African Journal of Rural Development, Vol. 5 (3) July-September 2020: pp.143-168. ISSN 2415-2838
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Strengthening Higher Education and Science, Technology and Innovation in DRC

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ABSTRACT

The state and quality of education of a country is strongly and positively correlated to its economic development. It contributes to building the workforce of knowledge-based progressive societies. Sub-Saharan Africa has experienced a proliferation of Higher Education Institutions (HEIs) particularly, private HEIs in the last two decades. The quality of the private universities is variable across the continent and dependent on the existence and level of implementation of the legislative requirements, the quality of governance at the HEIs, quality of the infrastructure and student recruitment. The Democratic Republic of Congo (DRC) is a signatory to the Southern African Development Community (SADC) Protocol on Higher Education and Training, and has acknowledged the role of higher education in national and regional development and the importance of a regional higher education system. The country has experienced two decades of instability which has impacted several sectors of its economy, including its education sector. For the last two decades, limited statistics has been published concerning the status, investment and challenges facing the sector. This information is important in designing appropriate strategies for enhancing the impact of this sector to the national and regional economy. Therefore, the objectives of this study were to i) review the current statistics (including investment) available on Higher and Technical Education in DRC, with a focus on those relating to Science, Technology and Innovation; ii) establish key challenges for Higher Education; and, ii) make recommendations for strengthening the sector and to inform future initiatives in higher education to be considered by RUFORUM and DR Congo Government in engaging with partners at national, regional and international levels. The results show that there is unequal distribution of HEIs across the provinces of DRC; with high concentration of HEIs in Kinshasa, North and South Kivu. The majority of the HEIs are offering Technical training (IST) (52.1%) followed by University training (31%). Pedagogical training (ISP) only represents 16.9% of the HEIs. There is a relatively higher number of public ISP and IST compared to the private HEIs, and relatively a higher number of private HEIs than public HEIs. The majority of HEIs, particularly the private HEIs are largely dependent on family funding. Student enrolment has increased gradually in both public and private HEIs ($p<0.05$), diluting significantly the government per student resource allocation. The country still has very few PhD holders who are mostly localised in a few HEIs. The sector is facing various challenges including, limited academic autonomy in selecting leaders and designing programme curricula, proliferation of HEIs, and a plethora of administrative staff both in the ministry and in the HEIs. Additionally, Research and Development (R&D) is mainly conducted by HEIs and government research centres in isolation because the national

Cite as: Majaliwa J.G.M. 2020. Strengthening Higher Education and Science, Technology and Innovation in DRC. *African Journal of Rural Development* 5 (3): 143-168.

Received: 10 May2020
Accepted: 15 July 2020
Published: 30 September 2020

innovation system is dysfunctional. Indeed, for the last three decades, R&D and STI have been marginalised.

Key words: DRC, Higher Education Institutions, investments, students' enrollments

