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Current statistics in Science, Technology and Innovation in higher education in Cameroon and the establishment of gender participation

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ABSTRACT
Higher Education (HE) in Cameroon aims at promoting and strengthening Science, Technology and Innovation (STI). However, statistical evidence indicates that there is no clear policy that addresses STI educational concerns in Higher Education in Cameroon. This study was carried out to document current statistics in Science, Technology and Innovation in Higher Education and to establish gender participation. The findings indicate that enrolment in STI fields for students and lecturers is relatively high in the natural sciences, but diminishes significantly in health sciences, agriculture and engineering. Numerical evidence indicate that there are more males enlisted in STI fields than females. This disparity is more pronounced in the field of engineering where female students are near absent. There is a need for more investments in STI in Higher Education in Cameroon but with special attention to addressing the gender disparity.

Keywords: Cameroon, Gender, Innovation, Science, Technology

RESUME
Au Cameroun, l'enseignement supérieur a manifesté beaucoup d'intérêt pour la promotion de la science, la technologie et l'innovation. Cependant, les statistiques probantes indiquent qu'il n'y a pas une politique claire pour adresser les problèmes posés par le STI dans l'enseignement supérieur, et il existe des disparités du point de vue du genre. Cette étude a été menée pour documenter les données actuelles vis à vis les STI au niveau de l'enseignement supérieur au Cameroun, et établir la participation du genre féminin. Les résultats montrent que le taux d'inscription des étudiants et enseignants est assez élevé pour les sciences naturelles, et diminue progressivement pour les sciences de la sante, l'agriculture et l'ingénierie. Les statistiques attestent que beaucoup plus de genre masculin s'inscrivent dans les STI que les filles. Cette disparité s'aggrave encore dans le domaine de l'ingénierie où les filles sont quasi absentes. Il est nécessaire que le Cameroun fasse un peu plus d'investissement pour les STI dans l'enseignement supérieur.

Mots clés: Cameroun, Gender, Innovation, Science, Technologie

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INTRODUCTION

Cameroon is a country in Central Africa situated below the Gulf of Guinea between the 2nd and the 13th degrees of the North latitude and 9th and 16th degrees of the East longitude. The surface area is estimated at 475 650 km^2. It has the form of a triangle that stretches from the south up to Lake Chad (close to 1 200 km), whereas the base spreads from West to East for about 800 km. It has at the South-West, a maritime border of 420 km along the Atlantic Ocean. Cameroon is bordered in the West by Nigeria, in the south by Congo, Gabon and Equatorial Guinea, in the east by Central African Republic, and in the north-east by Chad (National Institute of Statistics, 2013). It is a bilingual country with English and French as official languages, and operates with two subsystems of education inherited from its colonial masters.

The terms 'science and technology' can be understood in a broad sense, including fields as different as physics, political science and literature, or in a narrow sense that covers primarily academic and professional disciplines related to natural sciences, engineering, mathematics and computing. This report uses the latter definition. It is also important to recognize that the definition of science can include indigenous science and traditional knowledge systems. The concept of technology is, likewise, socially and culturally diverse, referring to hand-made tools as well as complex products and processes, for instance information technology (IT) systems. According to the Merriam Webster dictionary, Innovation can refer to something new or to a change made to an existing product, idea, or field.

Higher Education, also known as tertiary education in some countries, refers to all post-secondary education, including both public and private universities, colleges, technical training institutes, and vocational schools (World Bank, 2017). Higher education is instrumental in fostering growth, reducing poverty and boosting shared prosperity. A highly-skilled workforce, with a solid post-secondary education, is a prerequisite for innovation and growth: well-educated people are more employable, earn higher wages, and cope with economic shocks better. Higher education benefits not just the individual, but society as well (Jowi *et al*., 2016; Sam-Amoah *et al*., 2020). Graduates of higher education are more environmentally conscious, have healthier habits, and have a higher level of civic participation. Also, increased tax revenues from higher earnings, healthier children, and reduced family size all build stronger nations. Summarily, higher education institutions prepare individuals not only by providing them with adequate and relevant job skills, but also by preparing them to be active members of their communities and societies (World Bank, 2017).

Science and technology has gained increased prominence on the international political agenda due to its impact on sustainable development and democracy (UNESCO, 2015). Science, Technology and Innovation (STI) has been highlighted as an important driving force for countries' socio-economic development (Osagie and Alutu, 2016; Zavale, 2017). The ability to generate scientific and technological knowledge and translate it into processes or new products is a key instrument of economic growth and development (Mormina, 2019). In Higher Education (HE), universities are generally expected to play a critical role in the development of national and regional STI capabilities. One of the key factors of promoting scientific mind sets among learners is developing positive attitudes towards the science related disciplines and meaningful related career overtures (George, 2006). Given its long-standing commitment to the improvement of the status of women, UNESCO pays special attention to equal access of girls and women to scientific, technical, vocational education and training. In its Agenda for Gender Equity, UNESCO commits itself to

encouraging the equal access to knowledge in all fields, notably within science and technology as well as aiming at substantially increasing the participation of women in science and technical education programmes in order to provide them access to scientific and decision-making bodies.

Rationale and objectives of the study

In Cameroon, Higher Education plays a critical role in promoting science, technology and innovation. Indeed STI in Higher Education are central to economic development, trade competitiveness, and social progress. Improvements of STI in Higher Education are likely to promote better healthcare for the people, more innovative and productive businesses, the modernization of farming and agribusiness, and an enhanced human capital to address the challenges of climate change. Although STI and Higher Education are universally recognized as critical drivers of economic development, a major challenge is how to identify the right matrix of factors and policy initiatives that positively impact socio-economic development.

In Cameroon, many of the building blocks required to support STI and Higher Education policy development are universities, research institutes, Ministry of Scientific Research and Innovation, Ministry of Mines, Industry and Technological Development, National Science Academies and a growing private sector such as NGOs. However, the STI and Higher Education systems do not seem to be effectively coordinated and adequately focused on Cameroon's socio-economic needs. Furthermore, existing STI and Higher Education programmes intended to attract the private sector support do not appear to be motivating enough to drive investments and technological upgrading. Consequently, many of the country's important STI institutions are unable to effectively carry out their mandates. Despite the importance placed by UNESCO on gender equality in all fields of education especially in Science, Technology, Engineering and Mathematics (STEM) many females especially in Higher Education in Cameroon are still absent from these fields. From the Population Reference Bureau (2016), women represent a greater percentage (51) of the Cameroon population but are underrepresented in the fields of STI. It is within the above context that the aim of this paper was to review the current statistics for science, technology and innovation including investments in higher education in Cameroon and establish gender participation.

RESEARCH METHODOLOGY

The study was carried out mainly as a desk study involving literature review and document analysis. The desk research helped in the retrieval of information on statistics on STI for Higher Education in Cameroon. Additional information was collected through face to face and phone call interviews with key informants from the Ministry of Higher Education, Ministry of Scientific Research and Innovation, National Academies involved in STI and National Institute of Statistics in Cameroon. Data obtained during the study was analyzed by descriptive statistics using Microsoft Excel 2010. The data collection process is shown in Table 1.

For the analysis, the current available statistics on Higher Education in Cameroon in science, technology and innovation from 2015 to 2018 were collected and the evolution of STI in different State Universities in Cameroon was characterized in terms of student enrolment, human, infrastructural and financial investments. From interviews with different actors, the paper captured their perception about the STI situation in Higher Education in Cameroon. A comprehensive review was done on gender participation in STI, and key underlining issues, gaps and challenges for Science, Technology and Innovations (STI) in Higher Education in Cameroon. Subsequently recommendations were derived to improve STI in Cameroon's Higher Education at the national, regional and international levels.

Table 1. Summary of data collection process

Data and information collected	Method	Sources
STI in Cameroon Gender gaps and challenges in STI	Literature Review	Ministry of Higher Education, Ministry of Scientific Research and Innovation, Ministry of Mines, Industries and Technological Development, National Academies, Non-Governmental Organizations Scientific publications
Enrolment in Higher Education in STI in different universities, human, infrastructural and financial investments in STI in Higher Education Innovative active spaces for University students and graduates	Secondary data, descriptive statistics	National Institute for Statistics Ministry of Higher Education Statistical Year books of 2015, 2016, 2017 and 2018
Recommendations	Document analysis and interviews Compilation of secondary data and interviews	Annual Reports Key informants, Websites, Key informants from relevant ministries, national academies, HEIs, relevant stakeholders from government and private sector were interviewed.

FINDINGS AND DISCUSSION

History of Higher Education in Cameroon

The Cameroon higher education system presents a 'unitary' structure (Doh, 2007). Although each Higher Education Institution (HEI) has a considerable degree of autonomy, they are centrally administered by the Ministry of Higher Education to which they are accountable. Higher education is considered a national priority, organized and controlled by the State (ESSP, 2006). The Ministry of Higher Education (MINESUP) is the main governance body and defines policies for both the State and private higher education institutions. The Ministry is headed by a Minister who is assisted by a Secretary General, a General Inspectorate for academics and service control as well as various directors of departments (MINESUP, 2018). Universities are headed by Rectors or Vice-Chancellors in the French and Anglo-Saxon universities, respectively. They are assisted by Vice Rectors or Deputy Vice-Chancellors respectively. In addition to the Rectorates or Vice-Chancellery are the offices of the Secretaries General or Registrars for French and Anglo-Saxon Universities, respectively. They are in charge of routine administrative matters in the Central Administration of the universities. The Secretaries General or Registrars are statutory secretaries to the various decision-making organs of the Universities (e.g. the Committee of Deans and Directors, Senate and the University Councils). Directors head various services in the Central Administration of the Universities and Deans and Directors head faculties, schools and institutes. In the basic units of the universities there are heads of department and programme coordinators. Each University has a governing council

presided over by the 'President du Conseil de l'Administration' (Chairman of the University Council). In this council, the presidency of the country, the ministries of higher education, finance, public service, planning and labour as well as external stakeholders are represented (MINESUP, 2020).

The languages of instruction in higher education in Cameroon are French and English. Both languages are used in the bilingual Universities for teaching and learning depending on the first language of the student or teacher. Only French or English is used in the monolingual Francophone or Anglo-Saxon Universities, respectively. Admission into the university is based on the two high school graduate qualifications, the General Certificate of Education (G.C.E) Advanced Level and Baccalaureat (BAC) for English and French speaking high school graduates, respectively. Other requirements include language proficiency and relevance of high school subjects to the intended field of study. Admission into professional and technical university centres, schools and institutes are based on highly competitive entrance examinations (Njeuma *et al*., 1999).

Before 1993, the structure of the Cameroon Higher Education system was dominantly French-patterned. The pre-1993 higher education system consisted of the main university (the then University of Yaoundé) with several university-level institutions, professional/technical schools, institutes and centres which were completely separated from or simply lodged in the university. Thirty (30) years after its creation, this university had 40,000 students in a campus meant for 5000 students (Njeuma *et al*., 1999). There were funding problems and quality decline in the University of Yaoundé between 1992 and 1993, and the Government initiated a vast reform of the Higher Education system. The reforms were contained in presidential decrees numbers: 92/074 of 13th April 1992, 93/026 of 19th January 1993, 93/034 of 19th January 1993 and 93/027 of 19th January 1993. The objectives addressed by these decrees included amongst others: a) to encourage the participation of the different partners in the management and financing of Higher Education Institutions, b) enhance autonomy in academic, administrative and management issues, c) professionalize the higher education system, d) deconcentration and decentralisation, and e) increase inter-university and international cooperation. A principal feature of the reforms was that it granted autonomy to universities to generate extra funds through projects.

Besides education and general government strategy papers, there have been revisions and additions to the 1993 reforms which relate to higher education. Some of these include:

1. Law No. 005 of 16th April 2001 (LOHE) on the orientation of higher education in Cameroon. It defines the orientation of higher education in terms of teaching, research, and contribution to development, bilingualism and cooperation.
2. Decree No. 2005/383 of 17th October 2005 on New University Governance laid down the financial regulations applicable to universities.
3. The 9th August 2008 decree creating the University of Maroua.
4. Decree No. 2010/372 of 14th December 2010, creating a second Anglo Saxon State university, the University of Bamenda.
5. The University-Industry Charter signed on 20th December 2010 expressing the values that should be upheld and the rules and regulations in university-industry relations.
6. The 2006-2009 Education Sector Strategic Plan (ESSP).
7. The 2010-2014 Growth and Employment Strategy Paper (GESP).

