Scientific Research, Writing, and Dissemination (Part 2/4): Barriers to Effective-Research, at Engineering-School

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Abstract
This is the second-piece of a tetralogy on Scientific-Research, Writing, and Dissemination. This work critically examines the local-institutional-context, to identify actual or perceived-barriers, to effective scientific research, at Engineering-School. A survey-questionnaire was tested for validity and reliability (in compliance with the ISO 20252:2006 (E)); interviews; observations; and a document-analysis-instruments, were also utilized. The overall-finding, with no-fear of exaggeration, is that the current-state of scientific research, at the institution, can be perceived as ‘a-crisis in-the-making’. The profound-lack of, or in some-cases, non-existence, of essential-ingredients for effective research, were identified, and can be grouped into: (1) Economic (inadequate-funding for research and research-infrastructure; low remuneration; and self-sponsored-publishing); (2) Institutional (lack of Code of Practice, for Researchers; and mushrooming-campuses); (3) Behavioral (‘publishing-prostitution’; ‘brain-drain’; ‘complex of intellectual-superiority’; and lack-of time, motivation, recognition, and mentorship); (4) Demographic (gender-imbalance; and aging-faculty); and (5) Managerial (lack of marketing of library-services, and training, for technical-staff), among others. Largely, the research-findings were in-accord with the conclusions of the Commission for University-Education, Kenya. Additionally, the following relevant issues were elaborated-upon: The state of engineering-education and accreditation of engineering degree-programs; Gender in engineering-research and education; Aging-faculty; Mentorship in academic and research-activities; Funding for Research; Low remuneration of teaching-staff; Collaborative and ‘Multiple-Disciplinary’ Research; The Internet, as an institutional-research-tool; Lack of time and office space; Self-sponsored publishing-demands; Code of Practice for Research; Recognition of academic-staff; and Lack of Technical-staff, among others. Several recommendations also offered on how to improve the current depressing-situation. The findings, alongside with the theoretical-coverage, will, expectantly, make a contribution (in its small-way) toward the body of knowledge on the subject. The ideas and opinions, expressed in this work are the author’s own, and do not necessarily, represent those of the school; the university, or the government, or any of its institutions, at-large.

Keywords: faculty, accreditation, funding, multiple-disciplinary, mentorship, Kenya, developing-country.

1. Introduction.
1.1. Effective-research
Effective research is the subject-matter of this study. The University of Oklahoma, for example, identified 5 fundamental-attributes of effective-research, as follows: (1) Resourcing/Funding and Essential-Assets (built infrastructure, human-capital, and collaborative-networks); (2) Leadership of a Systemic-Program (creating collaborations within, or across-disciplines, mentoring students and junior-faculty, creating and leading centers, or building-toward larger or systemic-questions); (3) Dissemination (different-outlets and media, for disseminating scholarly-research, including conferences, lectures, journals, books, performances, exhibits, etc. Dissemination in prestigious and/or high-impact-outlets (measured, for instance, by journal citation-indices) is also a reflection of the quality of research. Increasingly, Open-Access (OA) dissemination, mandated by funding-agencies, can enhance the impact of scholarly-research. With collaborative and interdisciplinary-work, dissemination will include featuring scholarly-research, beyond traditional-disciplinary-boundaries, and translate that-work for varied-audiences; (4) Impact in-the Discipline and on-the World (the contribution to-the-field, in-the-form of citations, commercialization including patents and licensing, or other signs of attention. Impact in-the-world may be the most difficult to measure, but, ultimately, is the most-important. The value of research is that it impacts lives (both; directly and indirectly); and (5) Personal and Professional-Recognition (focused on the scholarship as in book-prizes or on the scholar as in awards, fellowships, editorships, prizes, national service, and memberships in-scholarly and professional-societies. Collectively, recognition, at the individual level, also influences impressions about the quality of departments, schools, institutes, colleges, or University).

Research is a key-ingredient, in the institutional-identity of universities, and an indispensable prerequisite for a successful-program, of teaching and public-service. Universities, especially their teaching, service, and knowledge-transfer-functions, and also their societies, however, suffer from the absence, weakness, and irrelevance of research (UNESCO, 2006). Ahwireng–Obinging (2000), for example, reflects that Africa is a ‘technological-wilderness’, peripheral to the knowledge-revolution, the convulsive-impact, of which, is only felt in-the-continent. Besides, in most African-countries, conditions for research have been severely-compromised, as manifest-by: inadequate-infrastructure; the generally poor remuneration; heavy-teaching-loads, and inability...
to-mentor young-faculty, among-others (Sawyerr, 2004). In-such institutions, research-facilities, are inadequate and outdated, by-the-international-standards. Libraries, of institutions of higher-learning, and other-research-institutes, are poorly-funded, and continue to-experience budgetary-cuts, every-year (Ondari-Okemwa, 2007). Most-importantly, adequate-funding is a-paramount-prerequisite, for effective-research; the-following-section is highlighted the-issue.

1.2. Research and Development (R&D): international- and local-perspective
R&D-indicators evaluate both; the-total-amount of human (number of researchers), and financial-resources (R&D spend; budgets, or research-grants) that are-used to-generate innovations and scientific-knowledge. Recent-study by Starovoytova (2017), cited Starovoytova et al. (2015a), who pointed-out on severe-shortage of researchers, as-well-as engineers, in-Kenya.

Regarding financial-resources, R&D intensity (expenditure on R&D), as a-percentage of GDP, in-most-countries, is between 0.25% and 1%, but there is a-considerable-variation. In-Europe, for-example, R&D-intensity varies from 0.2% of GDP of Macedonia to 3.5% and 3.9%, in-Finland, and Sweden, respectively. The-figure ranges from 2% to 3% in Austria, Denmark, France, Germany, Iceland, and Switzerland. In-North-America, the-United-States, and Canada, spend 2.7% and 2% of GDP, respectively, on R&D. In-East-Asia, Japan, Singapore, and the-Republic of Korea, spend between 2 and 3% of GDP on R&D, while China reports 1.3% (World Bank, 2010). Elsewhere, in-Asia and Latin-America, expenditure on R&D is lower, though in-several-countries expenditure approaches the 1% of GDP mark; Brazil at 0.9%, India 0.7%, Iran 0.7%, Malaysia 0.7%, and Chile 0.7%. In sub-Saharan-Africa R&D is generally-less than 0.3% of GDP (UIS, 2007).

In-monetary-terms, the-newly-industrialized-countries (NICs) spend, on R&D, USD 66, per-inhabitant, while China spends USD17, India-11, and Africa-only 6 (Ogbu, 2004).

In-2006, members of the-African-Union endorsed an-ambitious-target, for each-nation, to-spend 1% of its-gross-domestic-product (GDP), on-research and development (R&D). Besides, 2007 was declared the-year, for scientific-innovation, by-the-heads of state, in-Africa. African Innovation Outlook 2010, a-survey of some of the-scientifically-most-productive sub-Saharan-nations, showed that only-three-countries--Malawi, Uganda, and South-Africa--topped the 1% spending-threshold, in 2007. Most, including Kenya, however, remained far-from-that-mark, even when the-support, from-foreign-donors, was included. According to UNESCO (2007) R&D expenditure, relative-to-the-size of the-national-economy, in-Kenya, is generally <0.3%. Money, however, is-just-one of many-problems, as Nature reports, that many-labs are poorly-equipped, and science-students and faculty, get-little-practical-research, because research-centers are, often, separate-from-universities. Financial and logistical-support, for-science is typically-divided between-many-ministries, with little-coordination, and some-states rely-too-much on sporadic-foreign-funding. Even-when research-is-successful, it-is difficult to-move-forward developments, to-the-marketplace. Moreover, poor-governance, from-corruption to-ineffective-bureaucracy, distresses the progress, in-many-African-nations (Science in Africa, 2011).

1.3. Research rationale
The-major-centers of knowledge-creation and scholarly-communication, in-Africa, are universities (Teferra, 2004), where scholarly-research is conducted, by-a-community of academics and researchers, characterized by curiosity, expertise, cooperation, and intellectual-rigor, to-help solving numerous-problems, faced by society. On-a-large-scale, research is multi-beneficial, as its-output has a-direct-correlation to National GDP (SESRIC, 2009); it increases both; (1) a-nation’s international-economic-competitiveness (NSF, 2012), and (2) its-export-market-share, and commercialization (Furman et al., 2002). At the-human-capital-level, research can-lead to-an-improvement of standards-of-living, through an-earnings-increase and productivity (OECD, 2010).

Academic-research represents the-backbone-function of any-university. To-conduct an-effective research, however, sufficient-research-capacity is paramount. According to UNESCO (2006), research capacity consists, primarily, of: (1) Human-capital (trained people, capable of conducting research: faculty, research-staff, and graduate-students); (2) Funding (adequate and dependable); (3) Infrastructure (appropriate and functioning); (3) Time (specifically-allocated and sufficient, for-research); (4) Research Climates (encouraging and supportive from political-leadership, institution-administration, the-media, and the-public, at-large); (5) Structural-conditions (pooled-capacities and shared-facilities, to-avoid unnecessary-duplication); (6) Research-Ethics (existence-of, and conformity-to a-Research-Code of Ethics); and (7) Critical-Perspectives (criticism and critique, keep research from becoming self-serving and introvert), among-others.

On-the-other-hand, Ondari-Okemwa (2007) pointed-out on numerous and multifaceted-challenges, in higher-education and in-academic-research, which include: economic, technological, socio-political, and environmental. The-major-constraints, for the-research, also-identified, by different-scholars, are as-follows: (1) Lack of funding, for research, and inadequate-remuneration of staff vs. ever-escalating enrolment of students (Sendikakawa, 2005; McNicol, 2004); (2) Inadequate, and even, very-tightly-stretched, infrastructures (Sivakumaren, 2011); (3) Lack of time (Moahi, 2008); (4) Poor-research-skills; (5) Inadequate-literature, to
support the research (Anunobi & Emerole, 2008); (6) Lack of writing-skills (Powell et al., 2002); (7) Difficulty, in-selection of a research problem (Avemariautulu, 2005); (8) Lack of statistical-skills; (9) Isolation; and (10) Lack of support and appreciation, from the officials (Mc Nicol, 2004).

In addition, there is also a growing-body of scholars (across the globe), interested in scientific research and in research-productivity, of academic staff, at the university-level (Sax, 2004). These studies are informed by the fact, that universities are supposed-to-play a trio-logical role of: teaching, research, and service-to-community (Lertputtalak, 2008). UNESCO (2006), however, has raised serious concerns, over the nature of university-education, in the developing-countries. It is argued that most universities are under immense pressure, to increase their enrolment, in order, to meet the human-resource development-targets, of their respective-countries. This has led to teaching-becoming their first-priority and, often, their only pursuit, leaving research, largely, abandoned, and neglected.

At local-scene, Kenyan-higher-education-institutions, similar to most African-countries (see Tettey, 2006), are struggling with a multitude of problems, which affect their ability, to effectively-function, as centres of intellectual-excellence. For example Odhiambo (2012) points out that ‘there has also been a lot of dissatisfaction, in some-institutions, with regard to inadequate facilities, for teaching and research, in Kenya’.

Moreover, the majority of the scientific research, in Kenya, is conducted in government-owned research institutes, which have extensive international collaborations. Among the most distinguished, is the Kenya Medical Research Institute (KEMRI), which has centres, around the country, and does basic research, as well as developing drugs, vaccines, and products, such as diagnostic kits for HIV, among others. KEMRI, grown its research and publication-output by 45%, in the last 5 years, with an increasing number of papers co-authored, by researchers, at institutions, such as: the London School of Hygiene and Tropical Medicine, and the Centres for Disease Control and Prevention in Atlanta, Georgia. KEMRI provides a vital service, since Kenya lacks a flourishing private sector, for commercialization of research. Other research centres are also noticeable, such as: the Kenya Agricultural Research Institute (KARI), and the Kenya Marine and Fisheries Research Institute (KMFRI). Kenya is also considered, as major hub, for collaborations, between African scientists (Migosi, 2012; Science in Africa, 2011).

By contrast, the Kenyan universities continue to endure severe lack of funds, and inadequate, and dilapidated infrastructure. The government and donors, have focused on boosting primary and secondary education, but have completed neglected universities, say observers. The government provided only US $3.6 million, in 2010 on university-based research, according to Shaukat Abdulrazak, secretary of the National Council for Science and Technology. Besides, there is a severe shortage of professors, to serve a student-population, that grew from 90,000, in 2004, to more than 120,000, in 2008 (Science in Africa, 2011). In the past, however, Kenyan universities have been doing rather well, in terms of research and publishing. Ngome (2004), for example, observes that in the 1970s and early 1980s, the volume of research and publishing, at the University of Nairobi (UoN), the oldest and the largest public university in Kenya, was one of the highest, in Africa. According to the researcher, the key factors, that stunted the growth of research, in the Kenyan university system, are lack of adequate research funds, and severe shortage of qualified researchers.