RÉSUMÉ

L'état et la qualité de l'éducation d'un pays sont fortement et positivement corrélés à son développement économique. L'éducation contribue à constituer la main-d'œuvre des sociétés progressistes fondées sur le savoir. L'Afrique sub-saharienne a connu une prolifération d'établissements d'enseignement supérieur (EES), en particulier d'établissements d'enseignement supérieur privés au cours des deux dernières décennies. La qualité des universités privées est variable à travers le continent et dépend de l'existence et du niveau de mise en œuvre des exigences législatives, de la qualité de la gouvernance des EES, de la qualité des infrastructures et du recrutement des étudiants. La République démocratique du Congo (RDC) est signataire du Protocole de la Communauté de développement de l'Afrique australe (SADC) sur l'enseignement supérieur et la formation, et a reconnu le rôle de l'enseignement supérieur dans le développement national et régional et l'importance d'un système régional d'enseignement supérieur. Le pays a connu deux décennies d'instabilité qui a affecté plusieurs secteurs de son économie et notamment son secteur de l'éducation. Au cours des deux dernières décennies, des statistiques limitées ont été publiées sur les investissements et les défis auxquels le secteur est confronté. Ces informations sont importantes dans la conception des stratégies appropriées visant à renforcer l'impact de ce secteur sur l'économie nationale et régionale. Par conséquent, les objectifs de cette étude étaient de i) passer en revue les statistiques actuelles (y compris les investissements) disponibles sur l'enseignement supérieur et technique en RDC en mettant l'accent sur celles relatives à la science, la technologie et l'innovation; ii) définir les principaux défis pour l'enseignement supérieur et iii) faire des recommandations pour renforcer le secteur et informer les futures initiatives dans l'enseignement supérieur à prendre en considération par le RUFORUM et le gouvernement de la RD Congo en s'engageant avec des partenaires aux niveaux national, régional et international. Les résultats montrent qu'il existe une répartition inégale des établissements d'enseignement supérieur entre les provinces de la RDC; avec une forte concentration d'EES à Kinshasa, Nord et Sud Kivu. La majorité des EES offrent une formation technique (IST) (52,1%) suivie par les universités (31%). Les EES de formation pédagogique (ISP) ne représentent que 16,9% des EES. Il existe un nombre relativement élevé de FSI et de TSI publics par rapport aux établissements privés, et un nombre relativement élevé d'établissements d'enseignement supérieur privés par rapport aux établissements publics. La majorité des EES, en particulier les EES privés, dépendent largement du financement familial. Les inscriptions d'étudiants ont augmenté progressivement dans les EES publics et privés ($p < 0,05$), diluant de manière significative l'allocation des ressources gouvernementales par étudiant. Le pays compte encore très peu de titulaires de doctorat, principalement localisés dans quelques EES. Le secteur est confronté à divers défis, notamment une autonomie académique limitée dans la sélection des dirigeants et la conception des programmes, la prolifération des établissements d'enseignement supérieur et une pléthore de personnel administratif tant au ministère que dans les établissements d'enseignement supérieur. La R&D est principalement menée

par les EES et les centres de recherche gouvernementaux de manière isolée, car le système national d'innovation est dysfonctionnel. Au cours des trois dernières décennies, la R&D et la STI ont été marginalisées.

Mots clés: RDC, établissements d'enseignement supérieur, investissements, inscriptions d'étudiants

BACKGROUND

It is currently recognised that sustainable economic development is positively and strongly correlated to the quality of education and training delivered in a country (UNESCO, 2006; Bloom *et al*., 2014). Education helps to build societies and build the workforce that will contribute to sustainability agendas (Martin and Jucker, 2005). According to Saint (2009), education institutions serve as power houses for the production of progressive work force in a country, hence prepare citizens to participate in all walks of life. According to Salazar-Xirinachs *et al*. (2014) "Learning builds up dynamic capabilities which are key drivers of catching up and economic development". Education also contributes to the development of competitive, integrated and knowledge-based progressive societies (Von Tunzelmann and Wang, 2007), production of competent civil servants for effective running of the different sectors of life including government responsibility, business management, providing law and justice, banking, etc. Education has been useful in creating awareness on the concept of sustainability (Rowe, 2010; Weissman, 2012). In so doing, its role in shaping the way in which future generations will cope with the complexities of economic growth is not disputable. Higher education institutions (HEIs) contribute to providing the knowledge required for development. The HEIs are essential for design and productive use of new technologies, and providing foundations for a nation's innovative capacity (Carnoy *et al*., 1993; Serageldin 2000; Pillay, 2010). However, their participation rates in developing countries has remained very low, particularly in sub Saharan Africa, where the rate of participation was estimated to be less than 5% (Bloom *et al*., 2006).