Before 2008, the higher education system in Cameroon comprised of two degree structures according to the French and Anglo-Saxon (or Anglo-American) systems. To ensure mobility

between the two subsystems and in response to the pressures of regional integration and globalisation, the degree structures were harmonised according to the Bachelor, Master and Doctoral structures. The Francophone structure today is called the LMD system (Licence, Master and Doctoral cycles of 3+2+3 years each) corresponding to BMD (Bachelor, Master and Doctoral cycles) which existed in the Anglophone system. This new and comparable degree structure went operational from 2008. As at 2017/2018 academic year, the student population in State universities was 269,509 with 2112 teachers (MINESUP, 2018). There are 08 publics and 245 private HEIs in Cameroon (MINESUP, 2018). Public and some private and denominational Higher Education institutions in Cameroon are shown in Table 2.

Higher Education Objectives

Higher education objectives result from overlapping national and international policies. Cameroon is a signatory to several international conventions related to education. As a developing and aid-dependent country, Cameroon's higher education system is influenced by the UNESCO, World Bank, the African Development Bank and other sub regional organizations which shape what is deemed strategic for higher education (Doh, 2012). The history of Cameroon's higher education explains why and how the higher education objectives are shaped. The priority was and still is to reform the higher education system and enhance its relevance to societal needs.

At independence, higher education was mainly for training of cadres to replace the departing colonialist in the State administrative machinery. The issue of relevance to the job market was not a problem until the early 1980s. In 1983-84 the population grew fast and the State was unable to absorb all Higher Education graduates. From 1984, there was an economic crisis: State companies were closed and recruitment into the public service was stalled. This is when the question of relevance to the labour market became increasingly crucial. In the 1990s when liberalism, multipartism and university crises kicked in, the 1993

Table 2. Some Post-secondary or Higher Education Institutions in Cameroon

Types of University	Names of Universities/Institutes
Public	The University of Bamenda, University of Buea, University of Douala, University of Dschang, University of Maroua, University of Ngaoundere, Yaoundé I and Yaoundé II
Private Higher Education Institutions	Bamenda University of Science and Technology (BUST), International University, Bamenda and the Fotso Victor University, Saint Monica University, Saint Louis University, American Institute of Cameroon, Université des Montagnes, Cameroon Petrochemical Engineering Academy, The ICT University, Institute Siantou Supérieur. Fomic Polytechnic Institute
Private University which are denominational	Université Adventiste Cosendai, Catholic University of Cameroon, the Catholic University Institute of Buea, Catholic University of Central Africa, Catholic University, Protestant Christian University, Bali

Major training institutes: most are affiliated with State universities.
Annual Statistics for the Ministry of Higher Education, Cameroon for 2015, 2016, 2017 and 2018

university reforms were initiated. There was a need to partner with the socio-professional environment to have an exact idea of what they needed. This information had to be the basis of reforming study programmes. However, when it was noticed that the enrolment capacity of the university had been largely exceeded while the university centres had under enrolment, without thinking, university centres were turned into full-fledged universities. The idea was that some students will enroll in the university centre-turned university and the former lone University of Yaoundé would be decongested. In actual fact the reforms were more infrastructural while the study programmes remained the same.

Another objective of Higher Education was to enhance professionalism and employability. The idea was not just for the student to fit the needs of the job market but to be able to create jobs and be self-employed. This has been achieved to a great extent through the creation and opening of professional schools like Higher National Polytechnic Institute (ENSP) which was created specifically to train cadres for civil service and engineers for the development of Cameroon. Like its French counterparts, the focus on ENSP was rigorous science and competitive entrance examinations. While present-day ENSP has aligned its degree structure with the Bologna Process, ENSP has focused on structural changes by adopting the Anglo Saxon Bachelor-Master-Ph.D. (BMP) model from which the French License-Master-Doctorat (LMD) is derived, in a bid to align its systems with the global educational practices.

Enrolment in STI in Higher Education in Cameroon

University education in Cameroon takes three years for the liberal arts, science and business courses, four to five years for engineering courses, and six to seven years for medicine (EPDC 2014). Cameroon has recorded rapid progress, raising its enrolment rate from 5.8 percent in 2005 to 11.9 percent in 2011 (UNESCO, 2015). More high school graduates are enrolling into higher education after meeting all academic requirements, thanks to the creation of higher institutions of learning. Literacy among people aged 15-24 in Cameroon is 85% (EPDC, 2014). Cameroon's education sector strategy paper observed that, for the 2010–2020 periods, the annual growth rate was predicted at 2.1% corresponding to a yearly increase of about 420,000 inhabitants.

From 2015 to 2018, private universities in Cameroon have been expanding rapidly, both in terms of number and size while the State universities have increased in size but not in numbers. Though enrolments in higher education have increased significantly, the proposed programmes might not meet the needs of the job market. Enrolments have increased since 2015 mainly in public tertiary education institutions. But the allocation of students by discipline still suggests that there is a gap with the needs of Cameroon's economy. Enrolment in STI has increased from 2015 to 2018 in the classical scientific disciplines but much progress still needs to be made in Engineering and Agriculture; Engineering, for instance, accounted for fewer students in higher education enrolments between 2015 to 2018 (Table 3). This is contrary to the ratio of engineering to science students which is much higher in Ethiopia (59%) than in Cameroon (6%). The highest number of student enrolment in STI fields in Cameroon State universities is in the Faculty of Science followed by Faculty of Health Sciences, Agriculture and Engineering disciplines in seven out of the eight state universities which offer programmes in STI. The trend in evolution is shown in Figures, 1, 2 and 3.

Table 3. Evolution in Enrolment in STI fields in State Universities in Cameroon

Universities	Scientific and Technological Institutions	2015	2016	2017	2018
University of Bamenda (UBa)	COLTECH	614	756	892	892
	FHS	1320	1437	844	841
	FS	911	1381	1607	1879
	HITL	93	248	380	371
	NAPHI	—	—	—	305
University of Buea (UB)	COLTECH	349	335	385	327
	FAVM	609	674	565	527
	FET	487	593	455	654
	FHS	911	1029	1060	1054
	FS	3085	3071	2401	2524
University of Douala (UD)	FGI	1612	1925	2218	2005
	FS	8359	9303	10131	11008
	ISH	531	438	548	544
	IUT	2782	3389	4448	3767
	FMSP	—	1127	1375	1558
University of Dschang (UDs)	FASA	557	588	591	1377
	FS	7878	7599	8811	8859
	IUT-FV	3838	3902	3832	3465
	FMSP	—	—	—	504
University of Maroua (UM)	IMIP(FMIP)	1425	2026	1340	995
	ISS(ENSPM)	2345	2355	2405	2778
	FS	2631	3741	2565	2803
University of Ngaoundere(UN)	FS	4189	4318	3939	4901
	ENSAI	910	1070	1153	1089
	IUT	632	720	718	716
	ESMV	250	334	468	394
	EGEM	534	636	747	795
	FMSB	—	—	—	87
	EGCIM	—	—	—	35
University of Yaounde 1 (UY1)	ENSP	1125	1007	1196	979
	FMSB	2128	1781	2061	2079
	FS	19576	22979	21934	24328
	IUT-BOIS	211	181	181	202

Cameroon's Ministry of Higher Education Statistical Year book 2015, 2016, 2017, 2018

COLTECH: College of Technology, FHS: Faculty of Health Sciences, FS: Faculty of Science, HITL: Higher Institute of Transport and Logistics, NAPHI: National Polythenic Higher Institute, FAMV: Faculty of Agriculture and Veterinary Medicine, FET: Faculty of Engineering, FGI: Faculté de Genie Industriel, ISH: Institut des Science Haliéutiques, IUT: Institut Universitaire de Technologie, FMSP: Faculté de Médecine et des Sciences Pharmaceutiques, FASA: Faculté d'Agronomie et des Sciences Agricoles, IUT-FV: Institut Universitaire de Technologie- Fotso Victor, IMIP: Institut des Mines et Industries Pétroliers, ENSPM: École Normale Supérieure Polytéchnique de Maroua, ENSAI: École Nationale Supérieure des Sciences Agro-Industrielles, ESMV: École des Sciences et de Médecine Vétérinaire, EGEM: École de Géologie et d'Exploitation Minière, FMBS: Faculté de Médecine et des Sciences Biomédicales, EGCIM: École de génie chimique et des Industries Minérales, ENSP: École Normale Supérieure Polytéchnique, IUT-BOIS: Institut Universitaire de Technologie-Bois

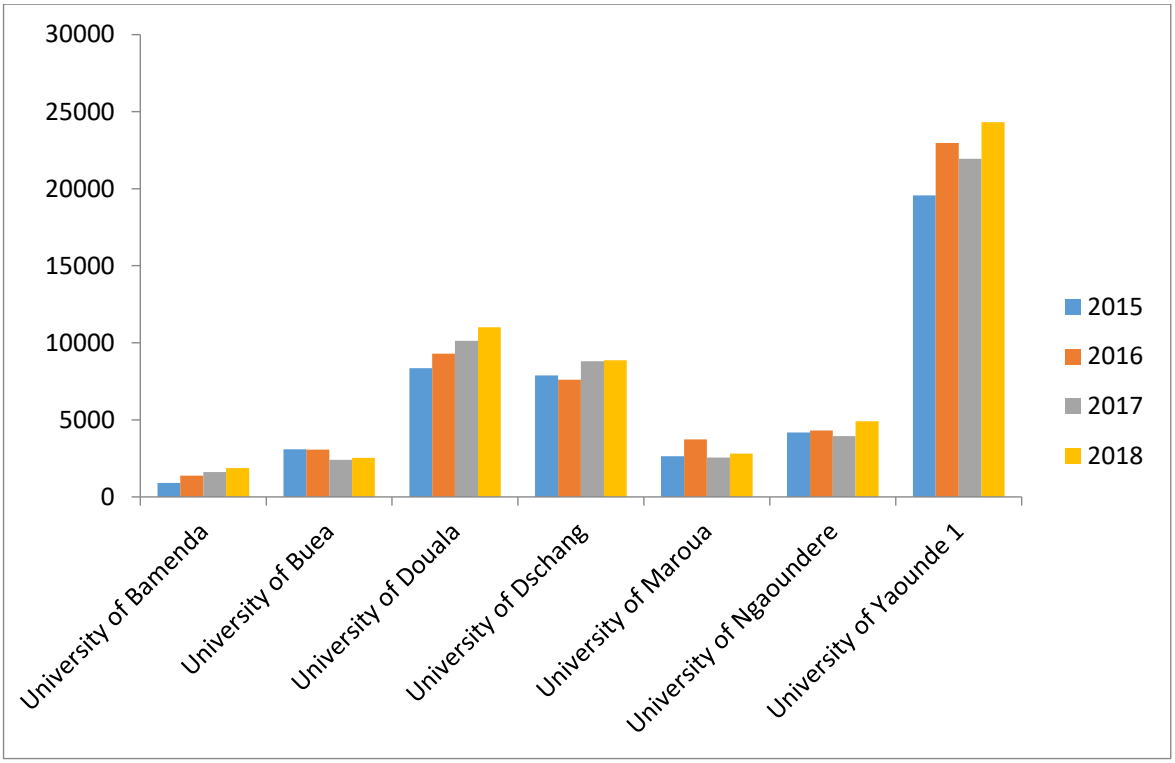

Figure 1. Evolution of Student enrolment in the Faculties of Science in seven State universities