Multiplicity of problems, perceptibly, drastically restricts knowledge productivity and scholarly publishing at university. Recognizing the barriers to effective research, at local institutional context, is the first and paramount step, in the minimization, or elimination, of such obstacles, as according to Whitehead & Schneider (2012), in identifying and avoiding the pitfalls, of the writing and publication process, early on, half of the battle is already won. In a long run, it can also contribute, to the reviving of the lost glory of university research, in the country. In the view of above circumstances, the low allocation for Kenya’s R&D; severe shortage of academic and research staff; and overall neglected research activity, among others, this study is assessing the barriers and problems, preventing researchers from effective research, at the School of Engineering (SOE), Moi University (MU), Kenya.

In order to offer wide-ranging perspective, on the topic, the following relevant issues are also elaborated upon, in the subsequent sections, of this article, such as: State of engineering education and accreditation of engineering programs; Gender in engineering research and education; Aging faculty; Mentorship in academic and research activities; Funding for research; Low remuneration of teaching staff; Collaborative and ‘Multiple-Disciplinary’ Research; The Internet, as an institutional research tool; Lack of time and office space; Self-sponsored publishing demands; Code of Practice for Research; Recognition of academic staff; and, Lack of Technical staff, among others. Several recommendations also offered on how to improve the current depressing situation. The study is important and potentially beneficial, in order to increase the research output, which, in turn, increases the institutional visibility, influencing the overall reputation of the university. Moreover, the findings, alongside with the theoretical coverage, will, expectantly, make a contribution (in its small way) toward the body of knowledge, on the subject matter.
2.1. Focus and design of the-study.
In order to conduct a survey and perform a document analysis, the study was divided into 3 distinctive parts, which shown in Figure 1.

Figure 1: Sequential parts of the study (Starovoytova & Namango, 2016a).

2.2. Sample size
To evaluate perceptions on barriers to effective research, among senior faculty, at the school, a confidential self-report questioner was designed and used, as the main instrument, for this study, with the sample size of 15 subjects.

2.3. Main instruments used
The study implemented an approach of projective technique, by requesting questionnaire respondents questions, about their perceptions on barriers to effective research. The respondents were guaranteed confidentiality, and the questionnaire was filled in anonymously, with no identification information. The designed self-report questionaire was used in eliciting information, from the subject sample; it consisted of two parts, namely: ‘Personal Information’ and ‘Barriers to Research’.

Besides, to elicit additional information, on the barriers to effective research, not only at the school, but at the institutional context, interview of the Chief librarian, MU, alongside with observations, were utilized in this study.

2.4. Data Analysis
As a standard procedure, the questioner is to be pre-tested, to ascertain its validity. This research complies with the ISO 20252:2006 (E): Market, Opinion and Social Research Standard; hence a preliminary study was conducted, at the school, using an initial version questionnaire, for determining the barriers to effective research. The findings, from the preliminary study, were used to come up with a final version of the questionnaire, which was designed and administered, in English language.

To estimate reliability, the correlation coefficient was used, according to Kothari (2004). The Statistical Package for Social Sciences (SPSS-17, version 22) computer software program was applied, to compute the Cronbach’s co-efficient. Descriptive statistics was employed to analyze both, qualitative and quantitative data.

3. Results and analysis.
3.1. Validation of the instrument
Upon validation, the general recommendation made, is that the instrument was acceptable, with some minor editing. Questionnaire data was coded, entered into SPSS and checked for errors. Data was analyzed, list wise, in SPSS, so that the missing values were ignored. Cronbach’s alpha test of internal consistency was performed, for perceptions and self-reports, and established high inter-item consistency (Cronbach’s $a > 0.8$).

3.2. Analysis of the questioner.
Total of 15 questioners were administered (to SOE’s senior academic faculty), out of which, 11 were submitted back, giving a response rate of 73%.

3.2.1. Analysis of part 1: Demographic Characteristics.
Figure 2 shows Demographic Characteristics of the respondents.
Figure 2: Demographics of the respondents (adopted from Starovoytova, 2017).

3.2.2. Responses to the questioner.

The research scholars, at the school, were facing a number of obstacles, in pursuing the research; absolute majority (100%) pointed out on the Research-Funding, and Low-remuneration, of the teaching staff. 82% indicated lack of the following: (1) Laboratory-testing-equipment; (2) Reliable and fast Internet-access, in the office; and (3) Time, available, to-do research. Lack of Technical-staff and Office-space was indicated by 73% of the respondents, while 64% stated that Self-sponsored-publishing-demands strain their already inadequate income. More than half of the respondents (55%), exposed Lack of mentorship. 36% declared an absence of the Code of Conduct for Researchers, while 27% recognized no appreciation or compensation, or any sort of acknowledgment, by the university administration, for their publishing, as the barriers to do effective research.

55% indicated that they used Internet to conduct a literature review, in a research, by mixed-modes (official office-provision & personal resources); 36% used only their-personal (modem, bundle, etc); while the remaining 9% used Internet, only from-the-office. 91% also declared that, they are not satisfied with the current Internet services, in both reliability and speed.

45% of the subject sample equally-stated, that: (1) the university has an Institutiona l Repository (IR) and (2) That they do not know if it has. The remaining-share (9%), however, indicated that the university has no IR. 55% confirmed, that they have accessed content in repositories of other universities; 36% indicated that they never did that, while 9% provided no answer.

On the question: 'Has your library provided a list of Open-Access journals, available in various disciplines, to library users?' equal-share (36%) of the respondents stated 'Yes' and 'No', while remaining 27% indicated that they do not know the exact position.

On hypothetical question: 'Suppose you have been promoted to a Full Professor, would you still do research and publish?' 55% said 'No'; while 36% 'Yes' and the remaining 9% indicated--'I do not know'.

In addition, to the survey's findings, the researchers identified and observed numerous barriers, to conducting an effective research, at the school; these are portrayed below.

3.3. Observed and identified barriers to effective research, at MU context

A barrier is defined as 'anything that obstructs progress, access, etc.; a limit or boundary of any kind' (Webster’s, 1989). In this study, barriers were defined as any perceived or actual impediment, to research and writing scientific literature, for dissemination.

The following barriers, to effective research, in SOE context, were identified, by the researchers: the university and SOE, as any other School of MU, has been experiencing financial constrains, for some time, now. University management had to focus, mainly, on the regular payment of employees salaries and the maintenance of insufficient and, every now and then, rapidly collapsing infrastructure. This, successively, influenced and directed the following consequences:

1) MU has a medium-size library, with rather undersized annual-budget-allocation, of only 2% from the tuition-fee-collection of PSSP (Privately-Sponsored-Students-Program), on-average ranging between KES 45-50 million, which equivalents to USD 450,000-500,000. Besides, to operate the library, 70 full-time workers
(remunerated by the-university) are working, in-two-shifts (8am-10pm), including week-ends. Over 10-years the-library received no text-books or journals, as printed-media; as they said, that everything now is in E-mode. To-this-end, the-Library, is in-agreement with the-Kenya Library & Information Services Consortium (KLISC) which, mandated, on-behalf of universities, to-negotiate the subscription-prices, directly, with the-publishers of e-journals. Institutional Digital Repository(IR), MU is currently, nonexistent, although library requested (5-years ago) the-Management, MU for a-dedicated-server (at KES 700,000, which equivalents to USD 7,000) to-accommodate and maintain all-the-scientific publications, by the-members of the-university-staff, including Master-Theses and PhD-Dissertations. The-absence of the-IR, affects, significantly, the-visibility of the-university, in-terms of publications, which in-turn, damagingly-influences, the-overall-reputation, of the-institution.

(2) The-drying-up of funds also-directly-affected scientific-research. The-engineering-school, for-example, as any-other school, at-the-university, receives KES 150,000 (around USD1, 500) annually, for-research. Faculty, from all-the-five-engineering-departments, of the-school, is advised to-write full-scale-proposals, including financial-budgets; these-proposals are then considered, by the-board, and the-winning-proposal will, supposedly, get the-research-money. However, due to-the-unwritten-procedure, at-SOE, money cannot be-given to one-project; most of-the-times, even this microscopically-small-amount is to-be-split between 2\textsuperscript{nd} (or even 3\textsuperscript{rd}) runner-up, making comprehensive-research unattainable. Besides, the-whole-exercise consumes a-lot of valuable-time; as-acording-to Munch (2009):

\begin{quote}
Staged-competitions devour extensive-stuff and resources, for coordination, for application processes, for-evaluation and implementation, which eat into actual research-work, so that the-very-best-researchers are falling into a newly-created-control-machine and run the-risk of drowning in its-depths.
\end{quote}

International, regional, and, even, local-conferences, are out-of-reach, for-most-scholars, at-the-institution, as they find it too-costly, to-sponsor-themselves, to-such-forums. Inability, to-regularly \textit{(if at-all)}, attend conferences, workshops, symposiums, and so-on; brings an-isolation, from a-sustained interaction, with a-research-community, of-similar-interests. This in-turn, limits the-exposure, of the-staff, to-recent and important-developments, in-their-fields.

It is rather-logical and pretty-effortless, to-suggest, at-this-point, that the-university should do-everything-possible, to-enable-scholars to-attend-conferences, organized locally, regionally, and internationally, \textit{but}, considering current-financial-constraints, in-university-education, in-Kenya, it is ‘easier-said, than-done’. A-more-realistic-proposal, hence, is directed to-the-individual-faculty, who is looking for financial-sponsorship, to-present a-scientific-paper. The-following-website \texttt{advance-africa.com}, for-example, provides more-than 40 links, to-different travel-grants, for-students, teachers, and university-lecturers; in-addition, \textit{research}-travel-scholarships, for-travel in Africa, America, Europe, Asia, and Australia, are-also-available. Moreover, it is-worth to-mention a-very-useful-link, presented on that-site, namely: ‘African Women Scholarships & Grants’, which, in-itself, consists of more-than 50 links, to-different sponsors, all-over-the-globe.

(3) Current, Book & Journal-allowance, at MU, is KES 12,000 (gross), leaving after a-30\% taxation only about KES 9,000 (USD 90) per-academic-staff, per-year. This-amount have \textit{not} changed much, since 2000, reflecting gross-underfunding, in-this-particular-area.

\section*{4. Data Analysis and Discussion.}

\subsection*{4.1. Overall-relevance of findings and the-efforts to combat the-barriers to effective-research.}

The research-findings are in-accord with the-Commission for University-Education (2016), which identified the-following-challenges found, to-face university-Research, in-Kenya: (1) Low-levels of funding, by the-universities and Government; (2) Lack of research-infrastructure; laboratories, and equipment; (3) Lack of qualified-human-resources; (4) Universities spreading too-thin; lack of geographical and thematic-focus; (5) Rapidly-expanding-privately-sponsored-teaching-programs that are pulling academic-staff, away-from research, into-teaching; (6) Poor-University-Industry-linkages; hence undermining the-relevance of teaching-programs, and low-levels of university-research-funding, by industry; (7) Poor-implementation of policies, on-intellectual-property-rights, research-ethics, plagiarism, and open-access to-information; (8) Poor-alignment of university-research to-national-development-goals and aspirations; (9) Poor-management, supervision, monitoring, and evaluation of university-research-programs; and (10) Low-impact of university-research and its-utilization, at-the-national-level.

The-other-issue of concern, is ‘mushrooming’ of new-university-campuses, all-over-the-country, and, even, abroad. The-Minister of Higher-Education, Mr. F. Matiang’i said, that the-government has-stepped in to-rein of out-of control-extension of campuses, in-different-cities and towns, in-Kenya and, even, in-neighboring countries. “We cannot allow this-madness, to-continue, in-the-education-sector. We-must-put a-stop to-it!” he said (http://ereadiness.kenet.or.ke).

To-address some of the-above-barriers, Kenya’s Commission of University-Education (CUE) has recently-
tryed, to-tackle the-problem of mushrooming-campuses, by closing 10 of Kisii-University’s 13 branches. CUE also closed MU’s 2 campuses (Kericho and Nakuru), out of currently-established 21 campuses. Moreover, MU-campuses in Kitale and Odera Akang’o are under-review, as they-are yet-to-meet the-minimum threshold, to-admit and teach students, in these-campuses.

Furthermore, CUE also-identified-strategies, for improving access to-research-infrastructure (libraries, laboratories, and ICT), as-follows: (1) Improving research-funding and capacity: proposal-writing, research project-management, report-writing, scientific-communication; (2) Improving collaboration and linkages: local, regional, and international. University-industry-linkages, Science-parks and research-support; (3) Intellectual-property: creative-works, inventions and innovations; commercialization of the-same; (4) Outreach, dissemination, benchmarking, and stakeholder-involvement, in-setting the-agenda and dissemination of university-research-products; and (5) Compiling and maintaining-data on universities, university-research and its-utilization, in policy-making and national-development.

Additionally, according to-University-World-News (2016): (1) Treasury of Kenya plans to-accredit 15 research-institutes, monitor research-systems, establish thematic-research-fairs, and develop nanotechnology-programs; (2) Kenya plans to-design and establish a-National-Science and Technology Parks master-plan; establish a-national-physical-science-laboratory, and license 2,500 research-projects; (3) The-government also-plans to-fund research, to-the-tune, of more than USD 30 million, up from USD 24 million, for the-previous-year.