The higher education enrolment growth has, however, been phenomenal, with some national systems in Africa expanding more than ten-fold since 2000 (Kruss *et al*., 2015). Very few public universities have been created; but a proliferation of private (totally or partially) universities has been observed in several SSA countries. Three types of private universities have been operating across the SSA region. These include the State supported universities that receive some form of support from the State and regulated by State authorities. The second category are the non-profit private universities operated by trusts and relying on the students' fees. The last category are the universities which were established for profit. These universities have proliferated from the beginning of 1990s (Varghese, 2004) and are outnumbering the public universities in several countries. The quality of the private universities is variable across the continent and is dependent on the existence and level of implementation of the legislative requirements, the quality of governance at the university, the quality of infrastructure and student recruitment procedures and rates.

Any SSA nation that aspires to develop and improve the well-being of its citizens must, therefore, take its human capital investment seriously (Oketch, 2016), and support learning processes to develop dynamic technological capabilities at all levels (Salazar Xirinachs *et al*., 2014) for their economic development. Science and technology links and knowledge exchange with universities, research organisations

and other organisations are critical for technological capability building, but equally so are linkages to those organisations or actors that build the skills required at all occupational levels of the firm. In this regards, institutions organising Science, technology, engineering, and mathematics (STEM) programmes and/ or Technical and Vocational Education and Training (TVET) are important in impacting the required scientific and technical skills. Universities involved in STEM training have remained very few in SSA, exposing the region to the dual challenge of recruiting and retaining diverse talents and ensuring that trainees receive the necessary STEM skills and resources to effectively compete and interact with their peers worldwide (Okeke *et al*., 2017). Also, despite the tremendous success registered in TVET training across the region, several transverse challenges affect the TVET training in SSA, including the quality of the teacher training, the curriculum of TVET schools and the adequacy of the infrastructure.

Moreover, the enrollment rates for higher education in Sub-Saharan Africa, though still the lowest in the world, have tremendously increased over the year, putting enormous pressure on public HEIs which in most cases were created during the colonial period (Bloom, 2005). The low enrollment in the region was attributed to the fact that the international development community had encouraged the African governments to put more emphasis on the lower level, as they believed that tertiary education was less important for poverty reduction (Bloom, 2005). The emergence of a highly competitive, globally integrated, knowledge-driven world economy has played a key role in reshaping this conventional belief and has boosted the enrolment in higher education across the region.

Financial investment to education in Africa, however, has remained very low. For example, between 1995 and 2005, only about 0.78% of the continental gross domestic product was invested in education, despite the fact that the enrolment had tripled (World Bank, 2010). Only about a fifth of its current public expenditure on education is dedicated to post-school education (World Bank, 2010). The mismatch between annual rate of enrolments and the public resources expenditure leads to a rapid decline in public expenditure per student. The situation is very alarming in the poorest countries and countries emerging or still in conflicts. Very limited funds are allocated per student and more resources are allocated to more compelling sectors including national security and military expenditure.

The Democratic Republic of Congo is a signatory to the Southern African Development Community (SADC) Protocol on Higher Education and Training, and has acknowledged the role of higher education in national and regional development and the importance of a regional higher education system. The country has experienced two decades of instability which has impacted several sectors of its economy, including its education sector. For the last two decades, limited statistics has been published concerning the status, investment and challenges facing the sector. Yet this information is important in designing appropriate strategies for enhancing the impact of the sector to the national and regional economy. The objectives of this study were to i) review the current statistics (including investment) available on Higher and Technical Education in DRC with a focus on those relating to Science, Technology and Innovation; ii) establish key challenges for Higher Education, and iii) make recommendations for strengthening the sector and to inform future initiatives in higher education to be considered by RUFORUM and DR Congo Government in engaging with partners at national, regional and international levels.

STUDY METHODOLOGY

Country context. DRC is geographically the second largest country in Africa and the largest in Sub-Saharan African (SSA) with its 2.345 million sq km. With an estimated population of 85 million, it is the third largest SSA population behind Nigeria and Ethiopia. The country has been subdivided into 26 administrative provinces since 2006 (Dunia and Zongwe, 2019). About 40% of the country's population is located in three provinces namely Katanga, Kinshasa and Bandundu. The major cities include the capital Kinshasa, Lubumbashi, Mbuji-Mayi and Kisangani. The population of the DRC is dominantly young, with about 45 % of its population below the age of 15. About 50 % of its population is female. The fertility rate is at 6.2 births per woman, one of the highest in the world (UN, 2015). The large youth composition renders the education sector a key focus area for the development agenda of the country and in ensuring young Congolese are able to fully participate in the economy.