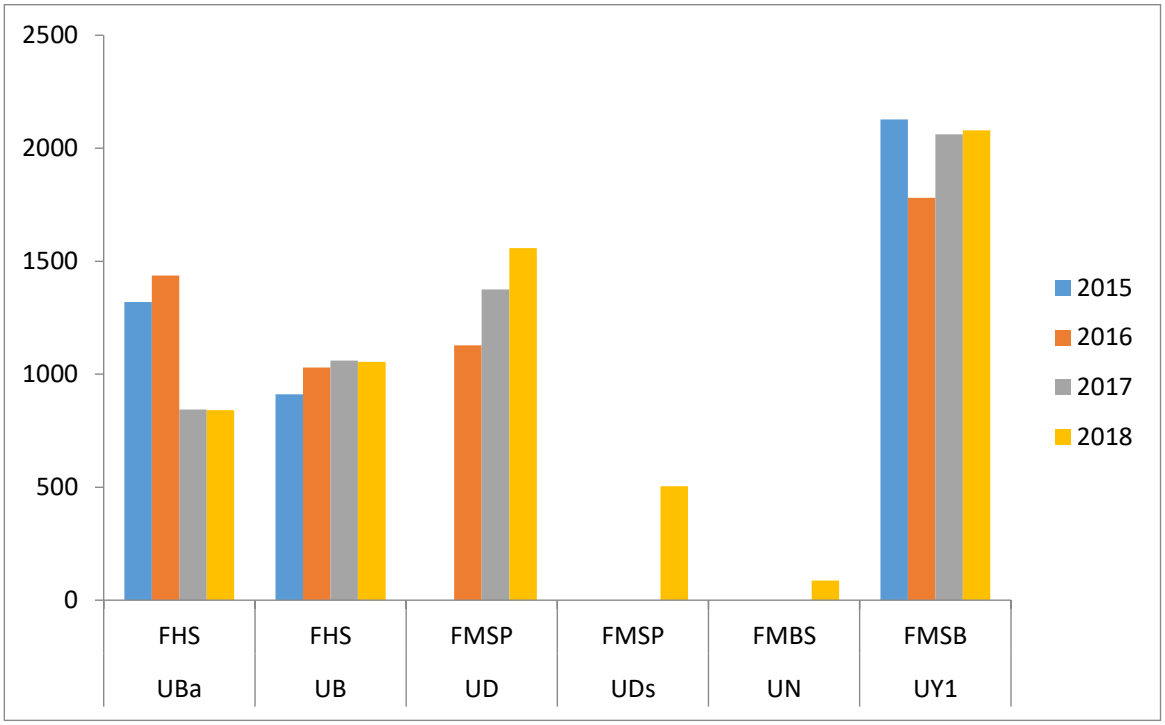

Figure 2. Evolution of Student enrolment in the Faculties of Health Sciences in six State universities

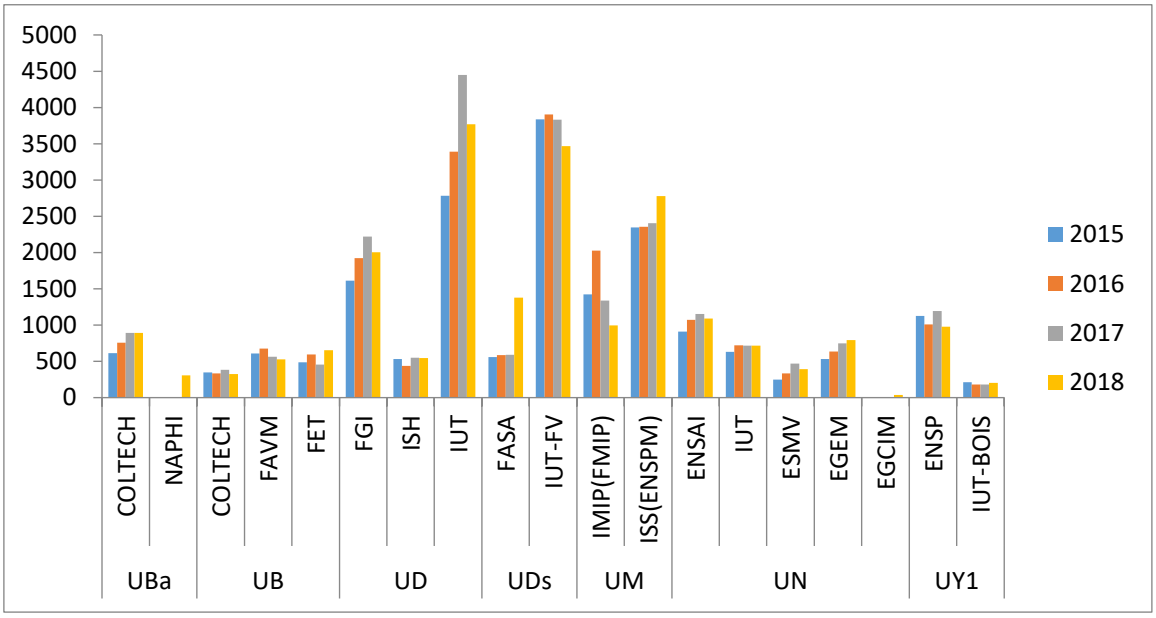

Figure 3. Evolution of Student enrolment in Technological disciplines (Agriculture, Engineering) in seven State universities

It is evident that STI in higher education plays a pivotal role in the socio-economic transformation of the country. Rapid growth of enrolment in STI will lead to poverty reduction and economic growth. However, Higher education enrolment in Cameroon remains very low in comparison to countries like Ethiopia, Nigeria, and Ghana. The fast growth of countries such as the Republic of Korea was simultaneously accompanied by a rapid growth in university enrolment. The recent fast pace of poverty reduction and economic growth in China has also been accompanied by a significant growth in university enrolment.

Human investment in STI in higher education in Cameroon

The importance of high-quality higher education in developing human capacity for economic growth and competitiveness in a knowledge-driven economy has prompted many African countries including Cameroon to prioritize it. For several decades, Cameroon has neglected and underfunded higher education, believing that it yielded lower social returns than other investments in the field, particularly primary and secondary education. A theoretical underpinning was that investments in higher education were regressive, reproducing existing social and economic inequalities (APLU, 2014). Prior to 2018, one of the challenges faced by universities in Cameroon was the shortage of lecturers inspite of the recruitment of 1000 university lecturers in 2010 by the Ministry of Higher Education to solve the problem of shortages of lecturers. To bridge this gap, in 2018 the recruitment of 2000 university lecturers was authorized by the Ministry of Higher Education in all State universities for a period of three years from 2019 to 2021. The recruitment of 1000 university lecturers was implemented iin 2019 and presently 500 university lecturers are in the process of recruitment for 2020 while 500 lecturers will be recruited in 2021. Other lecturers were also recruited in State universities in 2020 through numerical replacements of all those lecturers who had abandoned their duties, those who had died and those retired. In State universities in Cameroon, many lecturers within the STI fields are in the Sciences, followed by Agriculture and least in Engineering. This is shown in Table 4.

Table 4. Lecturers in STI fields in State Universities in Cameroon

Universities	Scientific and Technological Institutions	2015	2016	2017	2018
University of Bamenda	COLTECH	12	12	20	49
	FHS	12	12	16	15
	FS	37	37	42	73
	HITL	12	12	13	13
	NAPHI	—	—	—	11
University of Buea	COLTECH	06	05	05	07
	FAVM	12	13	13	23
	FET	36	41	41	11
	FHS	25	25	25	80
	FS	115	119	119	121
University of Douala	FGI	31	32	36	36
	FS	143	139	137	132
	ISH	32	31	38	35
	IUT	49	47	45	46
	FMSP	67	73	73	72
University of Dschang	FASA	88	92	71	80
	FS	—	—	162	155
	IUT-FV	88	92	71	189
	FMSP	—	—	—	17
University of Maroua	IMIP(FMIP)	30	30	30	56
	ISS(ENSPM)	84	84	84	85
	FS	72	72	72	72
		134	134	134	134
University of Ngaoundere	FS				
	ENSAI	37	37	37	70
	IUT	53	53	53	54
	ESMV	12	12	12	26
	EGEM	23	23	23	59
	FMBS	—	—	—	—
	EGCIM	—	—	—	—
University of Yaounde 1	ENSP	81	93	91	84
	FMSB	156	157	170	151
	FS	354	344	339	319
	IUT-BOIS	05	03	09	06

Source: Cameroon's Ministry of Higher Education Statistical Year book 2015, 2016, 2017, 2018

Infrastructural investments in STI in higher education

Readiness to support innovation and facilitate competitive business activities requires infrastructure such as basic telecommunication services, broadband Internet access, good transportation networks, water, reliable electricity supply, laboratory facilities, and tax systems that support private sector innovation. However, in many HEIs in Cameroon there is lack of broadband internet, the electricity supply is not constant, there is poor road network and insufficient laboratory facilities. Among the public universities, the University of Yaounde 1 and the University of Dschang have the highest number of laboratories while the University of Bamenda has the least. This is shown in Figure 4.

In recent years, both the private sector and the Government of Cameroon have made huge investments in the overall infrastructural development of educational institutions in Cameroon. Such developments include the establishment of new faculties within universities, the creation of new universities and other institutions of higher learning. All these are in a bid to respond to the growing domestic and international demand for quality graduates within the country, in particular, and the Central African sub-region as a whole. Despite these investments, the number of State universities is still insufficient though there is a proliferation in private institutions of higher learning.

Investment in the generation of human capital in areas of importance to national development is seen as essential to meeting development challenges and realizing opportunities. For example, as Cameroon depends on mining operations, and as such, institutions dedicated to training of mine managers and professionals have been created in HEIs. Also Agricultural-based institutes and health based institutions have been created to meet the need of the society. Despite these different institutions involved in training specialists, skilled manpower is required in all sectors of society. This makes generic training particularly important. For instance, engineers may be employed in a variety of sectors such as communication, education, energy, health,

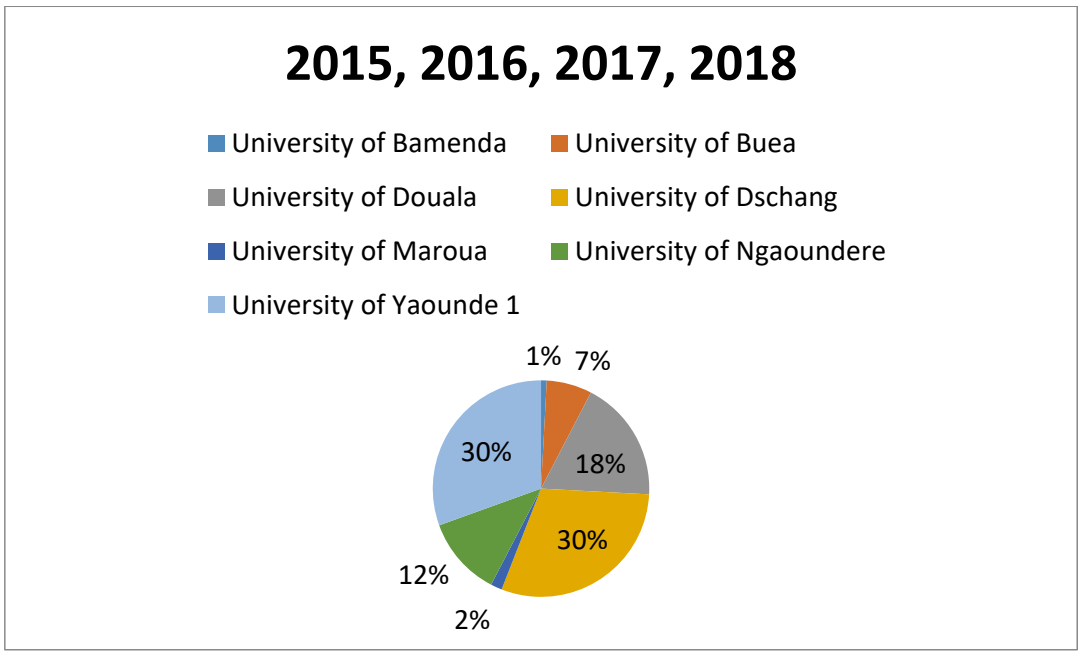

Figure 4. Laboratories in STI fields in seven State universities in Cameroon

sanitation and transport, among others.