Change is also-needed on the-Government-funding-model, for-universities; it-should-be-relevant to the-resource-allocation-rationale, supported by established-relevant-policy, on-the-same. Its-current ‘one-size fits-all’ approach is not-effective; instead programs should-be-financed, according to-how-expensive they are, to-prepare, and, to-run. For-example, training in-engineering-program(s), understandably, require much-more-funding, than that of Arts and Education (put-together); yet, under-the-current-system, the-government-funding-allocation, for all-programs, is-equal.

4.2. The-state of engineering-education and accreditation of engineering-degree-programs


Overall, in-12 universities, there were 503 engineering- full-time faculty-members, with only 33% PhD-holders; and about 57% of the-total-faculty-members, including assistant-lecturers, were registered, with Engineering Board of Kenya (EBK). Besides, only 3 universities (out-of 12): Jomo Kenyatta University of Agriculture & Technology (JKUAT); MU; and University of Nairobi (UoN), were-having critical-mass of engineering-faculty, and had the-real-potential, to-focus on-engineering-research, and doctoral-programs. SOE, for-example, had 56 full-time faculty-members, including 31PhD-holders (55%).

In-aggregate-terms (for-the-country), the-503 engineering-faculty-members, were adequate, for teaching the-10,343 undergraduate-engineering-students, giving a-faculty-students-ratio, of 1:21. However, the-faculty-members were spread, over-the-44different departments, in-the-12 universities, all-over the-country (Cannon, 2016). According to the-report, this-finding has 2 key-policy-implications: (1) If the engineering-programs were concentrated, in a-few universities and departments, universities could-offer better-quality engineering-education, and (2) The-three universities, with a-critical-mass of faculty, should serve as-centers of faculty-development, and also-focus on-postgraduate-studies, in-order-to-increase the number of PhD-holders, in Kenyan-universities.

With-regard to-accreditation of-engineering-programs, in-Kenya, it-was-recognized, that the-Engineers-Board of Kenya (EBK) and the-Commission for University-Education (CUE), have overlapping-mandates, in-terms of university-program-accreditations: the-CUE is-responsible for the-accreditation of all-university-programs; while the-EBK for all-engineering-programs. Moreover, they-are putting conflicting-demands; for-example, the-CUE currently-demands university-lecturers hold a-PhD. Yet, the-EBK demands that the-lecturer, heading faculty of engineering, must-be an-EBK registered-engineer. Many-universities, including MU, have argued, as to-the-difficulty, in-finding registered-engineers, with the-required-academic-credentials (PhD plus EBK-approved registered-engineer). As Sifuna (2010) indicates:

In many universities, a PhD degree is no longer a requirement for tenure and publications are a-less important criteria for judging who should be promoted ... Moreover due to very low salaries, it is no longer possible to attract competent staff from abroad to teach in public Universities.

This-is further-exacerbated by the-fact, that qualified-Kenyans may-be unwilling to-head an-engineering staff, as a-Dean of School, or Head of department, largely due-to-poor-terms of service, as-well-as the-ongoing political-battles, being-waged-over education, in-the-country. Until this-crisis is resolved, the-shortage of
On-the-other-hand, the-government of Kenya is taking steps, to-solve-the-accreditation-crisis; an-eleven-member-committee was-reportedly-constituted, in October, 2015, to-amend and harmonize laws, governing universities, professional-bodies, and government-ministries, specifically the-CUE and the-EBK. According-to-reports, the-CUE Secretary, Professor David Some believed, that the-situation between the-CUE and the-EBK can-only be-resolved, if the-National-Assembly reviews and amends the-various-Acts, providing for only-one-body, to-be-solely-responsible for accreditation, of university-academic-programs, in-Kenya.

According to Amimo & Bosire (2015), Canada, experienced similar-accreditation-crisis, where a-voluntary-professional-association, and ABET, Canada (a-professional-accreditation-body akin to the EBK, Kenya) affected a-compromise, whereby they-agreed to-recognize the-accreditations-criteria, of the-other body. In-order to-do-this, both-professional-associations came to-a-number of agreements, on everything; from the-registration of engineers, curricula-design, laboratory-standards, and the-credentials of lecturers, and university-administrative-staff. Effectively, both-bodies, now, work, symbiotically, for the-greater-good of engineering-education, across-Canada. Considerate-people learn from others’ mistakes, as-well-as others’ successes; accordingly the-EBK and the-CUE should-be-judicious, and work-out a-middle-ground, or a-compromise, accommodating major-concerns of both-organizations, rather-than-fighting, over accreditation, and using Acts of Parliament, as-obstacles, rather than bridges, to-negotiation.

The-following-sections address numerous-issues, which arose from the-findings of this-study.

4.3. Demographics of the-respondents.

Majority of the-respondents (91%) were-male; The-largest-combined-share (63%) represented the-two-most-higher academic-ranks: Full-Professor (18%) and Associate-Professor (45%); 73% of the-respondents were above 45 years-old, where the-largest-share (36%) was in-the-age-group between 50 and 60 years-old. In-addition, mainstream (91%) had teaching-experience of more-than 10years.

4.3.1. Gender in-engineering-research and education

The-personal-data, of the-academic-staff, is exposing-out severe-female-under-representation, at-SOE. University, research-activity, in-Africa, as in-other-continents, is still a-male-dominated-profession. Lesotho is the-only-country, in-Africa, with more-female-researchers, than men. Elsewhere, women make-up less-than 30% of researchers; this-situation is hardly-different from other-regions of-the-world (UIS, 2006).

In-the-local-context, according to-study by Starovoytova & Cherotich (2016b), SOE’ female admission-rates, for-the-period (2003-2014), was only 13.9%, moreover, female-male admission-ratio, of F/M is 0.143, at-the-school, meaning that for-every 7 male-students, admitted to-SOE, there-was only one-female-student. Furthermore, the-metaphor of the ‘leaky-pipeline’ (Capobianco, 2006), has-been-applied, for-many-years, to-describe the-progressive-loss of women, on-the-career-ladder. The-phenomenon is clearly-visible, in-the-higher-education-sector, with women accounting for 20% of engineering-graduates, but only 6% of professors, in-engineering and technology (European Commission, 2006). These-trends suggest that females’ participation, in-engineering-professions is likely to-be-affected.

Yet-another-study by Starovoytova & Namango (2016b) identifies an-interesting-phenomenon, which could-be one of the-major-contributing-factors, to-female-underrepresentation in engineering-education:

This-phenomenon happens when redundant-stereotypical-perception, about Engineering, and very-persistent out-dated-Gender-stereotype, meet head-to-head. Logically, in-order, to-attract much-more-females, into-engineering, both-stereotypes (Engineering and Gender) should be-challenged and, in-the-long-run, changed.

Boosting diversity, in-the engineering-student-population and, ultimately, the-engineering-labor-force, will-be indispensable, to-generating the-intellectual-drive and tapping-into the-pool of diverse-talents, essential to-long-term country’s economic and technological-success. All-stakeholders (including, but not-limited to: relevant-Government-Ministries, Engineering-Education-sector, Engineering research contributors, and engineering-workforce-professionals) should-place a-high-priority, on encouraging more women, to-engineering.

The-efforts, in-attracting, more-females, to-engineering, should start as-early-as the-secondary-school-level (see 9 specific-recommendations, made by Starovoytova & Namango (2016b), in ‘Perceptions of Female-High-School-Students on Engineering’. Besides, it-is very-important, to-motivate secondary school-female-students, towards science and engineering. A-shining-example of one of the-world’s greatest-female-scientist—Marie Curie, can-be given. Marie Curie was a truly remarkable-woman; born in 1867, in-Warsaw, Russia (now Poland), in-the family of educators; when she-turned 10, her-mother died, and the-farther lost-his-job, forcing-him to-rent bedrooms to-boarders, and Maria had-to-sleep, on-the-floor. After school, she wanted to-study-further, but universities, in-Warsaw, then, did not accept women, so she-had-to move, to-a-more-liberal-France.

Both; she and Mendeleev had to-overcome great-poverty, but Curie, in-addition, had to-master a-new-language, while being-considered an-oddity—a-woman-student of science. She was the-first-woman to-earn a-degree, in-physics, from the-Sorbonne University, Paris, France. She got married to-famous-professor-physicist,
Pierre Curie and had 2 children. Later-on she became the first female professor, in-physics, of Sorbonne University. On 10th December, 1911, Marie-Curie was awarded the Nobel-prize, in chemistry for ‘services to-the-advancement of chemistry, by the-discovery of the-elements Radium and Polonium’. She was the first-female-recipient of any-Nobel-prize and the first-person ever to-be-awarded two (she, Pierre Curie and Henri Becquerel had-shared the 1903 Nobel-prize in-physics, for-their-work on-radiation). She-died in-1934, from-leukemia; scientists were not yet-aware of dangers of radiation.

Marie Curie’s legacy cannot-be overstated. Poverty did not stop her, from pursuing an advanced education. Marriage, enhanced her-life and career, and motherhood did not limit her life’s work. At a-time, when men dominated science, and women did not have the-right-to-vote, Marie Curie proved-herself a-pioneering-scientist, in-chemistry, and in-physics. She was also a very-humble-person; Albert Einstein, who knew-her-well, wrote: ‘Marie-Curie is the only-one, whom fame has-not corrupted’. The-Curie-name lives-on in-many-ways, including (Veneza, 2009): (1) the-Pierre and Marie-Curie-University, in Paris; (2) the-Maria-Curie-Sklodowska-University, in Lublin, Poland; (3) the-Curie-Institute (from-the-earlier Radium-Institute) in Paris, and (4) the-Marie-Curie-charities. Also, named-after the-Curies were the-element Curium, the-Curie (Ci) unit of radioactivity, and the-minerals: Curite, Sklodowskite, and Cuproslodowskite. But, possibly, Marie’s most-lasting-legacy is the-inspirational-example, set to-new-generations of scientists (both; male and female) that rigorous and determined-research, can lead-to remarkable-discoveries.

Afterwards, the-efforts, to-increase female-representation, in engineering-education, should continue, at university-level (see Starovoytova & Cherotic (2016a) on ‘Female Underrepresentation in Undergraduate Education: Case study in School of Engineering’ for 8 particular-recommendations, on-how to-improve, the-current-situation of female-under-representation, at-the-school). In-addition, another-study, by Starovoytova & Cherotic (2016b) on ‘Challenges Faced by Female-Students in Engineering-Education’ has made 2 key-recommendations, in order-to increase retention and improve learning-environment, in-the-field of engineering-education, through female-student support and mentoring. All these-suggestions, if implemented, will enable to potentially reduce a ‘leaky-pipeline’ of female-talent, in engineering-industry, engineering-educational-sector, and, particularly, in engineering-academia and scientific-research.

4.1.2. Aging faculty

The personal-data, of-the-participating-academic-staff, is pointing-out, to-a-large-extend, on-the-aging, of the-engineering-faculty, at-the-school.

The problem of aging-faculty is also-reported from several-international-universities, for-example: Kyviko & Olsen (2008), discussed the-position with aging-faculty, in-Norwegian-universities; as Zedeck et al. (2010); Frasch et al. (2009); Mason et al. (2005); and Switkes (2001) addressed the issue, at-the-university of California, USA; while Kim & Moen (2002) highlighted the-Canadian-perspective. In addition, some-coverage, on-the-subject-matter, in-African-universities, was, also-described, including: Edwardo-Mondlane University, Mozambique (Mario et al., 2001), Makerere University, Uganda (Musisi & Nansozi, 2001); and University of Dar-Es-Salaam, Tanzania (Mkude et al., 2000), among-others.

Moreover, according to Zebeck et al. (2010), the-age, of the-academic-staff, and faculty-renewal, are important, for their-impact on-the-school’s-hiring-patterns, and the-university, as-a-whole. Aging of the-academy and their-work, incorporates several issues, such-as, for-example: peer-relationships, workplace-climate, quality of life, productivity, health and disability, dependent-care-issues, and a psychological-sense of personal-legacy and satisfaction, among-faculty, in-transition.

In Kenya, the-retirement-age, of university-teaching-staff, was increased; from 65, to-the-current 70 years-old. Other-countries, such-as Australia, New-Zealand, Canada, Russia, Denmark, Belgium, and Singapore, among-others, have the mandatory-retirement-age of 65 years-old. Academia also has the highest average-age of any-industry or professionals, in the-country. On-the other-hand, faculty-aging is an acute-problem, in Kenya, as academia is no-longer-attractive, for young-talents. With the uncertainty, of the-current-political-environment and, therefore, the overall-economy, the increase in the-cost of living, and severe-shortage of senior-academic-staff, in the-universities, professors have-to-work, throughout their-retirement-age, even, up-to their-physical death. The cliché-term ‘gray-haired-professor’ is very appropriate here.

On the other-hand, many, would probably-think, that retiring, at-the-age of 65, is not much-different from retiring, at-the-age of 70, especially if the-life-expectancy, in-a-particular-country, is-above 70 years-old. Studies, such-as Nyberg et al. (2012), indicated, that the working-memory (short-term-memory) and episodic-memory-performance, remain relatively-stable, until 60-65 years of age. Episodic-memory is a long-term-memory, which relates to-personal-experience (Umanath & Marsh, 2014). Although, in general, performance on episodic and working-memory, decline with the advancement of age, it depends on inter-individual-variability. Some individuals start declining, as early-as, in their 50s, while others preserve well into their 70s and 80s (Nyberg et al., 2012). Apart from age, health and income, also important factors, in the decision to retire (Yin-Fah, 2010).

