. They solved the problem. Can you tell me the expatriates are the best? In fact the minister was surprised that we have so much capacity here that we can solve these problems and yet industry is saying that expatriates are the best people to solve the problems. He changed his mind

A participant faulted much of the curriculum offered as not being 'in tandem with the contemporary practices of the world thus bringing about some disconnect between the industry and the academia'. Redesigning the curriculum to reflect current issues would create more confidence in what universities can do, thus contribute to strengthening of industrial links.

4.3.4. Resource availability

Access to funding emerged a strong motivator for collaboration (Table 2) while ease of getting funding was rated highly as a problem facing collaborations (Table 3). Resource availability was not included in the logistic regression analysis because in the survey, questions related to this dimension were only relevant to those who responded yes to involvement in collaboration

It was noted that there was low investment in research by the government. A participant from NACOSTI confirmed that the government spent approximately 0.4% of GDP on research, corroborated by statistics presented in UNESCO (2012) on R & D spending by countries in sub-Sahara Africa. Government funding to universities only constitutes approximately 30% of the universities operational budget, as established from records at two of the major public universities studied. As the universities struggle to meet the budget deficits, they barely have funds to commit to research. Perhaps this explains the high dependence on donor funding, consistent with Shrum and Campion (2000), Harle (2009) and Mouton (2008). The majority of the respondents (65%) indicated their source of funding as international organisations, compared to 14.8% by own institution and 17.6% by the government.

Access to special equipment scored highly as an important motivation for collaboration (Table 2, Column 2). A participant noted that they chose to collaborate with persons from organisations owning the equipment. However, access is complicated by university structures that put restrictions on use of their equipment. Some participants indicated that they preferred seeking collaborations with organisations with less rigid structures, such as research institutes. The Government of Kenya has allocated an 'equipment fund' in an effort towards solving this problem, whereby it purchases an expensive equipment, and locates it in one of the institutions for use by those who need its services from the surrounding institutions. This aligns with Finholt and Olson's (1997) proposal of concentrating expensive equipment in specific locations to maximise their utilisation. However, remote access mechanisms proposed by Finholt and Olson are hampered by nature of the equipment and poor computer networks and associated tools for access. The logistics of sharing the equipment in times of high demand, coupled with constrains of time and travel funds pose extra challenges.

5. Conclusions

This study finds a relatively high level of collaborative research within the academic research community in Kenya, as opposed to indications from past studies. Factors of personal nature such as level of skills and experience, level of commitment, individual work styles, and ethical issues have a bearing on how researchers conduct themselves and success of research collaborations. However, the results discussed in this paper shows a major influence of external environment factors and disciplinary orientation, as opposed to personal factors. External environment factors are those that an individual researcher does not have direct control over, and includes resource availability and institutional factors. Their effects would apply to both collaborative research and research in general.

The factors for investigation in this study were drawn from a synthesis of models, theories, frameworks and concepts in literature. However, noting that majority of the studies were on research collaborations in the developed world, the factors were investigated for their effect within the Kenyan context. This study reaffirms the validity of those that were found to have significant effects on research collaborations in Kenya. Their contextualisation within theKenyan case adds to knowledge on applicability of the dimensions they present for developing countries studies.

This study has highlighted important issues that inhibit the growth of and effectiveness of collaborative research, with implications for the researchers and policy makers at both the institutional and national levels. This study mainly focused on a sample of Kenyan researchers. However, the results indicate that the majority of research funding comes from outside the country, with a number of collaborations linked to international organisations. Future studies could extend the focus to international collaborations.

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