Financial Investment in research in STI in Higher Education in Cameroon

In Cameroon, most universities rely heavily on Government subsidies for their budget. Apart from reduced State budgets given to universities, the Government eliminated bursaries and student welfare support and introduced registration fees in 1993 for all the universities (Njeuma *et al*., 1999). For universities, reduced Government spending on education presented a huge financial challenge. The universities could raise money from the private sector and industries but this has been difficult (Njeuma *et al*., 1999).

The lack of funding has prevented the universities from expanding their infrastructure to meet soaring enrolment rates. In addition, inadequate funding has impacted on the universities' ability to acquire good pedagogic equipment (Odhiambo, 2011). According to Njeuma *et al*. (1999), in order to ensure quality education students must have access to good pedagogic equipment and classroom space. The State budgetary mechanism exacerbated the falling quality of higher education in Cameroon. UNESCO (2003) highlights the imbalance in the allocation of the university budget, which is tilted towards administrative expenses to the detriment of teaching and research. Inadequate research and teaching budgets deter research or impede the quality of research carried out by universities (UNESCO, 2003; Materu, 2007).

The cut in budgetary support to universities and the lack of safety net for the students was reported to have a huge impact on the quality of learning outcomes of the students (Njeuma *et al*., 1999; Konings, 2004). The elimination of student bursaries designed to attract students to universities increased the university dropout and failure rates (Njeuma *et al*., 1999; UNESCO, 2003). In Cameroon, the population living below the poverty line in 2000 was estimated at 48% (CIA, 2014) and 39.9% in 2007 (World Bank, 2014), and, therefore, the lack of some form of support to students from poor and marginalized backgrounds could put an end to their educational career or reduce the quality of their learning, especially if they are not able to meet the demands and cost associated with learning (UNESCO, 2003). In contrast to State funding of higher education, Psacharopoulos (1991) asserted that charging fees provides an 'efficient selection mechanism' and only those who are willing to be successful would pay the fees. Furthermore, charging fees would introduce accountability and transparency both at institutional and student levels. In Cameroon's Higher Education, fees are charged for professional programmes in State universities whereas private universities do charge fees for all their programmes.

To increase schooling and offer alternate paths to general education and training, the Government of Cameroon is preparing new strategies for Technical and Vocational Education and Training (TVET) and higher education with the goal of increasing investments in both. Doing so would better align the education and training system to the labour market needs of a middle-income country. The Government's ambitious targets require some key adjustments especially in rationalizing public spending on education to boost efficiency, and improving service delivery by ensuring, among other aspects, that a greater percentage of the education budget is decentralized to support school-based management.

Table 6 shows the investment budget in eight State universities in Cameroon from 2015 to 2018. From 2015 to 2016, the investment budget for many universities reduced or remained the same except for the youngest State university, the University of Bamenda. By 2018, most of the investment budgets of the universities were reduced except for the University of Bamenda and the University of Maroua where there was an increase in investment budget. It should

be noted that the University of Maroua and the University of Bamenda are the youngest State universities created in 2008 and 2010, respectively. Figure 5 shows the differences in investment budget in eight State universities. In 2015, the highest investment budget was allocated to the University of Yaoundé 2 while the least was to the University of Maroua. In 2018, the highest investment budget was in the University of Maroua while the least was in the University of Ngaoundere.

The priorities of the 2019 budget of Cameroon

Table 7 gives an economic look on the 2019 budget allocations of some Cameroon's ministries which directly or indirectly relate with STI in Higher Education. It suggests that the national

Table 6. Investment Budget in State Universities in Cameroon (In Millions CFA)

Universities	2015	2016	2017	2018
University of Bamenda	2292	3511	3511	4292
University of Buea	1445	1036	1036	905
University of Douala	1938	1938	1938	1948
University of Dschang	1445	1036	1036	1225
University of Maroua	1292	1171	2542	5351
University of Ngaoundere	2312	560	560	728
University of Yaounde 1	2213	2213	2213	1843
University of Yaounde 2	4235	4235	4235	2716

Source: Cameroon's Ministry of Higher Education Statistical Year book 2015, 2016, 2017, 2018

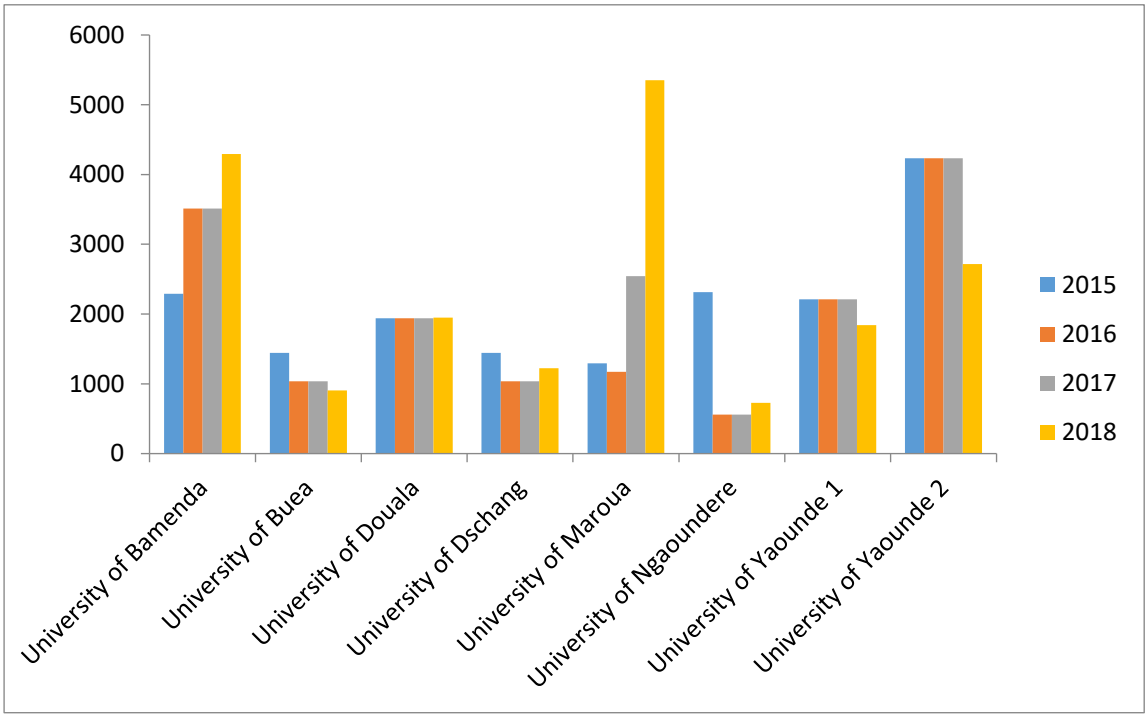

Figure 5. Differences in Investment Budget in eight State Universities in Cameroon

policy priority of the Government is not job creation. It includes expenditure lines related to human capital (primary education, secondary education and public health), debt service (domestic and external debt service), public works, government common expenses, grants and contributions to organizations and public institutions, defense spending and pensions. It is a rational choice to prioritize the investments in human capital and road construction and maintenance (public works) but not necessarily at the expense of the other expenditures. It is well known that human capital and public works have a significant positive effect on the GDP over a relatively long term. The investment in human capital in Cameroon is not targeted at both promoting entrepreneurial education (programs that teach people how to start businesses and thus creating jobs) as well as increasing significantly the number of STI graduates. Yet entrepreneurial education and STI skills are needed to catalyze Cameroon economic transformation through improved productivity (House of Commons Committee of Public Accounts, 2018).

Human capital which includes health and STI-education contributes to approximately two-thirds of the GDP of nations (Nkafu Policy Institute, 2018). Arguably, the budget allocation for health and education should be amongst the top five budget allocation of Cameroon. Currently it is ranked #10 for health and #3 for secondary education (it is #8 for primary education and #19 for higher education). As regards research and innovation which is another component of human capital, Cameroon's 2019 budget allocation is about 12 billion FCFA (i.e., 1 billion/month), or 0.25% of the annual budget. This is less than 0.1% of Cameroon's GDP (around $35 billion (CIA World Factbook, 2018) and is small when compared to the research budget (as a percentage of the GDP) of emerging economies like South Africa, i.e., 0.8% of the GDP (Government of South Africa, 2017).

Investment in Research and Development in Cameroon's STI

In Cameroon, like in most African countries, research is relegated to the background with no substantial budget allocated to it. It is common place to find research and innovative results lingering in the drawers or at their prototype state because funding is not readily available. The country's Ministry in charge of research for example, was allocated only a paltry of FCFA 10.3 billion in 2018 with little over FCFA 3 billion devoted to investment and research activities.

In 2015 for example, the Institute of Agricultural Research, IRAD was allocated FCFA 6.5 billion for research activities out of a total budget of FCFA 12.2 billion required during that year. As one researcher noted, good research results attract funding bodies on their own. Other researchers hold the view that it is better to fund their research at the initial stage for clarity purposes. Apart from the Government assistance to researchers through JERSIC, other funding bodies like the African Development Bank, World Bank and bilateral partners finance research initiatives in Cameroon. In 2015, the Ministry of Scientific Research and Innovation and Cameroon's Employers Syndicate (GICAM) agreed to work hand-in-hand so that research and innovative projects could be financed but the impact of that accord is yet to be felt. However, higher education and GICAM organize yearly innovation competition during university games and select and award prizes to the top three innovators from schools and faculties in Higher Education Institutions. Also, a Cameroonian business magnet, P.K. Fokam launched an award for Science and Technology in 2016 to promote applied research in Africa. However, the impact of these funding initiatives which for now are still inadequate is difficult to evaluate in terms of the contribution of research and innovation to the economy. The domain of technological innovation is notwithstanding promising with many youths making strides in development of apps.

Table 7. Budget of Cameroon's Ministries Concerned with STI in 2019 - Allocation (in million FCFA)

Ministries	2018	2019	DF	Weight 2019	Rank 2019	Rank
Higher Education	61401	55952	-5449	0.91	1.15	19
Scientific Research and Innovation	10300	11916	1616	1.16	0.25	38
Mines, Industry and Technological development	10409	11255	846	1.08	0.23	39
Public Health	175240	207943	32703	1.19	4.29	10
Agriculture and Rural Development	86613	84980	-1633	0.98	1.75	15
Livestock, Fisheries and Animal Industries	35100	32343	-2757	0.92	0.67	25
Posts and Telecommunications	46845	48351	1506	1.03	1.00	22
Employment and Vocational Training	20723	20587	-136	0.99	0.42	29
Forests and Wildlife	18591	19179	588	1.03	0.40	30
Environment, Nature Protection and Sustainable Development	8042	8009	-33	1.00	0.17	48

Source: Government of Cameroon, 2019: Bill No. 1041/PJL/AN on the Finance Act of the Republic of Cameroon for the 2019 financial year. Yaoundé: National Assembly

In Cameroon's 2020 finance bill, the budget allocated to the Ministry of Higher Education is XAF65.2 billion. In this bill, the ministry's operating budget has increased by XAF13.4 billion to XAF50.7 billion while its investment budget decreased by more than XAF10.2 billion. The reasons for this budgeting are still unknown but the presentation shows a real desire for change in higher education in the country. For university research, the budget is XAF11.6 billion and the stated objective is to increase the exploitation of research results on the priority development sectors of the Growth and Employment Strategy Paper within no more than two years. However, the budget does not indicate whether the university research budget will be allocated exclusively to public higher education or whether it will be extended to the private sector. Since 2009, the President of the Republic, through the Ministry of Higher Education gives research modernization allowances to lecturers in State universities in trimesters to carry out research.

The integration of graduates from traditional higher education faculties has also been taken into account in the budget. An allocation of XAF8.1 billion is earmarked for it. With scientific and technological fields poorly equipped and literary studies disconnected from reality, the achievement of this objective must be monitored. Finally, XAF7.4 billion will

be spent to increase the number of students in technological and vocational courses.