According to the latest WHO-data, published in 2015, life-expectancy in Kenya is: Male 61.1, female 65.8, and average-life-expectancy is 63.4 years, which gives Kenya a World Life Expectancy ranking of 145/191.
Poverty-head-count-ratio is at USD 1.90, a-day (2011 PPP) (% of population) 33.6%, in 2005 (World Bank, 2012). Kenyan Health-System ranked as 140/191(WHO, 2000); besides, according Tandon et al. (2001), composite-Index of Health system-performance, for Kenya, is 0.505, with uncertainty-interval of 0.461-0.549. The-composite-index is a-weighted-average of the-five component goals (health, health-inequality, responsiveness-level, responsiveness-distribution, and fair-financing). Critically-assessing, the presented-above facts, in-conjunction with-current-hugely inadequate remuneration of academic-staff, the-author would-like-to modify the-above-mentioned cliché-term ‘gray-haired-professor’ to more-explicit, in-current-context: ‘gray-haired, sick, and broke-professor’.

If not-managed-properly, the-loss of experience and expertise, will-affect: reliability, safety, productivity, innovation, and the-capability, to-solve pressing-issues, faced-by-the-country, in-the 21st Century. In-this-regard, mentorship, of younger-researchers, by senior-staff, could-provide a-potential solution, to-the-problem, of aging-faculty.

4.4. Mentorship in academic and research-activities

From the-survey, more-than-half of the-respondents (55%) exposed Lack of mentorship. Junior faculty-members also-stated, that they do, lack, practical and illustrative-guidance (from their-superiors) on-how-to-conduct effective-research, and how-to-write, for scientific-journals. These-findings, probably, reflect a-lack of: (1) proper-mentorship and genuine-concern, about greenhorn-colleagues; and (2) confidence, in-themselves, of the-younger researchers.

Mentoring is an-integral-part of scientific-activity, for raising-the-next-generation of scientists, teachers, and innovators (Alberts, 2010; Lee et al., 2007). Shah et al. (2009), for-example, indicated in their-study, that mentors were-essential, in helping to-guide, motivate, and reassure-participants, during the research and writing-process. All-researchers, in their-professional-career, have-had advisers and supervisors; very-few of us, however, are-really-fortunate, to-have been blessed, with mentor(s), as-well. An-adviser or supervisor directs the-conduct of research, offering leadership, on-issues, relevant to-research. A-mentor (who also may be an-adviser), takes a-personal, as-well as a-professional-interest, in the development of a-researcher. Numerous-successful-researchers, even, Nobel-Prize-winners and great-inventors, gratefully point-out, to-mentor(s), who helped them, on-the-way to their-achievement.

Mentoring is also an-element of informal-learning; other-examples include: coaching, networking, and self-directed-learning (Marsick &Watkins, 2001). Tierney’s research (1988) provides a-framework for higher-education-culture, which includes 6 major-components: (1) Environment; (2) Mission; (3) Socialization; (4) Information; (5) Strategy; and (6) Leadership. The-socialization-element represents one aspect of a-framework, where mentoring can-contribute additional-information.

Furthermore, the-concept of mentoring dates-back to-Greek-mythology, in-the-book ‘Odyssey’. Odysseus, left the-care of his-household, specifically his-son, to his-friend, named Mentor. Hence, the-term ‘mentor’ is, often, associated with-concepts-of: advisor, friend, teacher, and counselor. Hall (2002), defines-mentoring as: an ‘intentional-relationship, focused on developing self of relatively unseasoned protégé through dialogue and reflection; an-implicit-focus on development of the next-generation, in-context of interpersonal relationships’.

Mentoring-relationships can-be formal or informal. Traditionally, mentoring has-been considered more of an-informal-relationship, between caring-senior-individual(s) (mentor), who-are-paired-with younger-individuals (protégé). Formal-mentoring, on-the-other-hand, is often-initiated by an-organization, to-assist with-one, or more of the-following-functions: new-employee socialization/enculturation, complementing established formal-learning-processes, improving performance, and/or realizing-potential (Gibb, 1999).

While the-span of relationships may-vary, depending upon the-form; there-are, typically, 4 phases, that each-form-includes: (1) An-Initiation-phase initiates the-process, in-which the-relationship begins; (2) a Cultivation-phase launches new-levels-relationship (individuals continue to-test the-career and psychosocial-functions, that one-another can-provide); then (3) Separation occurs, which-allows individuals to-regain more-autonomy, both; structurally, within the-organization, and emotionally; and finally, (4) Redefinition-phase, where the-relationship takes-on a-new-style, either in-form or possibly, ending-it, completely (Kram, 1983).

On-the-other-hand, the-biggest-responsibility, of a-mentor, is to-be a-true-role-model; open-handedly-sharing their-vast-knowledge, experience, wisdom and enthusiasm, lending their-good reputation, and giving the-greenhorns access to-important-networks. Undeniably, there-is, however, a-potential-downside, to-this. The-unceremonious-nature, of the-formed-relationship, may-contribute to-favoritism, and the-young-researcher may-become too-dependent, on-the-senior-researcher. This-way, the-mentorship might-introduce unfairness, and have a-harmful-effect, on the-research. Another-concern is mutual-respect, and strict-professionalism, particularly between opposite-sexes. Various-studies have-been based-upon such-complex-relations (see Lee et al., 2007; Paglis et al., 2006; Rosser & Egan, 2005), and in-particular: for race and gender (see Crutcher, 2007; James, 2000), and sex-role-orientation (see Scandura & Ragins, 1993), among-others.

Even-though, mentoring has-been-around, for-decades, the-definitive-advantages are-still being discovered.
Fagenson (1989), for example, conducted a study, to-determine if mentoring truly-resulted-in the-positive-effects and benefits. When-comparing protégés to non-protégés, in an-organization, it-was concluded, that an-individual’s career-experiences and their-protégé-status, are-positively-related; ‘mentored individuals reported having more career mobility/opportunity, recognition, satisfaction, and promotions than non-mentored individuals’. Protégés in mentoring-relationships often-experience a-multiplicity of benefits, such-as: improved-self-confidence; an-increased-availability of advice, and relevant-information; an-opportunity for encouraged-reflection, on-practice; additional-personal-support; improved-effectiveness; an-awareness of culture, politics, and philosophy, of the-organization; and, access to a-confidant, for concerns or ideas (Rawlings, 2002). For young and mid-career-researchers, such-participation, especially under-the-mentorship of senior-colleagues, constitutes the-most effective form of research-capacity development. Thus, in the-absence of on-going research-activity, one cannot talk, meaningfully, about research-capacity-building. Besides, if and once-mentoring-occurs and the-protégés realize the-importance of growth, that transpires, within-such-relationship, they-can, then, pass-on their-mentoring-knowledge and experience, to-someone-else, rising in-the-academia-ranks, resulting in-a continual-cycle (Knippelmeyer & Torraco, 2007).

In-addition, it is a-common-misconception, that only mentee(s) benefit(s) from the-experience; even mentors, themselves, can-benefit, greatly, from the-mentoring, that they-provide; through relationship with younger-colleagues or students: (1) mentors’ academic and scholarly-thinking is rejuvenated, and provocatively-stimulated, via exposure to-new-ideas, and a-network of collaborators; and (2) mentors gaining respect and even, friendship. Mentoring fosters a-social-cohesion, in-science, that keeps the-profession vibrant and strong; every-researcher, at-a-variety of stages, in their-career, should-act as-a mentor, to-others (Darling-Hammond, 2006).

In-the-context of the-mentorship-relations with graduate-students, according to-the University of Michigan (2015), the-fundamental-value, for mentors, is to-be partial, to-the-student, but impartial, about the-student’s work. Mentor should-strive to-be: supportive, equitable, accessible, encouraging (to-reassure students of their-skills and abilities, to-succeed), and respectful; creating an-environment, which is intellectually-stimulating, emotionally-supportive, safe, and free of harassment. Mentor should-provide: full-attention; the-time and encouragement, to-open-up; career-advice; support, in-times of discouragement, as-well-as success, and be-mindful of signs of emotional and physical-distress; monitoring of their students’ progress and achievements, setting milestones, and acknowledging-accomplishments; leadership, by example; facilitation of the-training of the-graduate-student, in-complementary-skills, such-as: oral and written-communication-skills, proposal-writing, scientific-writing; lab-management, the-ethical-conduct of research, and scientific-professionalism, among-others.

Effective-mentoring, however, cannot be-done, in a-vacuum. A successful-relationship between a-graduate-student and mentor is built-upon a-foundation of commitment, at-the-institutional, at-the program, as-well-as, at-the-individual-level. The-institution must-be-committed, to-ensure that its-programs are of the-highest-quality, producing professionals who-are-both; ethical, and accomplished. The-department, in-turn, is responsible, for setting clear-expectations, and supervising-the-progress.

On-the-other-hand, as with all-relationships, between-humans, there is no guarantee for-compatibility, however both-sides, whatever the-circumstance, should-act-professionally and courteously. Moreover, according to Lee et al. (2007), institutions should-promote good-advising and mentoring, by-rewarding individuals, who-exhibit these-skills, and by-offering training, on-how to-become a-better-adviser, or mentor. The-provision of appropriate-incentives and training, to-senior-scholars, will enable-them, to-devote time and attention, to-the supervision and mentoring, of junior-colleagues and researchers, as-well-as, graduate-students. Moreover, only by-maintaining high-standards of conduct, advisers and mentors gain the-moral-authority to-demand the-same of others.

Younger-faculty-members, on-the-other-hand, should-be-motivated and given incentives, for constant self-improvement (through initially-lighter teaching-loads, special-support-services, and alike). Other-measures might-include their-insertion into-research-group(s), led-by senior-scholar(s); attachment to-senior-colleagues, as-mentors; as-well-as support for conference-attendance, among-others. Besides, junior-faculty-members, who-gained greater-access, to-peer-reviewed-articles, published by-their senior-colleagues, would-get a-clearer-perspective, of what a ‘well-written’ journal-article looks-like, which, hopefully, reduce their-hesitation, towards scientific-research and writing.

During this-study, a-lack of formal-mentoring-program, offered-in SOE, was also-recognized; hence, there is a-clear-need, to-consider developing of mentoring-program(s), as-part of the-School’ organizational-strategy. Effective-mentoring is manifold-beneficial: for-the-mentors, and mentees (junior colleagues, beginner-researches, and graduate-students); for the-discipline; and for the-department, school, and university, at-large. In-this-regard, effective- and well-balanced mentorship-programs should-be developed, by-the-institution, while informal-mentorship should-be-advocated for, practiced (at-different levels), and rewarded.

Additionally, self-help-groups have-been found, to-increase scholarly-outputs, in-countries, such-as the U.S.A. (Staines et al., 1986). Faculty-members need to-take steps to-help-themselves and each-other, through
self-help-groups, in which they can exchange advice and guidance, including feedback on drafts of articles. This could also reduce the number of negative reports and rejections, they receive, from journal reviewers.

4.4. Funding for Research

The Director of Research, MU, emphasized that the chronic lack of government funding, for research, is undeniably a major barrier, for research at the institution. According to Schultz (2001), the underfunding of higher education, at the very moment of the rise of the knowledge society, spreading throughout the globe, is irrational.

Research funding represents a critical factor, as it has been widely acknowledged that without funding, research cannot proceed, adequately, if at all (Proctor, 1996).

Given the high cost of research, questions are now also being asked about the relevance and impact of university, on national development, especially, in developing countries (CUE, 2016). According to Musisi & Nansozi (2001), for example: small allocations for research, resulted in following: (1) poor facilities; (2) limited access, to publishing facilities; (3) limited research database; (4) low output; and (5) absence of a research culture, among others. The probable reasons behind are: (a) lack of appreciation of the importance of research; (b) lack of skills to undertake research; (c) lack of experience, in research; (d) low-priority, given to research, at the university, and, in other public institutions; (e) lack of centrally initiated and managed research; and (f) emphasis on financial gain, as a motive, for undertaking research, among others.

On the other hand, every research (regardless of its type and area of specialization) includes the collection of some type of data, whether it is from the literature, from subjects, or from laboratory experimentation, to answer the research question(s). In most cases, universities conduct basic research, the output of which is of embryonic nature, meaning that it is, without immediate commercial use and requires refinement, through applied research, before it is ready, for commercialization (Gersbach et al., 2009). A broad consensus, consequently, is that university research is a long-term national investment, in the future of the country.

In establishing links with industry and other research institutions, basic research, at universities and applied research, could be mutually beneficial. Basic research, for example, impacts on applied research, through the channels of open science, such as publications, scientific reports, conferences, and public meetings (Cohen et al., 2002); through an embodied knowledge transfer, associated with scientists, moving from basic to applied research (Zellner, 2003); collaborative and contracted research ventures, as well as informal interaction, between basic and applied researchers (Cohen et al., 2002); joint industry-university research centers (Adams et al., 2001); academic consulting (Perkmann & Walsh, 2008); the patenting and licensing, of university inventions (Colyvas et al., 2002); or through the creation of new firms, as start-ups and spin-offs, from universities (Bania et al., 1993). Basic research benefits from applied research, for example, through allowing scientists to access data, instrumentation, and research material, as well as, to discover unresolved problems and open challenges, when performing academic consulting, to industry (Perkmann & Walsh, 2008).

