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

Diana Starovoytova
School of Engineering, Moi University P. O. Box 3900, Eldoret, Kenya

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-questioner 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–Obeing (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 (McNicol, 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-completely-neglected universities, say observers. The-government-provided only USD 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.

Multitude 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. Materials and Methods.

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-Figure1.

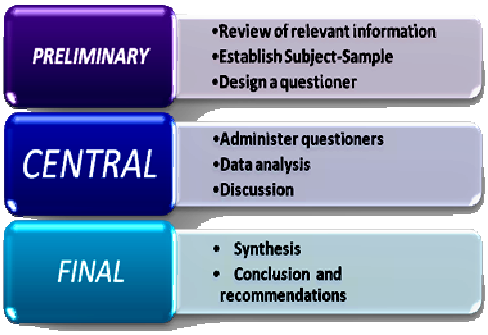

Figure1: Sequential-parts of the-study (Starovoytova & Namango, 2016a).

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-questionnaire 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-co-efficient was used, according to Kothari (2004). The-Statistical-Package for Social-Sciences (SPPS-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' senior-academic-faculty), out if which, 11 were submitted back, giving a-response-rate of 73 %.

3.2.1. Analysis of part1: Demographic-Characteristics.

Figure 2 shows Demographic-Characteristics of the-respondents.

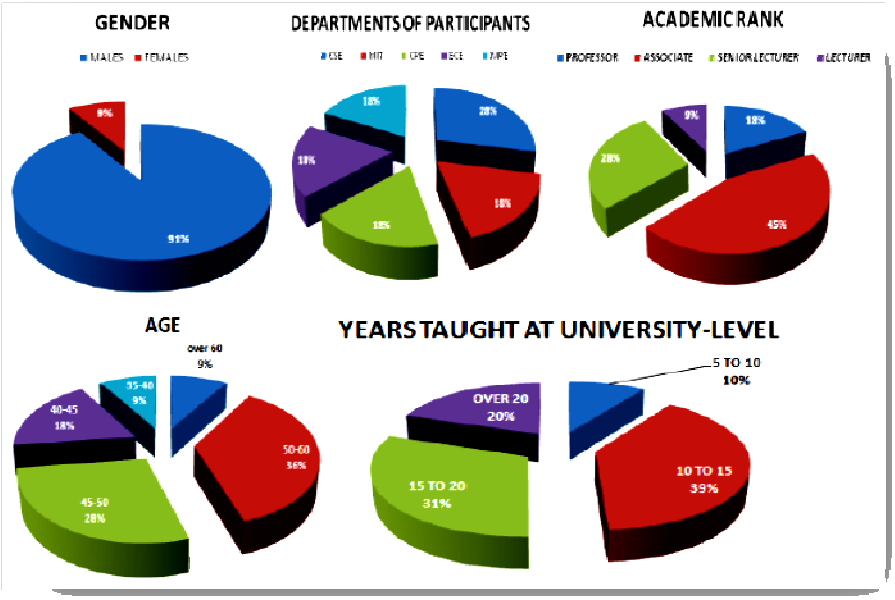

Figure2: Demographics of the-respondents (adopted from Starovoytova, 2017).

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 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-Institutional 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 to-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 45-50million, 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 10years 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 (5years 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-microscopic-amount is to-be-split between 2nd (or even 3rd) runner-up, making comprehensive-research unattainable. Besides, the-whole-exercise consumes a-lot of valuable-time; as-according-to Munch (2009):

> 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.

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 (*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, *but*, considering current-financial-constrains, 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 *advance-africa.com*, for-example, provides more-than 40 links, to-different travel-grants, for-students, teachers, and university- lecturers; in-addition, *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-*not* changed much, since 2000, reflecting gross-underfunding, in this-particular-area.

4. Data Analysis and Discussion.

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-

tried, 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 21campuses. 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

Kenya Education Network (KENET) launched the-2015 Baseline-Survey of the-state of Engineering Departments, in-the-country. It-identified: 44-engineering-departments, within 12-public-universities, offering 54-different undergraduate-engineering-degree-programs (as-of-November, 2014). According to the-report, published by KENET, the-research established, that there-were 10,343 undergraduate-engineering students, enrolled in-the 2014-2015 academic-year, representing *only* 3.6 % of the 289,336 total undergraduate-student-enrolment, in-the-12 public-universities.

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* 3universities (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-12universities, 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

qualified-engineers, will-probably, continue to-plague Kenya.

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-highest 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 (Venezia, 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 Cuprosklodowskite. 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 & Cherotich (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 & Cherotich (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: Kyvik & 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: Edouardo-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 Zedeck *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 60-65years 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-multitude 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-picture, 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

Absolute-majority (100%) of the-respondents, pointed-out on the-Research-Funding, as-one of the-major-barriers, to-effective-research. From the-interview, with the-Director of Research, MU, it-was 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 '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 7,000, 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 nonproductive-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-Okemwa (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-multitude 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,

2008; Lee & Bozeman, 2005).

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.

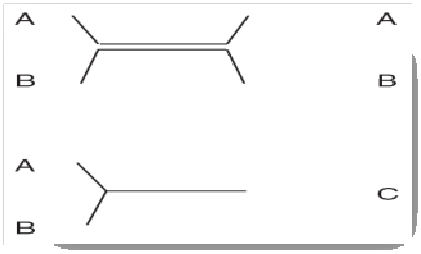

Figure 3: Difference between multi- and interdisciplinary-research-approach (Tabak, 2004).

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, boomed 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 (2006).

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 1.71collaborative-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-excepted (generally, the-benefits of collaboration should exceed its-costs). Adams *et al* (2010) cited Wolfram Mathematica®7, indicating the-top collaborating countries, in Kenya's 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-

departments (to-get more-comprehension on the-other-field(s)). Values, gained, through-such-activities, include: appreciating the-importance of collaborative-research, and accepting world-views and paradigms, different-from one's own.

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 i*nter* 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-proactive-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-infractructure.

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-in, 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) *C*ritical 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-projectors), 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 Starovoytova & 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 21newly 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 corresponding-authors (due-to desperation to-publish coupled with financial-constraint) 'selling' their-paper(s) to-their-colleagues (who, apparently, have *not* participated, at any-level, in the-research, moreover, at-times, *not* read the-manuscript or even the-title, and, hence, have *no* slightest-idea, what the-manuscript-is all-about), but who-are willing and able, to-pay for the-publication, in-exchange for a-small-favor--they *must-be* included in the-list of authors. Some, even, insist, that because they-have-paid, they should-be the-*first*-author. This-goes against the-very-essence of ethical-values, governing scientific-research and publishing-practices, and hence, this-kind of regrettable and highly-unethical-situations can-be condemned as '*publishing prostitution'*. To-avoid, this-kind of situations, the-university should-cover the-publication-cost; Another approach could-be, for author(s) to-ask publisher(s) to-wave or reduce the APC, if 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 12weeks workshop-practice (2^{nd} 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 grow, 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* provided the-correct-answer; for-instance: (36%), stated that the-library does *not* provided a-list of Open-Access journals available in-various-

disciplines, while 27% indicated that they do-*not*-know the-exact-position. These-responses 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.

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