Professionalism in Cameroon's Higher Education

The primary goals of the 1993 university reforms were to: "Make university programmes more varied, professional, adapted and responsive to the needs of the job market by providing more programmes that will enable graduates to find jobs in the private sector as well as create self-employment". While some State universities have made strides in the provision of professional education (University of Douala with its Institut Universitaire De Technologie, University of Dschang with its School of Agronomy, University of Bamenda with the College of Technology, just to name a few), this form of education is mainly seen at private universities within the country. The success rate of professional programmes has been formidable; more than 85 percent of graduates getting work within the first year of graduation versus graduates of non-professional programmes who find it difficult securing paid jobs after completing their studies. The majority of the programmes of most State universities have few links to the needs of the labour market and, according to the World Bank Human Development Network report, the private sector is minimally involved in the design of university programs and the curriculum contents in Cameroon. The report states that the education system of the country is rooted in the traditional Francophone African model, tilting towards the production of civil servants. It is no longer in sync with the needs of the economy in this era of neither «shrinking public services nor international best practices». Hence, there is a call for a constructive reformation which involves all stakeholders.

Many State universities, compared to their private counterparts, are under-equipped in terms of classroom infrastructure and modern libraries. The student-lecturer ratio is highly skewed to the disadvantage of the students. Lecture halls are overcrowded with as many as 1000 students scrambling for as few as 700 seats. The implication is that the lack of one-to-one encounters result in unsolved study-related problems. Additionally, unlike their private counterparts, State universities have limited internet connectivity, making research and access to useful online material difficult. In an information age where decisions are made in real time and based on analysis of life streaming data, the one thing an institution of higher learning cannot afford to be lacking is uninterrupted internet connectivity.

Given all of these public university shortcomings, the less-than-perfect private sector has been able to fill the gap in the development of the relevant human capital with highly sought skills both within and out of Cameroon. This is a clarion call for action on the part of the State to make the necessary reforms. Improving the quality of education in Cameroon will go a long way to set not just the country's standard but the standard for other nations of the region, and the needed response to the needs of both government and private enterprises. Actions such as, but not limited to the following, are necessary:

– Professionalize all State university programmes not only in name but course contents.
– Liaise with the private sector; formulate and shape course content for different programmes with consideration to areas of interest.
– Establish partnerships with reputable universities, both within Africa and out of Africa, and promote the development of exchange visits by lecturers. This will help improve teaching methods.
– Establish a Public-Private partnership whereby students will be required to undergo internships in private companies. Students will gain specific job skills that are directly transferable to paid employment upon

graduation.

– Promote the April 2001 National Assembly law which called on private enterprises and public organs to work together to provide coordinated training opportunities for students beyond the secondary school level of education.
– Finally, in the words of Professor Michel Tchotsoua during a symposium on industrialization in Cameroon organized by the Foretia foundation (held on April 21, 2016), the strategy of education has to be "Formation Opérationnelle", Stakeholders take into consideration current projects going on within the economy, as well as long term labour needs, before forming modules of university courses. By doing this, in the long term, there will not be any need to hire foreign experts to execute or maintain projects in Cameroon. These jobs will be done more cost effectively by Cameroonians. It is only when the Government considers and acts on these suggestions and those from studies of other international bodies that public sector education will begin to be representative of what it is intended to be the human capital needs of the job market within and beyond Cameroon.

Technology in Higher Education in Cameroon

Analysis of the technological structure of industrial production reveals that Cameroon's manufacturing industry is still heavily biased towards traditional low-value-added, low-wage activities, given its inability to adapt over time its production structure to higher-value-added activities involving more complex technologies (medium-and high-technology products). Devaluation of the CFA franc in 1994 did allow some gains in exports but this mainly benefited enterprises which were already exporting and sectors that were generally more prone to be involved in trade.

If the Cameroonian economy is to become an emerging economy by 2035, it must move from an economy of consumption to an economy that transforms raw material as well as ideas into refined products. This may only be possible if knowledge gained through research (either public or private) is shared with industry. For this to happen, enough sensitization must be done and sufficient information needs to be imparted on the issue. Stakeholders' awareness must be raised to the fact that productivity may only be boosted through technology transfer. These stakeholders include researchers (students and lecturers) but also industry leaders, promoters of small and medium size enterprises, decision makers and the general public.

There are various formal and informal ways through which technology may be transferred and the process certainly results in significant benefits for any economy. Whether the technology has resulted from public research in universities and research centres or from private research in companies' Research and Development departments, there are several ways in which it may be transferred to industry. These include both formal and informal ways. Formal technology transfer includes training and education by universities, the hiring of graduates and university researchers, collaborative research between universities and companies' research and development departments, technology services and consultancy from academia for the benefit of industry, patenting, licensing and any other form of commercialization of universities' protected intellectual property as well as spin-offs run by universities themselves. Informal technology transfer includes any informal exchange, that is, any exchange which is not subject to a contract but most often, researchers' publications (in scientific journals and other reviews) and paper presentations in conferences, seminars and colloquia.

For technology transfer to take place and deliver the expected benefits there must be a clear policy. Designing and adopting policy is the role of Government through policy documents, laws, regulations and any other

instruments. Political will is an essential but not the unique requirement for technology transfer; universities must be willing to disseminate their knowledge and industry must be ready to absorb that knowledge in the many existing ways and put it into practice. Then, universities and industry must not be stopped by a lack of clear Government policy or appropriate instruments that promote technology transfer as they can yield huge benefits in the process whether or not a clear national legal framework exists as there is no law that prohibits it. Instead there are several pieces of legislation that provide for technology transfer. In fact, people and passion are taken to be the main ingredients for technology transfer success. Besides, knowledge may only be generated through sound and reliable research. This means that universities must put mechanisms in place that promote research best practices thereby creating a conducive environment for innovation. If universities fail to innovate, then, there will be no knowledge to share. Well skilled personnel in management, accountancy, economics, intellectual property and basic contract law must be hired to perform these duties. Universities must therefore adopt sound strategies to manage research and research results determining the best ways to protect and commercialize them.

Technology transfer offers many benefits to the various stakeholders. For industry, and mainly local small and medium size enterprises, knowledge from universities may help in reducing production costs and increase revenue with new and more efficient operating methods. Technology transfer helps companies increase their technical capabilities and access management and marketing expertise as well as new sources of capital. Use of transferred technology warrants access to larger markets whether local or international and, consequently, to new distribution channels. All of this helps companies acquire and retain competitive advantage for their growth and that of the country. For universities, technology transfer helps in strengthening and establishing research conventions with industry in order to fund research and harness revenue to finance other activities within the university. Patenting, licensing and other commercialization of generated intellectual property (knowledge) helps universities establish their leading role or signaling their expertise in any given field. Technology transfer in the form of graduates and research staff recruitment in companies benefits universities in their graduates' employability skills as well as giving teaching staff more practical knowledge and experience that will result in better programme delivery and professionalization. Technology transfer allows universities to disseminate and impart knowledge generated more effectively which is their primary duty. The main benefit being diversification of sources of income and extra income funding. For Government, technology transfer helps in increasing productivity and competitiveness at both national and international levels and, hence, boosts economic growth. For technology transfer to occur in the Cameroonian context there must be a conducive environment. This is what is lacking in most developing countries. This notwithstanding, disparate and various policy and legal instruments, though not specifically devoted to technology transfer, exist that may help foster it. Besides, there are many other challenges that may hinder the process.

Cameroon lacks a clear policy on technology transfer or at least effective implementation mechanisms of some of the measures that may be used to carry it out. Some of these measures are contained in various laws including the 2002 Investment Charter, the 2013 Law on Incentives for Investment and Public Private Partnerships law and regulations. Specifically, there have been some attempts to make technology transfer formal and regular between universities and industries in Cameroon. One of such attempts is evidenced by a Charter that was signed in 2011 by the Ministry of Higher Education and Groupement Interpatronal du Cameroun (GICAM), one of the most influential

Cameroonian industry groupings. Its full implementation is still hindered by the fact that incentives that may promote technology transfer between university and industry have not been well developed. There, however, exist some conventions between public universities and private institutes of higher education and industry to foster technology transfer through collaborative curricula development to ensure degree holders' employability as well as organising internships and field visits to companies. Moreover, specific policy and legal instruments on technology transfer need to be adopted in Cameroon's Higher Education (Mekongo, 2017). Startups in Silicon Mountain face a lot of difficulties which they think can partly be solved by the Government. Approximately 90% of its startups can not survive because of the taxation system and other laws in the country. If the laws recognized the startup status and its inability to raise funds during its early stage, things would have been lighter on startups. Also, internet connectivity has retarded startup growth. This is the most basic, necessary and primary tool techies use to build their products. There will be no tech product without the internet.

However, Cameroon has launched programmes and initiatives to promote science, technology and innovation which benefitted universities. Cameroon's Vision 2035 embraces science and technology as 'key to global competitiveness' and turning the country into one of the top 20 economies in the world. In 2018, enrolment in agriculture, forestry, fisheries and veterinary programs increased in Cameroon while enrolment in health and welfare programs fell in Cameroon's Higher Education. Despite the existence of engineering institutions in Cameroon and sub-Saharan Africa that have been graduating hundreds of engineers annually, there has been little progress in the acquisition and effective utilization of technology for industrial development. Most industries in the region still depend heavily on imported technology and equipment, and on imported technical expertise for maintenance. One of the main reasons for this problem may be the type of training given by local institutions, most of which are more or less carbon copies of foreign institutions.

Assessment of Cameroon's Global Innovation Profile

According to the Competitive Industrial Performance (CIP) index established by UNIDO, Cameroon ranks at the bottom end of the scale, along with other low-income Sub-Saharan countries. This ranking indicates that CIP of low-income Sub-Saharan economies (Cameroon, Malawi, Uganda, Central African Republic, Madagascar, Zambia, Ghana, Tanzania, Zimbabwe and Senegal) declined between 1985 and 1998 as these economies failed to orient their production and export structures towards higher-value-added and more technology-intensive products (Schwab, 2013). The Global Innovation Index (GII) captures the multidimensional facets of innovation by measuring the innovation capacity of countries across the world and provides tools to tailor policies for promoting long-term output growth, improved productivity, and job growth (WIPO, 2015). The assessment of Cameroon's STI capacity is summarized in Table 11. Overall, Cameroon's STI-driven capacity development profile is poor. The WIPO (2018) report indicated that Cameroon was ranked 118 out of 138, and 111 out of 126 countries in the 2016 and 2018 global innovation index rankings, respectively.

Another useful index in assessing STI is the Networked Readiness Index (NRI), which measures countries' capacity to leverage information and communications technology (ICT) for increased competitiveness and wellbeing. The NRI has been initiated for the Global Information Technology Report (Dutta *et al*., 2015) and is designed to assess the state of networked readiness of some selected economies. The NRI framework is based on six principles (Deloitte, 2012):

(i) a high-quality regulatory and business environment is critical in order to fully leverage ICTs and generate impact; (ii) ICT readiness is a pre-condition to generating impact; (iii) fully leveraging ICTs requires a society-wide effort: the government, the business sector, and the population at large each has a critical role to play; (iv) ICT use should not be an end in itself, the impact that ICTs actually have on the economy and society is what ultimately matters; (v) the set of drivers interacts, coevolves, and reinforces each other to form a virtuous cycle; and (vi) the networked readiness framework should provide clear policy guidance. The NRI framework defines a composite indicator made up of four main categories (Deloitte, 2012): environment, readiness, usage, and impact. The environment is related to political and regulatory environment, as well as the business and innovation environment. The readiness includes the infrastructure, the affordability, and the skills. As for the usage, there are indicators for individual usage, business usage and Government usage. Finally, the impact highlights the economic and social aspects. According to the 2015 Global Information Technology Report the rankings of the overall NRI 2015 showed that advanced economies are better than developing ones at leveraging ICTs. The NRI for Cameroon in 2015 was 126 out of 141 countries and in 2016 it was 124 out of 139 countries (Table 8).