Above elaborations, undoubtedly revealed, the imperative need, to timely increase budgetary allocations, to university education, in Kenya. Besides, Schultz (2001) pointed out on the crucial importance for African universities and other institutions, themselves, taking up the initiatives, for the research revitalization process, which could be undertaken with a minimum of additional resources.

4.5. Low remuneration of teaching staff.

Everyone of the respondents (100%), also indicated, that Low remuneration of teaching staff, is one of the major barriers, to effective research.

According to Munene (2014): ‘…the frequent high-octane skirmishes, over university salaries, have become toxic to the nation and disruptive to academic programs’. Just to illustrate, the current position: a Tutorial fellow (with Masters Degree) in Kenya, earns before 30% tax not more than KES 130,000 (USD 1,300); a lecturer, who holds a PhD, earns an average salary of KES 150,000 (USD 1,500); while a Professor in Kenya earns an average salary of KES 230,000 (USD 2,300). With an inflation rate of 10-12% and with no free public secondary and tertiary education, for dependents, these salaries are barely sufficient, to sustain a lower-middle class lifestyle, for the academic staff. Twenty years ago, however, a university professor, a judge, and a member of parliament, earned similar monthly pay and benefits. Today, a member of parliament takes home around USD 9,400, while a judge makes USD 7,700, per month.

Another relevant issue is the quality of performance of the faculty (Odhiambo, 2012). In a merit based system, salary increases, are additionally based, on the performance indicators (in the areas of teaching, research, and community service). The system appeals to the values of: individuality, accomplishment, and rewards. In the absence of a merit based compensation system, in Kenya today, however, a highly productive professor or lecturer, will, essentially earn the same salary, as their non productive counterparts; longevity in rank being the only condition, for annual salary increments, the amount of which does not even cater for the
high-rate of inflation. In-addition, low-salaries, also-mean, that academics cannot afford journal-access-fees, and, hence, the latest-research-developments, in-their-field, are-unreachable, which, in-turn, can-affect the-relevance, and overall-quality, of their-research.

The Salaries and Remuneration-Commission (SRC), of Kenya (mandated to-harmonize remuneration and benefits of state and public-officers) is, yet, to-evaluate public-university-lecturers. Lecturers, on-the-other-hand, have proposed a Collective-Bargaining-Agreement (CBA), putting-forward their-demands; including not-only better-basic-salary and allowances (corresponding to-the-professional-workforce, with the highest-level of education, in-the-country), but-also in-the-areas of physical-facilities, laboratory-equipment, research-funding, additional-recruitment of staff, and overall improvement of working-conditions. The CBA, however, is, yet, to-be-considered, by the-government.

Besides, all-professors and lecturers, in-the-same-rank, receive similar-salaries, irrespective of disciplinary-affiliation. Professors and lecturers of medicine, or engineering cost much-more, to-train, to-recruit, and most importantly, to-retain, than their-counterparts, in the-humanities, and social-sciences. Logically, there-should be some-differentiation (a-coefficient), based on-the-area of expertise. By-infusing market-based disciplinary-differentiation, in-the-base-pay for university-academics, Kenyan-universities will-ensure, that faculty-retention is feasible, especially, in-disciplines, with high-market-demand. Faculty-retention is paramount, in maintaining research-capacity of any-university; failure of which manifests in the-widespread-phenomenon, commonly-known as ‘brain-drain’.

Because of the-poor-working-conditions, in-the-institutions of higher-learning, in sub-Saharan-Africa, the-region has experienced a mass-exodus of scholars, to-academic-institutions, for-example, in: North America, Europe, Australia, New-Zealand, the-Arabic, oil-rich-countries, and, recently, to-Japan. According to Ondari-Okenwa (2004):’...it is ironic, that the-sub-Saharan-countries can prepare, but cannot preserve, local-intellectual-capital’. Reasons for this brain-drain include: (1) low and eroding-wages and salaries; (2) unsatisfactory-living-conditions; (3) social-unrest; (4) political-conflicts and wars; (5) declining-quality of educational-systems; (6) lack of research- and other-facilities; (7) inadequacy of research-funds and (8) lack of professional-equipment and tools.

In-this-study, in-particular, 82% of the-respondents, have reported severe-shortage of staff, due-to ‘brain-drain’. According to Tijssen (2007), low-remuneration, apparently, directly-contributes to brain-drain-phenomenon. This-particular-topic, due-to-its-importance, and also, considering the-multiplicity of surrounding-it-issues, involved, is rightfully-deserves a-comprehensive-address, which-is-out of the-scope of this-study; nevertheless, brain-drain-problem will-be elaborated-on, in a-separate-publication, by the-author (optimistically, within-this-academic-year).

In-the-view of the-above, the-remunerations, for-academics, in-the-country should-be not-only improved, but improved, considerably, even-though, they may-not match those of academics, in-DCs or, even, in-NDCs. Besides, many sub-Saharan-African-countries, such-as: the DRC, Nigeria, South-Africa, Sierra Leone, Botswana, and Kenya, among-others, are-blessed with abundance of natural-resources, which, if well-managed, can generate great-revenues, part of which can-be-used, to-improve remunerations, of local-scholars, as-well-as, other-highly-qualified-professionals. Such-revenues can-also be useful, in equipping laboratories, and stocking libraries, which-necessary, for-research, and generation, of new knowledge. On-the-other-hand, according to Duque et al., (2005), Kenya, disappointingly, was receiving repeated-sanctions, from the-international-donor-community, for-corruption and mismanagement of national-resources, as-well-as donor-funds, particularly in mining- and oil-exploration-sectors.

4.6. Laboratory-testing-equipment
To-meet, the-grand-challenges, of the-21st Century, Kenya must-be, an-innovation-driven-nation, which can capitalize, on-advances in-sciences, technology, and engineering (Starovoytova et al., 2015). To-be-able, to-create and innovate, however, researchers must-have not-only ideas, but-also facilities, to-enable them to develop, and to-test, that-ideas. Current-institutional-facilities, on-the-other-hand, are inadequate, for advanced-engineering-research, that can-support increasingly-systems-oriented, interdisciplinary-technological-innovation, to-contribute, to-industrial-leadership, in-the-region. Ogbu (2004), for-instance, very candidly-assessed the-situation, as-follows:

We have research institutes and laboratories that have not only become skeletons of their past but some are now mere consulting outfits. If there is no donor money, even salaries of the researchers will not be paid.

In-engineering, particularly-so, research should be empirical, thus, necessitating laboratory-testing equipment. Majority-of-the-respondents (82%), however, have indicated lack-of laboratory-testing equipment, as-the-main-barrier, to-the-effective-research. Moreover, research, in-many-fields of engineering, requires versatile, sophisticated, and costly-equipment, alongside with instruments, that rapidly downgrade. Effective-
research, in many engineering areas, on-the-other-hand, needs so-called ‘clean-rooms’, where depending on classification and usage, air-change occurs from 10 to more than 600 times, an-hour, while in a normal air-conditioned-home, air changes only 0.5 to 2 times, per-hour. Research in such-areas, as, for-example: microelectronics, earthquake-prediction, power-systems, nanotechnology, bioengineering, and advanced-materials-science, among-others, require Class10 and Class100 clean-rooms. Under ISO 14644-1: 2015 classification-system (for limited-particle-sizes from 0.1 µm to 5.0 µm) the ‘cleanest’ clean-room, is referred-to as Class1; and the ‘dirtiest’ clean-room is a-class 100,000. According to CleanroomFAQs, the-cost of clean-rooms, alongside with high-precision-instruments, can-easily-exceed USD100 million. Understandably and regrettably, a lack of funds had contributed to-lack of well-equipped laboratories in the-university, which in-turn, contributed to-fewer-scientific-results, particularly in research on advanced-engineering-areas.

Government and industries (interested in research-output and application) should-invest, in-upgrading and expanding laboratories, equipment, and information-technologies, among other infrastructural-needs of research, in-universities, and schools of engineering, to-ensure that the-national capacity, to-conduct effective-advanced-engineering-research is satisfactory, to-address the-technical challenges, that lie-ahead. Universities should also work-together, with industries, to-solve industrial problems, via collaborative-research.

Furthermore, while waiting for the-government, universities should-initiate-cooperation with research-institutes (with better-infrastructure), such-as, for-example, the-Kenya-Industrial-Research & Development-Institute (KIRDI), which facilities could-be-upgraded, further, to-accommodate the advanced research. The presentation at UNESCO (2006) forum, by Xue Lan, reported on the-triple-helix of the connection, between industry, government, and universities (50% of research, in-China, is sponsored by industry and the-corporate world), which obviously has an-impact on the-content of (applied) research. Reports on-India, also-emphasized that there, most of the research is done, in the-applied-field.

Accordingly, the-point to-emphasize here, is a-Collaboration (with the-capital ‘C’) among universities, industries, and research-institutes, to-reduce replication (of facilities) and, hence, to-eliminate unnecessary-expenditure, and to-bring, their-collective-intellectual-power, for the-common good. In this-regard, discussion on collaborative-research is in-order.

4.7. Collaborative and ‘Multiple-Disciplinary’ Research

55% of the-respondents publish only within their-area of specialization, out of these-published with other-disciples, only 18% published with areas, other than engineering; the-rest published with other-branches of engineering. The-average-number of authors is 3, while 36% indicated that they prefer to-publish solo.

The continued-dominance of individual, rather-than team or multidisciplinary-work, tends to-limit the-capacity of researchers, to-undertake fundamental-multifaceted-work-required, to-achieve breakthroughs, in modern-science, and technology.

Besides, interviews with the-engineering-faculty, revealed rather-interesting-phenomenon; the majority of faculty, seems-to-be-suffering from a self-induced ‘complex of intellectual-superiority’, manifesting in apparent-psychological-separation between us (engineers) and them (the-rest of academic fraternity). This-‘complex’, probably, contributed to the-complete-lack of interest, in other fields’ developments, and, hence, lack of understanding and no appreciation of other-disciplines. In-addition, it probably, resulted in unwillingness to-do a-research not-only with other-disciplines, but also, surprisingly, with other-branches of engineering. According to Starovoytova & Namango (2016b) there are over 36 major-branches, and more-than 200 sub-fields and areas of expertise of engineering; besides, new-areas of engineering, periodically-emerge; for-example: WorldQuant University, U.S.A. offers the-world’s first-absolutely tuition-free, entirely-online Financial Engineering Master’s degree-program.

On-the-other-hand, Starovoytova (2015b) pointed-out that TRIZ-originator (Altshuller) discovered that: Chemists, biologists, physicists and engineers were unknowingly repeating each other’s work because they never looked to see if anyone outside their own area had similar problems and answers to those problems. G. Altshuller saw that science and technology had become a Tower of Babel. Each wrote patents in their own scientific language and technical terminology, and similar problems were solved with analogous solutions but no-one, until G. Altshuller noticed that there was a huge duplication of work.

To avoid similar to-Tower of Babel situations, and to-add-value, save-time, and recourses, in-research, it should-be encouraged, to-conduct a-collaborative-research, where resources, facilities, and people, are brought-together, in common-research-pools. Besides, collaborations should-be not only with other-branches of engineering, but also with areas outside-engineering, like, for-example, behavioral-sciences.

Bozeman & Boardman (2014) define research-collaboration as ‘social processes whereby human beings pool their experience, knowledge and social skills with the objective of producing new knowledge, including knowledge as embedded in technology’. Collaboration also enhances effectiveness; it is more-often leads to high-impact-research, and patents (Wuchty et al., 2007), and acquires more-citations (Gaughan & Ponomariov,
Moreover, according to UNESCO (2006) the main-priorities, for the-development of research, are: relevance, quality, and international-cooperation. Besides, it takes a-collaborative-effort, to-produce knowledge. The-prospective, for-pooling talent and resources, can potentially-benefit research, in-general, and the-under-resourced-institutions, such-as, Kenyan-universities, in-particular. To-this-end; establishment a-central-research-management-facility, within an-institution, and making research-management a profession, were suggested by-the-Association of Commonwealth-Universities. Besides, hardly-any African universities are in-a-position, to-excel-in-more-than 2 or 3-areas, of research-specialization. In-this regard, individual-institutions should-identify and concentrate-on-building-up particular-institutional-capacities, in a-limited-number of areas of strength (actual or potential). Concentration of post-graduate-studies, in-the-selected-areas, may-facilitate the-building of the-necessary critical-mass of researchers, in-these-areas (Association of Commonwealth-Universities, 2001).

Besides, in-recent-decades, the-growth of scientific and technical-knowledge, has-motivated engineers, pure-scientists, social-scientists, and humanists, to-join-together, in addressing complex problems, that must-be attacked, simultaneously, with-deep-knowledge, from different-perspectives. Different-terminologies are-used to-describe such-joining. Terms, starting with-prefixes Intra-; Cross-; Multi-; Inter-; and Trans- (before-‘Disciplinary-Research’) are often-used-interchangeably; however, there-are some-important-distinctions.