Innovation Spaces for Higher Education in Cameroon

There are a number of innovation spaces active around the country which higher education students and graduates utilize and these include: Centre for Entrepreneurship, Research and Innovation (CERI) hosted by Catholic University Institute of Buea, ActivSpaces found in Buea and Douala, ZixtechHub found in Limbe, Agro-Hub found in Buea and Silicon Mountain found in Buea. The primary focus of these innovation spaces are on supporting pre-Incubation, Incubation and Acceleration.

Table 8. Cameroon's Innovation Capacity Profile

Indicator	Year	Innovation Ranking	Source of Information
Ranking: Global Innovation Index (GII)	2018 ranking (out of 126) 2017 ranking (out of 127) 2016 ranking (out of 138) 2015 ranking (out of 141)	111th 117th 118th 110th	ACBF report, 2017, 2018, Annex 1 GII Rankings 2018
Network Readiness Index Ranking	2016 ranking (out of 139) 2015 ranking (out of 141) 2014 ranking (out of 141)	124th 126th 131th	ACBF report 2017, Annex 2
Gross expenditure on research and development in Africa as a percentage of GDP and per capita	NE	NE	WIPO, 2018
GERD contribution	NE	NE	WIPO, 2018
Research and Development	2018	117th	WIPO, 2018

NE=

The CUIB Centre for Entrepreneurship, Research and Innovation (CERI) was established in June 2011 as the business and research arm of the Catholic University Institute of Buea. The CERI focuses on Science, Technology, Engineering and Mathematics disciplines (STEM). The aim is that over time CERI will evolve into a Research Park, and supports training and development of entrepreneurs, leaders and innovators within the STEM disciplines. Further CERI is focused on fostering innovation and economic competitiveness through collaboration among national and international stakeholders from the education and research, public and private sectors.

ActivSpaces has established two co-working spaces in Douala and Buea in Cameroon, focused on supporting web and mobile developers, designers, researchers and entrepreneurs. There are a number of business models being applied, including a monthly fee for co-working space offered to freelancers and entrepreneurs, free co-working space for innovative tech start-ups, and revenue share for start-ups accepted in their six-month Activation Bootcamp (which started in January 2015). ActivSpaces is a member of the AfriLabs Network. MTN partnered with Microsoft and ActivSpaces to launch a competition from July - October 2015 to identify software developers who can support local content development. The winners received a six-month incubation period with ActivSpaces among other items. ActivSpaces has organised a number of events focused on Java and training for start-ups.

Agro-Hub was founded in 2009 based on a recognized gap of marketing and distribution infrastructure for agriculture. During 2015, it focused on inbound marketing for agriculture in Cameroon to provide content to persons wishing to buy agricultural products or invest in agriculture in Cameroon. It works with small scale farmers and buyers to support resilient and sustainable supply chains. ZIXTECH Hub was set up in 2018 as a division within Zixtech Organisation in Limbe. ZixtechHub provides co-working space and incubation services, business support as well as a 6-month incubation program. It became a member of AfriLabs in September 2018.

Another innovation space is the Silicon Mountain found in Buea. This is a privately-run center for high technology, innovation and social media that has produced groundbreaking innovations. The aim of Silicon Mountain is to assist students connect to the cyberspace to tap the latest knowledge and enhance their studies and assure success, as well as drive the country's digital economy. The Silicon Mountain is serving as home for techies, designers, tech enthusiasts and techpreneurs from around Cameroon who are comfortable settling in Buea. Some interviewees suggest that the Silicon Mountain should be supported and sustained by the Government with the budget for "densification" of research and development and promotion of innovation.

Silicon River is another innovation space which the Government of Cameroon plans to open in Yaounde in 2030. This is in their effort in scaling up the digital economy and spurring innovations. "Every African country needs to have its own African Silicon Valley. Cameroon wants to build a silicon nation, that is to say put in together all the efforts to be number one in Africa in terms of technology and innovation," said the Head of Department of Technological Innovations at the Ministry of Scientific Research and Innovation. The new tech hub will be modeled after the U.S. Silicon Valley and will take up a sizeable portion of the country's budget, officials said. An inter-ministerial committee has been set up to spearhead the initiative. The Government says Cameroon Silicon River will be a platform for research and innovation that provides infrastructure and support for young, creative,

and entrepreneurial software developers and other technologists.

It should be noted that at individual university level there are ground breaking innovations taking place. A student in the National Higher Polytechnic Institute (NAHPI) in the University of Bamenda has constructed a functional ATM machine while another student in the Faculty of Engineering (FET) in the University of Buea has constructed a 3 D printer from waste electronic components. The President of the Republic of Cameroon has been encouraging university students with ground breaking innovations. There is a yearly presidential prize for innovation through the Ministry of Higher Education and the Ministry of Mines, Industry and Technological Development. Also, the President of the Republic through the Ministry of Higher Education has provided 500,000 laptops to university students in both public and private Higher Education Institutions to boost innovation.

Supporting bodies for STI in Higher Education in Cameroon

Many Governmental and non-profit organizations have been established to enhance and promote the STI in Higher Education in Cameroon. Some of these are shown in Table 9.

Table 9. Supporting bodies for STI in Higher Education in Cameroon

Name of Supporting bodies	Key STI Activities
Ministry of Mines, Industries and Technological Development	- Carry out technological development in conjunction with the Ministry of Scientific Research and Innovation. - Promote and defend a quality label for products meant for the local market and for export in conjunction with the administration concerned. - Facilitate liaison between government and the World Intellectual Property Organization (WIPO), the African Intellectual Property Organization (OAPI), as well as the United Nations Industrial Development Organization (UNIDO) in conjunction with the Ministry of External Relations.
Ministry of Scientific Research and Innovation	- Responsible for the development and implementation of scientific research and innovation policies. - Intensify the transfer function of research results to the economic sectors, promoting the culture of innovation and creating new mechanisms to finance the national research and innovation system. - Organize yearly editions of excellence days of Scientific Research and Innovation.
MIPROMALO (Local Materials Promotion Authority)	- It is a State research and innovation structure playing a leading role in the production of scientific knowledge and technological innovations on local materials to meet the demands of the Cameroonian people in search of a better life as well as our more efficient and competitive industry.
African Institutes for Mathematical Sciences (AIMS), Cameroon	- It is a pan-African network of centres of excellence for postgraduate education, research and outreach in mathematical sciences. - Its mission is to enable Africa's brightest students to flourish as independent thinkers, problem solvers and innovators capable of propelling Africa's future scientific, educational and economic self-sufficiency.

Denis and Lenora Foundation	- Was established to catalyze Africa's economic transformation by focusing on social entrepreneurship, science and technology, innovation, public health and progressive policies that create economic opportunities for all. - The activities coalesce around the following core programs: The Health Initiative, the Small Business and Entrepreneurship, the Sustainable Development Program and the promotion of Sciences, Technology, Engineering and Mathematics (STEM).
Higher Institute for Growth in Health Research for Women (HIGHER Women)	- Created to empower Cameroonian women scientists who have a motivation and inspiration for health research. - They provides the country's early-career women scientists with the mentoring, skills development and career planning they need to establish an enduring presence in the field of health research.
Organization of Women in Science for the Developing World, OWSD-Cameroon	- Seeks to empower female scientists and promotes their access to science and technology and increase their participation in decision-making process for the development of their countries and the international scientific community. - The activities include: setting up STEM clubs in secondary schools; collecting data on gender statistics and participation of women in STEM research; teaching and governance; advocating for policies for gender mainstreaming in science and women's equal access to educational training and resources; and providing training and resources for women scientists, for career development and work-life balance.
Cameroon Academy of Sciences (CAS)	- The main goal of the Academy is to promote the progress of science, technology, and innovation for the economic, social, and cultural development of Cameroon.
Cameroon Academy of Young Scientists (CAYS)	- The main goal of the Academy is to promote the progress of science, technology, and innovation for the economic, social, and cultural development of Cameroon.

Gender Gaps in Science, Technology and Innovations in Higher Education

Despite the importance placed by UNESCO on gender equality in all fields of education especially in Science, Technology, Engineering and Mathematics (STEM) many females especially in Higher Education in Cameroon are still absent from these fields. From the Population Reference Bureau (2016), women represent a greater percentage (51) of the Cameroon population but are underrepresented in the fields of STIs. This is shown in Table 10.

Table 10. Statistics on gender gaps in student enrolment in STI related fields in Cameroon State Universities

Name of university	Institutions	Female	Male	Total
University of Bamenda	College of Technology (COLTECH)	375	454	829
	Faculty of Science (FS)	719	1160	1879
	National Higher Polytechnic Institute (NAPI)	62	243	305
University of Buea	College of Technology (COLTECH)	45	282	327
	Faculty of science (FS)	1123	1401	2524
	Faculty of Engineering and Technology (FET)	115	539	654
University of Douala	Faculte De Genie Industriel (FGI)	267	1738	2005
	Faculte Des Sciences (FS)	4058	6950	11008
	Institut Universitaire Des Technologies (IUT)	1357	2410	3767
University of Dschang	Faculte Des Sciences (FS)	3869	4990	8859
	Institut Universitaire Des Technologies Fotso-Victor	1026	2439	3465
University of Maroua	Ecole Nationale Superieure Polytechnique	916	1862	2778
	De Maroua (ENSPM)	890	1913	2803
	Faculte Des Sciences (FS)	756	4145	4901
University of Ngaoundere	Faculte Des Sciences (FS)	137	579	716
	Institut Universitaire Des Technologies (IUT)	186	793	979
University of Yaounde 1	Ecole Nationale Superieure Polytechnique (ENSP)	9301	15027	24328
	Faculte Des Sciences (FS)	32	170	202
	Institut Universitaire De Technologie Bois (IUT)			
Total		25,234	47,095	72,329

Source: Ministry of Higher Education 2018 Annual statistics (July 2020)

The situation of under-representation of females is more profound in science and technological fields. The highest number of student enrolment by gender in the Faculties of Science, Agriculture and Engineering field in Cameroon state universities is dominated by males. The trend in evolution is shown in Figure 6 and 7. Even though in some regions of Cameroon females out number males in secondary schools, this numerical strength for females does not translate into their numerical strength at the tertiary level. Science subjects are not

considered to be among the favourite subjects of lower secondary school students. Francis *et al*. (2003), for example, reported that 14-year-old students had negative attitudes towards science subjects and positive attitudes to their native language. The situation is worse at the tertiary level, where most female students are found in fields of study traditionally perceived as "female territory". These disciplines include among others, teaching, nursing and social work. In most trade training institutions, female students are found in secretarial, dress making, cookery, marketing and accounting programs; while the males dominate in mechanical and crafts areas. The gender gap is more in engineering and technology fields. At the Higher Education level, females appear to lose interest in science, technology and innovation, and continue to drop out of STI related disciplines. With Cameroon intending to have an emerging economy by 2035, which requires a scientific and technological foundation, this may not be feasible if half of the population (female) continue to pursue careers only in the social and service sectors. This has been a concern in Cameroon's Public Policy Framing where some initiatives have been undertaken to encourage and motivate more girls to science related subjects. For example, the Ministry of Scientific Research and Innovations, initiated an innovation prize in 2018 during the 6th edition of the Excellence week for scientific research and innovations. This project "Youth's Innovation and Research", was aimed at motivating the youths especially the females into science oriented professions. Also, the Perl Foundation in August 2015 launched a one-month program to train women and girls on introduction into computer science using the python programming language. The course was massively attended by many women and girls in the city of Bamenda in the North West Region of Cameroon.