According to the-definitions, provided via ResearchGate Q&A:

Intra-disciplinary--working within a-single-discipline; Cross-disciplinary-- viewing one-discipline, from the-perspective of another; Multi-disciplinary--people from different-disciplines, working together, each drawing on their-disciplinary-knowledge; Inter-disciplinary-- integrating knowledge and methods from different-disciplines, using a-real-synthesis of approaches; and Trans disciplinary-- creating a-unity of intellectual-frameworks, beyond the-disciplinary-perspectives.

In-particular: Inter-disciplinary-research (IDR) is a-mode of research, by teams or individuals, that integrates information, data, techniques, tools, perspectives, concepts, and/or theories, from two or more-disciplines, or bodies of specialized-knowledge, to-advance fundamental-understanding or to-solve problems, whose-solutions are-beyond the-scope, of a-single-discipline, or field of research-practice. The-lower-part of Figure 3 shows that IDR (A and B join-together to-work, on-common-question, or problem. Interaction may-forge a-new-research-field or even, new-discipline, or hybrid-research-field, C. On the-other-hand, Multi-disciplinary-research, shown in the-upper-part of the Figure 3 (A and B join together, to-work on-common-problem, and split-apart, unchanged, when work-is done). With-their-own specific-meanings, these-terms should-not be used, interchangeably. Instead, the-more-general-term ‘multiple-disciplinary’ is suggested, for when-the-nature of involvement of multiple-disciplines, is unknown or unspecified.

Figure 3: Difference between multi- and interdisciplinaresearch-approach (Tabak, 2004).

Moreover, IDR can be one of the-most-productive and inspiring of human-pursuits, leading to-a-new knowledge. IDR is inspired by the-drive to-solve-complex-questions and problems, whether generated by-scientific-curiosity, or by-society, and lead researchers, in-different-disciplines, to-meet at the-interfaces and frontiers, of those-disciplines, and, even, to-cross-frontiers, to-form new-disciplines, such-as: bio-engineering; genetic-engineering; bio-geochemistry, and paleo-seismology, among many-others. The-following-examples, illustrate how applying social-sciences and humanities supports, in-solving engineering-problems, such-as in: (1) programming-theory (synergy of mathematics, cognitive-psychology, and linguistics); (2) usability-research (cognitive-psychology, experimental-psychology, linguistics, and ergonomics); (3) innovation-research (sociology, economy, psychology, and human-factors engineering); and (4) design-methods (cognitive-psychology, mathematics, and linguistics), to-name just-a-few.

On-the-other-hand, IDR, is not a-new-concept. The-history of science, and engineering, from the-time of the-earliest-scholarship, up-with examples of the-integration of knowledge, from many research-fields. The pre-Socratic-philosopher, Anaximander, brought-together his-knowledge of geology, paleontology, and biology, to-recognize that living-beings develop from-simpler to more-complex-forms. In-the-19th Century, Louis Pasteur became a-model inter-disciplinarian, responding to practical-questions, about diseases, and wine-spoilage, with
surprising-answers, that laid the-foundations of microbiology and immunology. Similarly, many of the-grand-
research-triumphs are-products of interdisciplinary-inquiry and collaboration: discovery of the-structure of DNA;
magnetic-resonance-imaging; the-Manhattan-Project; laser-eye-surgery; radar; human-genome-sequencing; the
‘green-revolution’; and manned-space-flight, among-others (Kafatos & Eisner, 2004).

On an-individual-level, studies show that situational-factors, such-as exposure-to-ideas, outside one’s own-
discipline, may-have a-positive-impact on-researchers, in their-own-discipline. Creative and influential-
researchers are more-likely to-keep-up with-developments, outside their-own-domains, and this
interdisciplinary-curiosity can lead to-major-breakthroughs, on their-own-projects. For-example, it was Charles
Darwin’s reading of Malthus’s ‘An Essay on the Principle of Population’ that led to-his Theory of Natural-
Selection (Martensson, 2016).

On-the-other-hand, multiple-disciplinary-teamwork has both; benefits and drawbacks; the-latter, however,
are outside-the-scope, of this-concise-paper. Readers interested in more-details, on-both; can-refer to Choi & Pak

Moreover, the-National-Academy of Engineering (2004) in ‘Facilitating Interdisciplinary Research’ stated:
Interdisciplinary-thinking is rapidly becoming-an-integral-feature of research, as a-result of four-powerful
‘drivers’: (1) the-inherent-complexity of nature and society, hence, the-complexity of research-problems; (2) the-
increasing-specialization, across-disciplines and fields; necessitating the-desire to-explore, problems and
questions, which are not confined to-a-single-discipline; (3) the-rising-costs of technological-equipment; calling,
for-its-sharing; and (4) the-development of new-information and communication-technologies.

Furthermore, for-an-effective collaborative-research-project, academic-staff should-be homophile (two or
more-individuals, who interact, and have certain-similar-attributes), to-the-extent, that they-desire to-share
information and to-benefit, from researches of their-counterparts. Besides, according to OECD (2011), many-
actions should-be carried-out, in-such a-research, including: (1) acquisition of funds, and formation of
collaborative-teams. For-example, diversity and synergy, should-be-considered, in the composition, of the-
proposed-research-teams; such-as: involvement of younger-researchers and individuals, with diverse-
backgrounds, expertise, skills, origins, age, and gender; (2) oversight and management of grants and personnel;
(3) hiring, contracting, accounting, auditing, writing, and editing of proposals and publications; (4) public-
communications; and (5) maintenance of equipment, among-others. Besides, knowledge and adherence, to-ethics
and safety-standards, is paramount (see Starovoytova (2017) for more-details). Lastly, a good-research largely-
depends on the-integrity and commitment of the-researcher(s).

A-survey, conducted by Misra and his-colleagues, on 76 randomly-selected, professors, from across-
disciplines, at-large-research-institution, pointed-out, that:

Scholars reporting higher-levels of trans-disciplinary-orientation produced scientific-outputs that were-
judged to-be more-inter-disciplinary and trans-disciplinary in nature, as rated by independent evaluators
that is, they were more-successful in synthesizing concepts, ideas or methods from multiple-
disciplines and extending behavioral routines exemplifying a-trans-disciplinary-orientation.

A-clear-understanding of the-personal-qualities, which constitute an-individual’s orientation and how it-can
be calibrated, is-crucial for-guiding educational and training-efforts, designed to-promote the next-generation of
scholars’ engagement, in-cross-disciplinary-collaborative-research. The-researchers also-found, that trans-
disciplinary-orientation was also-positively, but, marginally-related to-independent ratings, of creativity, and
intellectual-quality, of the-scholars’ work (Misra et al., 2015).

According to Duque (2005), Kenyan-scientists have an-average of 1.71-collaborative-projects. Kenyan-
researchers have the-lowest-levels of productivity, but the-highest-levels (in Africa) of external collaboration,
just the-opposite of what should-be-expected (generally, the-benefits of collaboration should exceed its-costs).
research and publications, as-follows: USA-32.0%; UK-23.6%; Germany-6.8%; Netherlands-5.8%; and
Belgium-4.8%. Kenya, as-expected (being from the-Anglophone African-group), has-developed advanced-links
to-the U.S.A and UK (contributed by its-common English language-base).

On-the-other-hand, according to the-Organization for Economic Co-operation and Development (OECD,
2011), ideally, cooperation, between-researchers and institutions, from Industrialized-Countries (ICs) and
Developing-Countries (DCs) should be a-true-partnership (bringing-together partners, with distinct and
complementary-strengths). The-partnership should-be achieved, through a-balanced bi-(or-multi)-directional-
flow of resources, efforts and benefits, resulting in lasting-positive-outcomes. In-reality, however, the-
contributions, from the-various-partners, are usually-perceived, as unequal and the-term ‘asymmetry’ is-used, to-
describe this-perceived-inequality.

The-author suggests, to-the-researchers, participating in ‘multiple-disciplinary’ research, for maximum-
success, infusing-themselves, in the ‘other’ field(s), by: (1) Reading books and journals, from outside one’s
discipline, to-familiarize-themselves, in the-new-terminology, and new-methods; (2) Establishing close-working-
relationships with researchers, in another-discipline(s); and (3) Seeking opportunities, to-teach classes, in other-
Networking is another promising element of research-capacity-building. Researchers and institutions can be encouraged, to establish working relationships, in different ways (depending on the program’s priorities) for example: Linking multiple scientific domains (including support for multi- and inter disciplinary research); Institutional-networks, beyond the academic sphere; and Linkages across geographic boundaries, among others (OECD, 2011). For example, university scientists, in the Nairobi area, have significant opportunities, for interaction with programs and scientists, in a variety of international agencies, including a number of major international research centers, in agriculture and the environment (Mbarika et al, 2002), hence, they should fully exploit the networking opportunity.

On the other hand, university researchers, themselves, should adopt a more pro-active attitude, they could help departments identify their research needs, formulate appropriate research proposals, and contract to do the research (Djangmah & Anyimadu, 1997). The following international, regional, as well as, continental platforms and initiatives, could be considered and approached, for assistance: The United Nations system; High-level meetings: G8, and G20; The International Council for Science (ICSU) family of independent scientific organizations, in addition, inter-academy associations, such as: IAP, IAC, and ALLEA; The Academy of Sciences for the Developing World, Regional Office for Sub-Saharan Africa (TWAS-ROSSA); African Institutions Initiative (WellcomeTrust); NEPAD-the New Partnership for Africa’s Development; and Kenyan Young Scientists, among others (OECD, 2011).

The university should also create Centres of Leadership and Excellence, to serve as both: (1) models, for what research-based universities, can accomplish; and (2) resource centres, for advice and assistance, to other institutions. Even under the best of circumstances, not all universities, around the world, however, can be centres of excellence, in research; nevertheless, potentials for becoming a centre, should be critically investigated. Research infrastructure development should be also directed in some niche areas, and national, regional or, even, international cooperation, using that infrastructure.

In Kenya, due to the scarcity of resources, and the substantial extent of fragmentation, and spreading of the necessary, for research, facilities, sharing and cooperation, become crucial, for the further development of research. The university (on behalf of the engineering school) should establish research collaborations with relevant, high performing complementary research groups, at research intensive universities, institutions, and private organizations.

On the other hand, in universities, the capacity of individual researchers, including their skills, competencies, attitudes, and values, is developed, primarily, through appropriate training programs and courses, alongside with actual involvement, and exposure to the research activities. Special initiatives, aimed at individual research capacity development include: the Study Program for Higher Education Management, developed with the financial support from the Dutch and Swedish governments, of the Association of African Universities (AAU); Multinational Working Groups (MWG), National Working Groups (NWG), Small Grants Program for the Writing of Dissertations and Theses, and Training Institutes, of the Council for the Development of Social Research, in Africa (CODESRIA); and the work of the National Mathematics Centre, of Nigeria, developed to enhance collaboration, between young Nigerian scientists, and experienced local and international scientists (Sawyerr, 2004).

Another promising collaboration opportunity is, so called, ‘sandwich programs’ for Postgraduate studies, combining works, at the graduate’s home institution, and work at another institution. Such programs have advantages over full-time postgraduate study abroad, including: (1) increased local relevance of themes and topics; (2) reduced likelihood of brain drain; and (3) lower costs, among others. One such program in the school, for example, is a collaboration between MIT, SOE, MU, Kenya and Donghua University (DU), China, is proven rather successful, in terms of its outputs. The Kenyan candidates complete their course work and research proposal writing, at MU, and then they proceed to DU (with excellent research facilities) to complete their research component of the program; and finally, they come back to MU, to write and defend their thesis. In this particular set up, successful students will graduate with Masters in Science in Industrial Engineering, from MU. Other programs, however, give a degree from the two collaborating partners.

4.7. The Internet, as an institutional research tool
The widespread digital availability, of vast quantities of information, data, and literature, is one of the most remarkable changes, in the technological environment, in which universities and research, currently operate. The Internet is, often, characterized, as a combination of email technology, for communicating; and web technology, for information gathering (Mbarika et al, 2002). The Internet has been credited not only for distributing information power, and generation of knowledge, but also for storing, large amounts of information, and knowledge. However, this is only possible, where there is ubiquitous computing, embedded networking,
and pervasive-Internet. In sub-Saharan-Africa, however, the-presence of the-Internet is-still extremely-low (Ondari-Okemwa, 2007).

The-mainstream (91%) of the-subject-sample, declared that-they-are not satisfied with-the-current Internet-services at-the-school, in-both; reliability and speed. In-contrast, Arunachalam (2003) believes that the ICTs, specifically, the-Internet, rather than bridging-the-digital-divide, will-widen the-knowledge-divide or the-disparities, in-people’s capacities, to-do-research, and their-ability, to-use-the-technologies, to-their-advantage.

According to Duque et al (2005), Kenya is-one of seven African-countries, with-more-than 10 Internet-service-providers (ISPs), with-a-high-speed-national Internet-backbone (4G), is-under-development. On-the-other-hand, only one-half (51%) of-Kenyan-scientists, report reliable-access to-the-Internet. This-paradoxical situation could-be attributed, to-service-acquisition by the-institutions, rather-than-the-Internet service-provision; either-the-Internet-connections are too-costly, for-academic-institutions, to-maintain, or the electrical-power-supply is-poor and unreliable. Very-few-institutions, of higher-learning, in-the-country, enable scholars to-have free, fast, unlimited, and reliable-access, to-the-Internet.