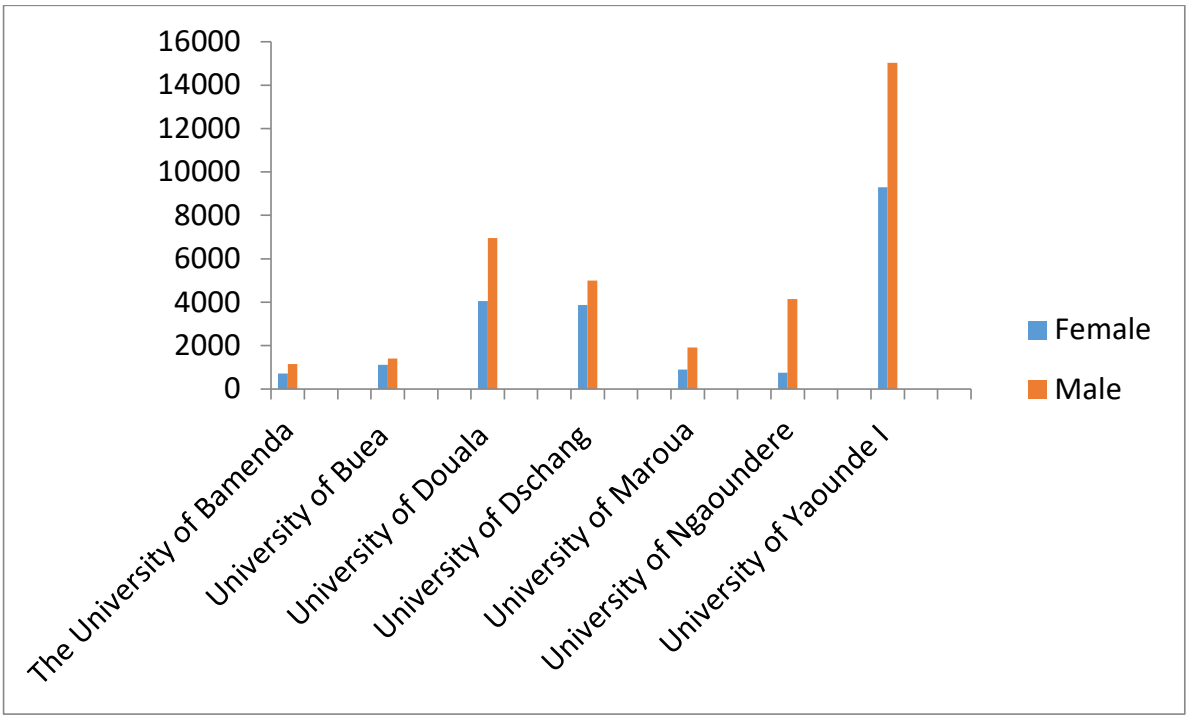

Figure 6. Statistics on gender gaps in student enrolment in the Faculties of Science in Cameroon State Universities

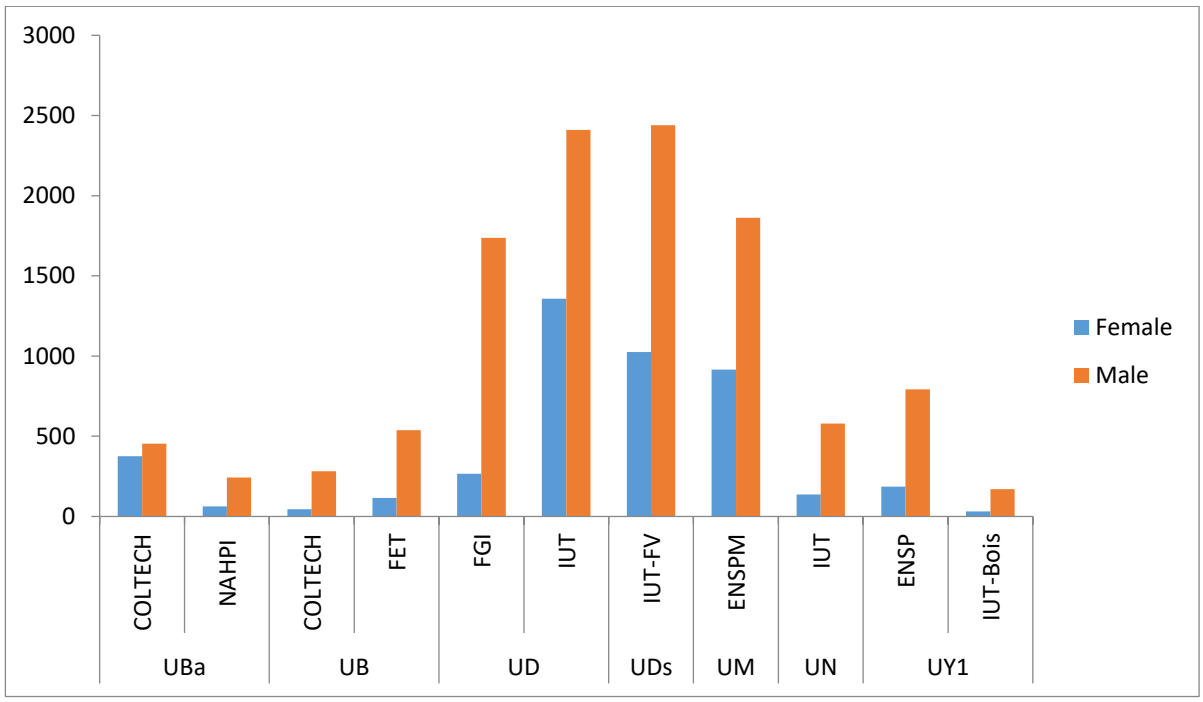

Figure 7. Statistics on gender gaps in student enrolment in some Agriculture and Engineering fields in Cameroon State Universities

Globally, there is an indication that there is gender imbalance of STEM students in Higher Education. According to UNESCO's report, female students represent 35% in STEM related specialisation in Higher Education. It goes further to state that the highest gap is seen in Information Management and Technology where only 3% of female students register in the field, 20% are software developers, 7.4% as construction managers and 24.8% are in technological agriculture. These statistics portray that these fields are male dominated because of one reason or the other. According to UNESCO Institute for Statistics (2015) only 10% of female students were enrolled in STI related fields in the tertiary level in Cameroon. The gender gap in Cameroon is felt more in engineering and technology fields, as shown in the case of University of Buea (Table 11).

Table 11. Statistics showing gender gap on student enrolment in Technology related fields at the Faculty of Engineering and Technology in University of Buea

Programmes	Female	Male	Total
Network Engineering	46	168	214
Power Systems	55	325	380
Software Engineering	04	20	24
Telecommunication and Network	10	26	36
Total	115	539	654

Ministry of Higher Education 2018 Annual statistics (July 2020)

Looking at technology in Higher Education especially with reference to Information Communication and Technology (ICT), Castaño *et al*. (2011) explained that the gender digital divide is a gap between men and women in the intensity of the use of computer and internet connection as well as in the participation in the basic uses of the internet. They indicate that this kind of segregation could be measured through equality and ICT indicators. In the Cameroon context very few female students are enrolled in Computer Sciences.

Sikora (2014) explored gender patterns in the participation in school science subjects and in adolescent career preferences. In secondary schools, of the students drawn to science careers, boys are four times more likely than girls to be attracted to occupations related to physical science subjects such as physics, mathematics, engineering and computing, while occupations related to life science subjects appeal to twice as many girls as boys. González *et al*. (2017) indicate that the relationship between women and technologies has historically been reduced to an image of phobia towards technology, which defames women as being against the use of technologies. These differences stem from diverse factors. Anker (2020) distinguishes between two forms of occupational segregation by gender: one horizontal and the other vertical. The first type of segregation refers to the role assignment imposed by the sex division of labour, which encourages women to join the healthcare, social, educational, administrative and commercial retail sectors (Rubio, 2008). The second type of segregation refers to the limitations that prevent women from moving upwards in the corporate hierarchy. This situation also presents itself in the Cameroon Higher Education sector especially in relation to the academic staff whereby out of 1175 teaching staff of faculties related to STI in some state universities, only 199 of them are women as seen on Table 12.

Challenges of gender participation in Higher Education

A lot of issues and factors have been identified to influence gender differentials and low participation in Science Technology and Innovation related fields worldwide and in Cameroon in particular. Literature from diverse sources has indicated that some of the causes of gender gaps and challenges in STI in Higher Education include gender stereotypes/ biases, cultural believes, sex-role (gender-role) socialisation, educational, religious, psychological, individual characteristics, lack of female mentors and models. According to Home (2002), factors responsible for the low participation of females in science, technology, engineering and mathematic fields are attitudes and expectations of parents, teachers and instructional strategies. Fielding (2014) reiterates that while the attraction, education and retention of women in science, engineering and technology are deemed vital to the socio-economic development of all countries, many women and girls in sub-Saharan Africa countries such as Cameroon are excluded from participating in science and technology activities by varied factors such as poverty, lack of education and aspects of legal, institutional, political, and cultural entrapments. Research findings have indicated that gender differentials in Higher Education are invariably rooted in inequalities nursed at the primary and secondary levels where the process of scientific interest is to be established to blossom at the university (Aguele and Uhumuavbi, 2003). These inequalities include traditional and religious beliefs, remoteness, poverty, child labour, social roles required for the different sexes, argument about biological build-up of women and birth order. Some other factors that have been identified by Ifeluni (1997) include lack of support from education policy makers, different socialization patterns for boys and girls at early stages of life, early marriages, and teachers' attitude towards girls.

Table 12. Statistics on gender gaps among the teaching staff in STI related fields in Cameroon State Universities

Name of university	Institutions	Female	Male	Total
University of Bamenda	College of Technology (COLTECH)	12	37	49
	Faculty of science (FS)	19	54	73
	National Higher Polytechnic Institute (NAPI)	02	09	11
University of Buea	College of Technology (COLTECH)	00	07	07
	Faculty of Science (FS)	34	87	121
	Faculty of Engineering and Technology (FET)	02	09	11
University of Douala	Faculte De Genie Industriel (FGI)	4	32	36
	Faculte Des Sciences (FS)	25	107	132
	Institut Universitaire Des Technologies (IUT)	10	36	46
University of Dschang	Faculte Des Sciences (FS)	18	137	155
	Institut Universitaire Des Technologies Fotso-Victor	13	176	189
University of Maroua	Ecole Nationale Superieure Polytechnique De Maroua (ENSPM)	13	72	85
	Faculte Des Sciences (FS)	12	60	72
University of Yaounde 1	Faculte Des Sciences (FS)	27	107	134
	Institut Universitaire Des Technologies (IUT)	08	46	54
Total		199	976	1,175

Ministry of Higher Education 2018 Annual statistics (July 2020)

Gender role and Stereotyping

Gender stereotype contributes enormously to the low level of female representation in STI related fields in Higher Education. This stereotypical thinking creates the impression that some particular fields of study especially science and technology are good only for men. The stereotypical challenges faced by the female gender in participating and learning science courses are universal as Donaldson *et al*. (2008) posit. Madara and Cherotich (2016), reiterate that gender stereotypes restrain female students from incorporating into the science fields and achieving their fullest potential. Starovoytova and Cherotich (2016) on their part state that, when science-stereotype and gender-stereotype collide, females are made to see science as 'too hard, noisy, dirty and to an extent a masculine profession'. These stereotypes limit women to some tasks like web page design, database maintenance, and computer security programming. The stereotypes therefore prevent most females from performing other professions such as those related to hardware or those with more responsibilities like computer designing, because they are considered more characteristic of the masculine gender, due to their strength (Fountain, 2000). In Cameroon a study carried out among female students of the Faculty of Arts at the University of Bamenda (UBa) indicates that some students preferred Arts oriented careers like teaching and school counselling to

science oriented careers so as to have enough time for their family businesses (Wiysahnyuy, 2020). Some of the UBa students said they were interested in certain science oriented careers but were in a state of dilemma because they believed some careers like engineering were male inclined.

Lack of intrinsic motivation

Another challenge related to gender participation is based on individual lack of intrinsic motivation, interest, attitude, self-confidence and perception of STI related courses or fields for female aspirers. This shows that female students have preferences for some science subjects which they perceive to be easier and void of calculations. Sánchez-Vidal (2016) confirms that the lack of confidence in one's own competences justifies this gap given that women think they are less valid than their male counterparts. Moreover, greater resistance is observed in the use of technologies in some women, which hinders their professional learning and training compared to their male counterparts. This 'technophobia' translates into negative behaviour towards machines that always seem difficult to operate, bad, slow or boring. This situation is not different with female students and workers in institutions of higher learning in Cameroon, where women shy away from fields like computer science and engineering because of phobia on the operation and maintenance of the technological gadgets. In a review of students' attitudes towards science, Osborne *et al*. (2003) state that interest and experience are important dimensions to elaborate in order to make school science more engaging for young people and to make more students to study sciences. There are important differences between girls and boys to consider, but within science-oriented education there are few studies concerned with the student perspective (Francis and Greer, 1999; Brok *et al*., 2005; Jenkins, 2006). This is also the case in Cameroon where very scanty literature or research has been carried out on students' perspective on Science, Technology and Innovations especially in Higher Education. It has also been realised that teachers' expectation and teaching methods contribute to gender gap among students in Higher Education. According to Aguele and Uhumuavbi (2003), female participation and interest in STEM diminishes as they move up in the educational ladder towards the university level due to a variety of factors that are primarily related to teachers' expectations.

Lack of role models

According to Botella *et al*. (2019), one of the main reasons for low representation in STI is the lack of visibility of women already working in the technological world. This discourages other women from enrolling in these fields. This trend decreases the percentage of women, which also reduces their support network and can cause work place dissatisfaction to arise in the end. Generally, role models are always very influential in students' choice of fields of study, therefore the fact that students do not really see females who have succeeded in some fields of sciences and technology discourages them from enrolling in these fields. The Minister of Higher Education in Cameroon indicates that women constitute only 7% of professors in Cameroon and not all of them are in the Sciences. This number may discourage female students to strive to get to these levels, though there are a few female models in STI who have been serving as models and mentors to young girls and female early career researchers. We have the example of Prof. Rose Leke who made her mark in the 1990s by investigating the immunology of parasitic infections, particularly malaria and has become an international leader and mentor to female youths and women scientists especially in Cameroon. Other female scientists who have been mentoring young female scientists in Cameroon are Prof. Theresia Nkuo-Akenji and Prof. Uphie Chinje Melo, among others. Though these female professors are sources

of inspiration to young female scientists in Cameroon, it should be noted that they are more into the biological and medical sciences.

Lack or inappropriate career orientation

The low representation of female students in STI in Higher Education is also related to the lack or inappropriate career orientation in secondary schools and during the admission process into the Universities. According to Wiysahnyuy (2020) in her study on Career dilemmas among female students of the faculty of Arts in UBa, some female students indicated they had interest in science subjects but due to lack of orientation, they went in for the Arts. This suggests that these students had little or no career orientation before and during their admission into the university. Cameroon graduates many School and University Counsellors annually. It is important that these counsellors are put to use appropriately rather than being posted into the classroom or appointed to unrelated services in ministerial departments as obtains currently.

Sexism

Sexism is also identified as one of the reasons female gender faces challenges in participating in science fields. Sexism often portrays the female gender as one made to follow and not to lead in the science fields (Seymour, 1995). It may be possible that in Cameroon, illiteracy and lack of orientation have limited parental exposure, girl child and caregiver exposure to the relevance of not only encouraging the girl child to be educated, but to undergo science studies in higher institutions. Looking at the African context, most science successful females are seemingly not dating, not engaged and definitely not married mostly because their perceived success tends to scare away the male gender (Bowman and Brundidge, 2013). This tendency discourages some girls and women especially in Higher Education not to enrol into STI fields which demand many years of education. However, with recent innovations and campaigns run by the UNESCO, their understanding of the importance of educating girls is on a rise (Kiluva-Ndunda, 2001).

CONCLUSION

Cameroon lacks a clear Higher Education policy on STI. As the industrial revolution enabled the countries that efficiently embraced it to grow rapidly, advancements in STI remains today the key to economic development and sustainable growth. Clearly, STI education is critical to Cameroon which seeks to become an emerging country by 2035, as STI education is the key foundation to technological development and innovation. It is only by investing in the advancement of STI through a new education strategy that focuses on the development of a highly skilled workforce that the full growth potential in Cameroonian's Higher Education can be unleashed. It is therefore evident that for the country to attain higher middle-income status by 2035 it must actively engage in the training of highly skilled STI professionals who will power the economic transformation of the country in the foreseeable future.

Despite the importance of STI in the national development, there exists a gender gap in science, technology and innovations education; female students are underrepresented in science and technology programmes in higher institutions of learning. Cameroon, one of the countries which has a strategic development plan to mature by 2035 is faced with an endemic dearth of female actors in STI ecosystem. Extant literature has presented divergent and convergent factors that suggest reasons for the underrepresentation of females in STI fields like computer sciences, Physics, Mathematics and Engineering despite government efforts to encourage female participation in these fields. The factors that coincidentally transcend spatial settings and culture are related to parental pressure, gender role socialisation and stereotypes, interest patterns, perception motivation, societal beliefs and practices, socio-cultural practices, socio-economic conditions, school-environment

conditions and institutional policy practices. On the other hand, differences are visible between developed and underdeveloped settings or milieus where counselling services are more efficient and focused on the demands of the job market. Any efforts directed towards promoting and achieving sustainable female participation in science and Technology would require multiple perspectives and multi sector approaches including policy changes to correct these shortcomings in the society.

RECOMMENDATIONS

This review finds that many of the building blocks for fostering STI development include universities, research institutes, and a growing private sector already in place in Cameroon. However, the STI system does not focus sharply enough on Cameroon's socio-economic needs and STI is not clearly stated in Higher Education policy. Funding allocations for STI are determined by the Government and external funding agencies and often do not relate to the priorities of research institutions and universities, and much less to those of the private sector, farmers and informal enterprises. The spirit of cooperation underpinning the STI in Higher Education represents a constructive way forward for Cameroon as it seeks to strengthen its development agenda by incorporating science, technology and innovation. From the analysis, the data showed that there is a great need for more investments in upgrading the skills of all those involved in STI. The recommendations presented in this review to strengthen STI in Higher Education in the national, regional and international levels focus on funding, human capital, capacity building and infrastructural investments, among others.

National Recommendations

1. Policy for STI in Higher Education should be designed to increase the number of students and lecturers involved in the study and application of Science, Technology and Innovation. The Ministry of Higher Education should institute regular STI scholarship and award for students, lecturers as well as all Higher Education Institutions that will stimulate scientific advances that are of national interest.
2. Cameroon needs to increase capacity support for the development of STI in Higher Education through international partnerships and linkages among researchers, academia, government, industry, and civil society actors. Higher Education Institutions in Cameroon should invest more effort in building capacity, and networking among institutions of education in STI should be intensified.
3. The Government of Cameroon through the ministries of Higher Education and that of Post and Telecommunications should ensure widespread Internet access, and where possible provide free Wi-Fi and uninterrupted power supply especially at technology hubs, university campuses and medical facilities.
4. At an early educational level, there should be the encouragement on the establishment of many STI programmes for primary school pupils and the creation of STI clubs for secondary and high school students to increase exposure to various STI careers. Various STI camps and competitions should be encouraged for secondary education students especially during the long holidays.
5. Formal partnerships should be established between the business community and higher education centers especially national polytechnics. Specifically, GICAM and the Chamber of Commerce in Cameroon should have specific roles in this process. Knowledge gained through research (either public or private) must be shared with industry to change the economy of Cameroon from a consumption economy to an economy that transforms raw material as well as ideas into refined products.

6. Cameroon should set up sustainable financing mechanisms for STI. The private sector and development partners should support and complement the Government's efforts by providing funding, investing in critical skills (education, training and so on). The budget for Research and Innovation (related to STI) should be significantly increased over the next five years to be similar to that of emerging economies like South Africa. The research focus should include digital economy, small and medium size enterprises, agriculture and health to name but a few.
7. Technology transfer should occur in HEIs, and as such, universities must equip themselves with technology transfer offices that will help draft sound policy and contract templates, do all the paper work (contracts and files to protect any intellectual property) but also train all researchers on technology transfer related issues so as to make sure there is always a win-win contract whereby universities, researchers and industry benefit.
8. The Government should increase the quota of women in STI related fields during University recruitment. This will enable them to serve as models to young female scientists in the Universities and in their various communities. This should also be considered during the competitive entrance examinations into various teacher training colleges especially in physics, mathematics, computer sciences and engineering fields. After training, these female teachers will act as role models in secondary and high schools especially to those who perceive science and technology as male dominated fields.
9. From the review of literature, there is evidence that insignificant research has been carried out on gender participation in STI in Cameroon especially in Higher education in relation to students' perspectives, teaching methods and teachers' expectation. More research should be carried out in this direction. This will help to orientate the policy makers and all education stake holders on the various strategies or actions to put in place to enhance gender balance in this sector of education. The Ministry of Higher Education should come up with action-oriented research projects on gender participation in STI, and select and sponsor researchers who will carry out these projects to enhance policy implementation.
10. The Government should ensure that school counsellors participate in the admission processes of students into the Universities. Since admission into most of the universities takes place online, students should also be provided with online counselling before they select their fields of study. When the students are eventually admitted, there should be rigorous follow up by school counsellors and mentors to make sure they do not drop out.
11. Although the mentoring programme is already going on in Cameroon, there is need for it to be extended to secondary education and to work in collaboration with the school counsellors to ensure the continuation of STI education of female students at the tertiary level. Also role model motivational talks should be given to female students in Higher Education.
12. Higher institutions of learning in Cameroon should organize workshops, seminars and conferences showcasing women in STI accomplishments as this will go a long way to imbue confidence in female students in the STI fields. Some of these could be done during the commemoration of the women's day activities in Cameroon. The Ministry of Social Affairs, Secondary and Higher Education should come out with educative, mentoring and sensitization programmes for girls and women in STIs fields.
13. Literature has shown that there are some aspects of the curriculum in relation to STI which are gender bias especially in secondary schools. If female students start perceiving the content of STI subjects to

be masculine in nature it will obviously affect their enrolment into these fields. Therefore, the Ministry of Secondary Education should modify the curriculum to make it "gender free" curriculum that attracts both sexes to the technical fields. This will enhance continuation into higher education. In addition, they should provide broader opportunities for female students to take the technical education primarily in the industrial field which has few female students. This is critical to reduce gender imbalance in the technical fields and to provide a broader non-traditional programme for female students.

Regional Recommendations

1. In pursuing STI-driven development, African governments must make serious commitments to develop human and institutional capacities by investing substantially in high quality universities, state of the art equipped and maintained laboratories, ICT infrastructure, and research funding mechanisms.
2. Regional bodies such as members of Central Africa States should design mobility programs for scientists and engineers, foster regional university collaborations, encourage public–private partnerships across national borders, and facilitate the adoption of regional intellectual property rights protection frameworks.
3. African countries need to enhance regional cooperation and adopt a coherent framework of cooperation between governments, scientists, universities, policymakers, the private sector, and civil society. They should increase investment in STI in higher education, and research and development, while encouraging partnerships between public and private institutions.
4. Prescription of textbooks used in teaching in Cameroon and Africa should be censored and should not only portray images of 'White' males as successful in science and technology fields especially in terms of mathematical sciences, operation and maintenance of machines.
5. RUFORUM (The Regional Universities Forum for Capacity Building in Agriculture) should work in collaboration with the Government of Cameroon to give scholarships to outstanding female students from diverse fields of STI to study in other African countries with better facilities.

International Recommendations

1. Science, Technology and Innovation and Higher Education policies in Cameroon should be aligned with long term International policies to enable the nation to attract the required support for implementation. There should be an increase in attention to the international dimension and provision of more opportunities for cross-cultural research and exchange in the learning environment. Exchange visits of female mentors and models should be used in order to encourage female students to enroll in STI related fields.
2. Cameroon must build strong partnerships with governments and organizations around the world given that the production of knowledge and technology has become increasingly global and interconnected. Universities in Cameroon need to establish new connections and strengthen existing partnerships with universities in countries such as India, China, Brazil, the Republic of Korea, United States and European countries.
3. There is a need for a coordinated collective effort (from skills surveys and diagnostic analysis) to be mounted across countries to identify the critical STI skills essential for Cameroon's economic growth and the current gaps depending on its resource endowments and national development plans. This exercise should involve the Government, the private sector and academia. Cameroon should close the STI

investment gap with the developed world.

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STATEMENT OF NO-CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this paper.

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