Besides, ALC (2016), pointed-out, that-the-lack of immediate-access, to-electronic-content, is seen, by-researchers:

…as a hindrance which slows their progress and can mean important information is not taken into account.

Most-manage to work around these limitations, but are frustrated by them.

On-the-other-hand, research, in-the 21st Century, requires proficiency, in-the-area of the 4Cs: (1) Critical thinking, and problem-solving; (2) Communication; (3) Collaboration; and (4) Creativity and innovation; all of which are-addressed by Grid and Cloud-Computing, under the-umbrella of E-Infrastructure (Udanor et al., 2015).

E-Infrastructures can-be-defined as networked-tools, data, and resources, that support a-community of researchers, largely-including all-those, who-participate-in and benefit, from-research (European Commission, 2011). E-Infrastructures include-services, as-diverse-as: (1) the-physical-supply of backbone-connectivity; (2) single-or multi-purpose grids; (3) supercomputer-infrastructure; (4) data-grids and repositories; (5) tools for visualization, simulation, data-management, storage, analysis, and collection; (6) tools-for-support, in-relation to-methods or analysis; as-well-as (7) remote-access-to research instruments and very-large-research-facilities.

In-2011, a-project, at-the-University of Nigeria, named Brain-Gain-Initiative (BGI), successfully set-up the-first-ever Grid Computing-Infrastructure, in-Nigeria (The-Lion-Grid), under the-funding of UNESCO and HP (Brain-Gain-Initiative). According to a-survey, carried-out by-European-Commission (2011), more than 85% of e-Infrastructure-users, recognizes e-Infrastructure as-important or very-important, to-their-work. Most-would also-see their-research-work or programs, impaired, if the-e-Infrastructure did-not-exist.

E-infrastructure, such-as Grid and Cloud-Computing, is yet to-come to-the-university, hopefully, in-this-Century. The-author is confident, that this-infrastructure is not-only timely and highly-valuable, but an-absolutely must-have, for-all-institutions, that endorse reliable and cutting-edge-research, in-this-vibrant E-Century.

Clearly, more-OA, to-sources of scholarly-information, libraries, and software-codes, would-tremendously-benefit research, in-those-countries that suffer, from severe-shortages, in more-conventional-research-facilities.

To-date, however, as was pointed-out several-times, this-access is-still prohibitively-expensive. Organizations like OECD, the-World-Bank, and UNESCO, but also-companies, involved in-producing the-appropriate-technology, are being-called-upon, to-make their-influence-felt, in-the-direction of making these-vital-resources, for-research, more-openly and equitably-available.

Lor & Britz (2005) also-argue that the-nature of knowledge, is that it-has-to be created cumulatively, meaning that access-to-information is required, to-create new-knowledge. Although many-universities in-resource poor-countries, such-as Kenya, might-not possess the-necessary-funds to subscribe, to-international-journals, they could-support their-faculty, by identifying and subscribing to a-few-key-journals. Furthermore, differentiated-journal-access-fees can also support and encourage African and developing country-scholars, improving their-access, to-current-literature and existing-research.

Many-interventions are-available, to-potentially-counter-balance the-barriers to-effective-research, providing free, or heavily-discounted, access to the-scientific-literature, to-researchers, in-developing countries; these-are: (1) HINARI (collaboration-between-publishers, WHO and Yale-University-Library) offers free-access to over 3300 biomedical-journals, to-countries with-the-lowest per-capita-incomes, and access for a-nominal-fee (USD1,000 for the-full-collection) for 113-countries, in-total. Downloads by developing-country-researchers are running, at-an-annual-rate of above 4-million-articles; (2) AGORA (HINARI’s sister-program) provides access to-the-journal-literature, in food and agriculture, and a-third-program, OARE, was launched, in 2006, to-provide access in-environmental-sciences; (3) HighWire Press offers free-access for developing-countries, to 320-high-quality journals, based simply on a-software, which recognizes from where-the-user is accessing the-site. BePress (Berkeley-Electronic-Press) has-a-similar-arrangement; (4) Some-publishers offer similar-schemes, independently (e.g. the-Royal-Society of Chemistry, the-National-Academies-Press); (5) INASP’s PERI-scheme
negotiates affordable, sustainable, country-wide-licenses, which-provide access-free, at the-point of use, for researchers; and (6) eIFL (Electronic-Information for Libraries) provides country-wide-access, to thousands of titles in social-sciences, humanities, business and management by libraries in 40-countries of the-Soros Foundations’- network (Publishing and E-learning Consultancy, 2006).

4.8. Lack of time and office-space

Majority of the-subject-sample (82%) indicated lack of time, available, to-do-research, as a-barrier, to-effective-research, as-well-as to the-limited-number of publications, while office-space was stated by 73%. According to a-study by Keen (2007), academics are reported, that they too-often lack the-time, confidence, and resources. Time, as-a-barrier, to-writing-for-publication, was also identified by Pearson et al. (2004).

According to-the-CHE, Kenya’s 30 universities are being-crippled, by acute-shortage of professors. Due-to severe-shortage of staff: (1) the-faculty, at the-school, often, carry heavy-teaching-loads, at-times, up-to 5 undergraduate and postgraduate-courses, per-semester, without both; modern teaching-aids (such as-proectors), and traditional-support, of graduate-teaching-assistants; and (2) the-university, are increasingly-turning, to-part-time-lecturers, but many of them, have-only-attained Masters-Degrees.

Kenya, although a-developing-country, is rather-expensive, where it-is considered (by-the-majority) as abnormal to-be-poor; hence, almost-everybody is vigorously-looking for money, and hence, are distracted-into, at-times, illegal or corrupt-pursuits, aimed at-ensuring their-own and their-, at-times, large-families material-survival. Interested-readers could refer to Starovoitova & Namango (2016b) for the-examples, of the-selected most-known integrity or corruption-scandals, in-Kenya.

Besides, current-number of universities (public and private) in-Kenya is 51; moreover, according to-the Universities Act (2012), the-government anticipates to-set-up, at-least-one-public-university, in-each of the 47 counties. The-prevailing-practice is to-open a-campus, and then start-thinking about facilities, teaching-staff, and the-rest. With an-increase in-the-number of campuses, in-most-urban-centers, the- limited-academic-staff, is reduced, to-accepting part-time-teaching-jobs, to-supplement their-law remuneration, at-the-expense of research. Running-around various-mushrooming-campuses, all-over the-country, leaves them with little or no time, for-research, and also possibly-distress quality of their teaching.

In-addition, many-senior-scholars, at the-university, are now-preoccupied with-other-things, particularly, university-service and administration, which may-obstruct their-research-productivity. For-example, MU newly-established-directorate (with 13positions), absorbs many-full-professors; also professors can-become: (1) Deans of 15 schools of MU; (2) deputy-vice-chancellors, or (3) principals of 21 newly-established mushrooming-campuses, of MU. Each of these-senior-positions entails mass of responsibilities, and, in-addition, time; spend, attending many-endless-meetings, leaving them with no possibility for teaching, research, and scientific-writing.

The-research-findings are in-accord, with a-study by Mweru (2010), describing lack of time, for research:

Overcrowded lecture halls, an excessive number of exams to grade, numerous university meetings, and serving on various university committees were all cited as taking up any extra time that could otherwise have been used to write journal articles. Furthermore, senior faculty members complained about having to supervise up to twenty Masters’ and Doctoral students’ projects and theses. Little time was left for research and publishing. In addition, those interviewed stated that if they did find some extra time, it was spent on teaching extra classes in private-universities or colleges to supplement their incomes. Low faculty wages were therefore seen as a major hindrance to research and publication.

Additionally, in-the-local-context, MU is kind of a-rural-university; the-closest to it, Eldoret town, is 40km-away, consequently, faculty have-to-spend, at-least 2hours, per-day, for travelling (on a rough-road) from-town to the-university-campus, as, currently, all-residential-houses, within the-campus(initially-build, for lecturers) are given to-students, due to the-ever-expanding-intake and lack of hostels’-capacity.

Moreover, the-taxable-monthly-transport-allowance is insufficient, to-travel to-university every-day, so, many-lecturers only come once or two-times per-week (just to-teach).

The-other-issue is office-space, which was indicated by 73%; some-people do-not have an-official-place, which they-can-call ‘my-office’. This-is an-extra-excuse (although justifiable) for them not coming to-the-campus, every-working-day. On-the-other-hand, due to rather-high-demand for housing, and hence, rent in-town, many-faculty, especially the-younger-ones, preferring to-rent small-places, where, at-times, there is no space to-put, even, a-reading-table, hence, they are deprived of adequate-conducive working-environment, both; at-the-office and at-home.

The-author, strongly-believes, that substantial-improvement of academia’-remuneration, will go a-long way in-providing contented-faculty, confident in their-financial-abilities, which, sequentially, will release them, form the burden of running-around and part-timing everywhere, possibly, which finally, leave adequate-time for research.
4.9. Self-sponsored-publishing-demands

An-article-processing-charge (APC), also-known-as a-publication-fee, is a-fee which is charged to-authors, to-make a-work-available OA, in-either an-open-access-journal or hybrid-journal (Van Noorden, 2013; Solomon & Björk, 2012; Suber, 2012). Ideally, this-fee is usually-paid by an-author’s-institution or research-funder, rather than by the-author, themselves. In-the-school, however, this-is not the-case, as 64% of the-respondents indicated that self-sponsored-publishing-demands strain their-already inadequate income. They have also-indicated that the-average APC is USD 300, which is a-substantial-amount, particularly if coming from the-lecturer’s microscopic-salary.

A-well-known and widespread, so-called ‘author-trading’ phenomenon (Bozeman & Youtie, 2016), where you-make-me an-author, in-yours, and I-will-make you-an-author, in-mine is perceived, however, less-severe than the-one, explained in-the-following-account. During this-study, another interesting and rather unexpected-phenomenon was-revealed; some of the-first or correspondence-authors (due-to desperation to-publish coupled with possible, as Kenya is considered a DC or a-3rd world-low-income-country. The-following-practice in South-Africa, can-be also used, as-an-example.

According to Tijssen (2007), one-of-the-best-practices, in-the-region, is South-Africa’s Department of Education, which provides some-incentives, to-scholars, who-publish in-journals, which the-department has-accredited, for-purposes of subsidy. There-are-currently 253 South-African-journals recognized by-South Africa’s Department of Education, as meeting the-minimum-requirements, for state subsidy, under the-policy of rewarding-academics, who-publish in-these-outlets. The-South-African Department of Education also-recognizes several-other-journals, published-elsewhere, for the-purpose of subsidy. Most of the-journals, recognized by-the-Department of Education, are indexed by the ISI in-its-citation-indexes (Science-Citation-Index, Social-Science-Citation-Index, and Arts & Humanities Index).

4.10. Code of Practice for Research

36% of the-respondents declared an-absence of the-Code of Conduct for Research, at-the-university, leaving them with no official-guidance, on the-subject-matter. The-Code of Practice for Research is, however, an-essential reference-tool, to-support researchers, and research-organizations, in-the-conduct of research, of-the-highest-quality and standards.

The-most-common-definition of ‘ethics’ is: norms for conduct that distinguish between acceptable and unacceptable-behavior (right vs. wrong). According to-the ‘bad-apple’ theory, most-scientists are very ethical. Only researchers, who-are morally-corrupt, economically-desperate, or psychologically-disturbed, do commit-intentional-misconduct. Yet, according to-the ‘stressful’ environment-theory, misconduct occurs, because various-institutional pressures, incentives, and constraints, encourage people, to-commit misconduct, such-as: pressures to-publish, or obtain grants, or contracts, career-ambitions, the-pursuit of profit or fame, and poor-oversight of researchers, among-others (Shamoo & Resnik, 2015).

On-the-other-hand, research and writing-problems have received a-good-deal of attention (see Vahakangas, 2013; Plemmons, 2012; Saha & Hurlbut, 2011). Ethical-drifts (due to-desperation for-promotion; scholarly-immaturity; etc.) in-research can-significantly harm human and animal-subjects, students, and the-public, at-large. For-example, a-researcher, who fabricates-data, in-a-clinical-trial, may-harm or, even, kill patients, or a-researcher, who fails-to-abide by regulations and guidelines, relating to-radiation, or biological-safety, may put-at-risk their-health and safety, and/or the-health and safety of their-colleagues and students.

The-importance of ethics, in-research, cannot-be overemphasized; for-example; (1) norms promote the-aims of research, such-as knowledge, truth, and avoidance of error; (2) ethical-standards promote the-values that are-essential, to-collaborative-work, such-as: trust, accountability, mutual-respect, and fairness; and (3) many of the-norms of research promote a-variety of other-important-moral and social-values, such-as: social-responsibility, human-rights, animal-welfare, compliance with the-law and regulations, and public-health and safety (EPSRC, 2006).

According to Shamoo & Resnik (2015), many different-professional-associations, government agencies, and universities, have adopted specific-codes, rules, and policies, relating to-research-ethics. Many government-agencies, such-as: the-National-Institutes of Health (NIH); the-National Science Foundation (NSF); the-Food and Drug-Administration (FDA); the-Environmental Protection-Agency (EPA); and the-U.S.A. Department of
Agriculture (USDA) have ethics-rules, for funded-researchers. Other prominent research-ethics-policies include: Singapore Statement on Research-Integrity; the-American Chemical Society, The-Chemist Professional’s Code of Conduct; Code of Ethics (American-Society for Clinical Laboratory-Science) American-Psychological Association; Ethical-Principles of Psychologists and Code of Conduct; Statements on Ethics and Professional-Responsibility (American Anthropological Association); Statement on Professional-Ethics (American Association of University Professors); the Nuremberg-Code and the World-Medical-Association’s Declaration of Helsinki, among-many-others. These-agencies document: honesty, objectivity, integrity, carefulness, openness, respect for intellectual-property, social-responsibility, non-discrimination, competence, legality, animal-care, and human-subjects protection, among others.

Use of the-Code can-assist, researchers and organizations, in-fulfilling the-requirements of regulatory, funding and other-bodies, and ensure-that important-issues have-not-been-overlooked. Education in-research-ethics (on important-concepts, tools, principles, and methods) should-be-able to-assist researchers, dealing with the-ethical-research-dilemmas, such-as, for-example: human-embryonic-stem-cell-research, cloning, genetic-engineering, and research, involving animal or human-subjects, among-others. Although, codes and policies, are-very-important and useful; they do-not-cover every-situation, they, often, conflict, and they-require considerable-interpretation. It-is, therefore, important, for researchers, to-learn how to-interpret, assess, and apply, various-research-rules, and how-to-make-decisions, acting-ethically, in various-situations. The-vast-majority, of decisions, however, involves the-straightforward-application, of ethical-rules.

The-university should-be committed, to research-excellence, and to-the-rigorous-pursuit of new-knowledge. As-such a ‘Code of Ethics for Research’ should-be designed and implemented, by the-university, to-promote the-highest-standards of scholarly and scientific-integrity, in-research, and help prevent-misconduct. A-Code should-be-applicable, to-all subject-areas, and should-not attempt to-micro manage-research; in-addition, it-is not disciple-specific. A-Code defines university’s policies and expectations, in-relation to-the-conduct of research, under its-patronage; it should-be a-periodically reviewed ‘living-document’, reflecting-changes, in-legislation and guidance, and other-developments, in-good-practice, in-research.

4.11. Recognition of academic-staff
27% of the-respondents documented no appreciation/compensation, or any-sort-of-acknowledgment, for their-publishing, by the-university-administration, as the-barrier to-do an-effective-research. In-parallel, Chege (2009), pointed-out on-one of the-most-significant contributing-factors, which has-killed intellectualism, in-Kenyan-higher-education, as a-lack of motivation, among-lectures.

Recognition for scientific-excellence, which is normally-acquired over a-prolonged-period, is based on-the-social-appreciation of an-individual’s performance (Rehrl et al, 2014). Furthermore, social-recognition of achievement provides non-material, but powerful-incentive to-research-excellence and innovation. Academic-staff, regardless of their-academic-position, desires to-be appreciated and recognized (in-one-way or the-other), for doing a-good-work. Although, even, when-appreciation is openly-expressed, by their-students, the-most-valuable, and hence, desirable, however, is appreciation, by-their-colleagues. This-lack of recognition, from the-colleagues, can-contribute to-discouragement, apathy and even, complete, or partial-withdrawal, of the-staff, from the-research-activities.

On-the-other-hand, some-faculty, frankly, do-not-know, what, exactly, their-colleagues have-published (Collaborative on Academic Careers in Higher Education, 2014); some, even, if they know the-developments, do-not-have free-time, to-spend on-reading and evaluating of the-publication(s), of other-colleagues; and another, potential-reason, behind the-phenomenon, is prevalent-rivalry. According to Sennett & Albin (2013), in a-research-environment, ordered by-rivalry, where-competition, always, takes-precedence, over-cooperation; the-expression ‘working together’ is steadily-losing its-relevance and its-proper-meaning. For a-successful-research, the-researchers should-follow the-famous-slogan, stating that: ‘Coming-together is a-beginning; keeping-together is a-progress, and working-together is a-success’.

In this-regard, SOE-should-cultivate a-culture of recognition, that reward academic-excellence, by creating ways for students, academic-staff, and university-administration, to-draw-attention to-the accomplishments, of the-faculty, by, for-example, providing a-summary-booklet, indicating staff with largest-number/amount: (1) research-grant(s) attracted; (2) citations; (3) publications, in reputable-journals (with CI above 5); and (4) awards/recognition received, from outside-university, among-others.

4.12. Lack of Technical-staff
Technical-staff play an-indispensable-role in generating the-data, on which further-experiments, analysis, scientific-papers, technical-reports, research-proposals, and theories, are-built; technicians ‘keep the-laboratory-wheel turning’; in-some-instances, if they are not-there, all-laboratory-work stands-still. The-role of the-technical-staff is-clearly recognized by-the-academic-staff, as 73% of respondents indicated lack of technical-staff, as a-main-barrier to effective-research.
Currently, the school employs approximately 20 technicians, which represents 14% of the total staff profile. Technical staff provide a vital role, to play in supporting research, teaching, and a number of other activities of strategic importance, across the school, as well as daily operational requirements. About 90% of technical staff are on permanent & pensionable terms of service. The technical staff are employed under grade system, where Chief Technician is equivalent to Lecturer, in terms of basic salary and other benefits. The retention of technical staff, at the school, is satisfactory; one of the contributing factors to it, is that technical staff, can study (under staff development program) on part-time basis, toward Undergraduate, as well as Masters, and PhD degrees.

As a routine, the technicians at the school, are involved in the following (teaching and research related) activities: (1) performing laboratory sessions with students; (2) organizing and oversee field and industrial trips; (3) conducting 12 weeks workshop practice (2nd year of study); (4) supporting undergraduate student research projects; (5) assisting in scholarly research activities; and (6) maintenance of research equipment, among others. Although this work is, generally, not regarded, strictly, as teaching, however, it provides a key means for transferring knowledge. In terms of work, itself, many technicians have very close links with the academic staff and students, as 'much of the research is technician driven'. Some students, even, had a closer working relationship, with the technician(s), than with their supervisor(s).

On the other hand, IT skills are becoming increasingly important, for technical support, of education programs. For example, a study by Arteaga & Lucas (2005) assesses the shortage of university IT technical staff, and noted the following, regarding the services they provide:

- Information Technology (IT) support groups are aware that in order to meet the needs of faculty and students who use the university’s computer labs, it is imperative to provide up-to-date equipment and software. As the number of supported computer labs and multimedia rooms grows, the quality of the support may suffer due to the lack of staff needed to properly maintain the equipment. Needed patches, updates and virus definitions can be neglected due to lack of time and resources. Printer, scanner and projector maintenance can also suffer.
- As the use of various computing technology becomes more and more common, in the classrooms, as well as, in the laboratories; the need, for trained support professionals, undoubtedly, becomes a high priority. The range of needed services is vast, and according to Ali & Murthy (2010), the list is as follows: (1) Installing hardware; (2) Installing software; (3) Maintaining hardware, (fixing and repairing); (4) Troubleshooting software problems; (5) Monitoring software updates, to install patches and fixes; (6) Providing technical support to students; (7) Managing different computer labs; and (8) Researching and providing hardware software specifications and prices, among others.

Moreover, according to Smith (20014), the specialist technicians, in IT Labs, are expected, to add value, to the research, working as part of teams. The technicians work in one of 5 main roles: (1) Networks; (2) Platforms; (3) (internal) Customer Services; (4) Global collaboration environment; and (5) Applications and business software development and tools. Moreover, the general competencies, required, would be (Shrivastava & Shaw, 2004): in the installation, operation, and maintenance of technical equipment (including software), network administration, and security.

Furthermore, faculty, teaching computer and technology related courses, go through continuous updates, of their courses, to accommodate recent technology developments. The recent technological updates are more frequent (Arteaga & Lucas, 2005), and they might affect other existing technologies (Ali & Murthy, 2009), moreover, the range of technological options is increasing (Bardzell, 2006). This complexity necessitates the consultation and cooperation of faculty with technical staff. Not surprisingly, the majority of technicians (62%) concentrated in Electrical, Computer and Communication division, to satisfy ever increasing demands, of the school.

Highly skilled technical support is also essential to effective research. Training, especially, for technical staff, at the school is, however, too often, seen as a cost, rather than long term investment, in the future human resource. As such, the training of technicians occurs, mostly, on an ad hoc basis, with on the on job training, the main method used. Besides, very little opportunity, for external training, was observed and reported. For many researchers, technicians are 'the glue that holds the science and research together' (Ali & Murthy, 2010), thus, in order for that glue not to dry up, technical staff should be regularly trained, on the new developments, in their fields; taking into account current financial constraints, in house training should be given a preference, to reduce the associated cost.

4.12 Library
As stated, in section 3.3, of this paper, MU library does not have an IR, however, only 9% provided a corrected answer. On the other hand, on the question: 'Has your library provided a list of Open Access journals available?' The majority of the respondents (aggregate 63%) again, did not provide the correct answer; for example: (36%), stated that the library does not provide a list of Open Access journals available in various-
disciplines, while 27% indicated that they do-not-know the-exact-position. Theseresponses point-out on the-gap of information. In-this-regard, the-study suggested, the-library administration should-prepare a-small -booklet, listing all their-services, which should-be put-on MU-web-site. In-addition, regular-training should-be conducted on-how-to-utilize the-OA-facilities, provided by the-library.

5. Conclusion and Recommendations

5.1. Conclusion
The-numerous-barriers, identified, during-this-study, can-be grouped-into: (1) Economic (inadequate funding for research and research-infrastructure; low-remuneration; and self sponsored publishing); (2) Institutional (lack of Code of Practice for Researchers; and mushrooming campuses); (3) Behavioral (‘publishing-prostitution’; ‘brain-drain’; ‘complex of intellectual superiority’; and lack-of: time, motivation, recognition and mentorship); (4) Demographic (gender imbalance; and aging-faculty); and (5) Managerial (lack of: marketing of library-services; and training for technical-staff), among-others.

This-study was-based, on a-limited-coverage, of a-particular-Engineering-School, hence, in a- strict-terms, it-should-not be generalized to other-schools, at MU, or Engineering-schools, at other- universities. It-would-be very-naive, however, to-assume that all-the-multifaceted-issues, identified in-this study, are specific to-the-subject-sample, or isolated to the-Engineering education-sector.

The-ideas and opinions, expressed in this-work are the-author’s-own, and do not, necessarily, represent those of the-SOE; the-university; or the-government.

5.2. Recommendations
The-recommendations, that were-made, in-the-previous-sections are summarized, as-follows:

The government should:
(1) Timely-increase budgetary-allocations, to-higher-education;
(2) Change the-model of government-funding, for-university, via market-based disciplinary-differentiation;
(3) Substantially improve the-remuneration, for academia, with merit-based-compensation-system;
(4) Facilitate the-EBK and the-CUE to-work-out a-middle-ground on-the-accreditation-issue; and
(5) Direct the-research-infrastructure-development in some-niche-areas, and national, regional or, even, international-cooperation, using that-infractructure.

Besides, while waiting for the-government, to-fulfill its-pledges and very-impressive-plans, university should-be proactive (in-its-small-way) by initiating new-fruitful-collaborations, as-well-as:

University should:
(1) Establish Centers of Leadership and Excellence;
(2) Acquire E-infrastructure, such-as Grid and Cloud-Computing;
(3) Cover the-faculty-publication-cost;
(4) Design and implement a ‘Code of Ethics for Research’;
(5) Develop effective-and well-balanced mentorship-programs;
(6) Initiate-cooperation with research-institutes (with better-infrastructure);
(7) University-library-administration should-prepare a-small-booklet, listing all their-services, which should-be put-on MU-web-site;
(8) Conduct regular-training (across the-university) on-how-to-utilize the-OA-facilities, provided by the-library; and
(9) Organize regular-training to-increase-awareness on the-services, available at the-university-library.

The-school should:
(1) Increase female-representation, in engineering-education, by encouraging more-women, to-engineering;
(2) Develop ‘sandwich-programs’ for Postgraduate-studies, including at PhD-level;
(3) Cultivate a-culture of academic and publishing-recognition; and
(4) Regularly-train technical-staff, on the new-developments, in-their-fields.

6. Acknowledgement
The-author recognizes the-very-diligent-commentary and advice, on-earlier-manuscripts, received from several-senior-faculty, SOE. Thank you, all.

References


Duque, B.; Ynalvez, M.; Sooryamoorthy, R.; Mbatia, P.; Dzorgbo, D. and Shrum, W. (2005). “Collaboration paradox: scientific productivity, the Internet, and problems of research in developing areas”, Social Studies...


of Dar es Salaam’s institutional transformation program (Vol. 1). Dar es Salaam, Tanzania.


ISSN 0851–7762.


Tijssen, R. (2007). “Africa’s contribution to the worldwide research literature: New analytical perspectives,


UIS (2007). Fact Sheet; A global perspective on research and development.


World Bank (2012). *Living a long and healthy life – Africa and Kenya are only starting to catch up.*