Humanitarian context. The country has experienced several years of armed conflicts, particularly in both Kivu provinces (South and North), inter-ethnical clashes in Ituri and Mitumba regions, the Kamunia Nsapu clashes in the Kasai region and the conflict in Mai-Ndombe. Millions of people have been internally displaced creating more pressure on existing infrastructure (schools and health related) in the host localities. In addition, the country has also faced several episodes of Ebola virus outbreak in North western and Eastern parts of the country. According to the Humanitarian Response Plan (HRP) of 2017 – 2019, about 15% of the population of DRC need humanitarian assistance, and about 60% of them are children. The situation has been aggravated by the pandemic of COVID-19 which has affected activities in most of the major cities of the country.

Socio-economical. DRC natural, mineral and energy resources potentials contrast with the scale of poverty of the majority of its population. About 16 million people are food insecure (UNDP, 2018). In 2017, the per capita income averaged US$ 458 and with a GDP growth rate of about 3.7% (Central Bank of Congo, 2016). More than 70 % of the population lives below the poverty line. The multidimensional poverty indices that measure the intensity of household deprivation in the areas of education, health and standard of living, show that more than 50.8 % of the Congolese population would still live in multidimensional poverty, nearly 36.7 % would be in severe multidimensional poverty, and about 18.5 % in a situation close to multidimensional poverty (UNDP, 2016). This shows that poverty reduction requires a strong growth-oriented economic policy (at least 10-12 % per year for ten years), coupled with a satisfactory distributive policy, in order to realistically halve the poverty status by 2030.

Structure of pre-university education. Since 1990, all DRC citizens have the right to equal access to education and vocational training. Public education is "free and basic education is compulsory". The right to establish private schools is subject to the approval by the line Ministries; namely le ministère de l'Enseignement primaire, secondaire et technique (MEPST), le ministère de l'Enseignement supérieur et universitaire (MESU) et le ministère des Affaires sociales, action humanitaire et solidarité nationale (MAS). According to the World Bank, the primary school completion rate stood at 72.8% in 2012 (World Bank, 2014).

The secondary school consists of two tracks: the long cycle and the short cycle. The long cycle is also referred to as formal secondary education, while the short cycle is the technical vocational education/training (TVET). The formal secondary education (FSE) lasts six

years and leads to higher education after the final State exam. The FSE starts with two years of common training (tronc commun) before the pupils are split into three major streams – general, teacher education, and technical of four years (Bashir, 2009). There are several options within each stream; the four-year programme is divided into scientific (biology and chemistry and mathematics-physics), pedagogical (psychology and pedagogy), literature (Greco-Latin) and technical (general mechanics, electronics, electricity, and arts).

School enrolment in pre-University education system. Generally, the school enrollment rate has increased in the country at all education levels. (MINEPSP/CTSE, 2013). In 2010, the gross enrolment ratio was at 41.1% for both male and female secondary school students, with male students (51.2%) having the highest enrolment ratio compared to 30.13% for female students (http://uis.unesco.org/en/country/cd).These rates have increased at 0.88% and 1.1% per year for male and female students, respectively.

Structure of higher education system. The higher education sector was designed by the Belgians as a copy of their system. French is the language used for instruction and the academic year runs from September to June. The Higher education system in the DRC is run by the "Ministere de l' Enseignement Superieur et Universitaire (MESU). Private higher education in the DRC was first established in the early 1990s, when the government authorized private institutions to operate. The number of private institutions has risen significantly over the years with the proportion of students' enrollment in institutions of higher education, growing over the years. Traditionally, the non-university HEIs were supposed to train in specific domains, however, recently, several of them have started adding new courses on their curriculum, and many have been raised to the rank of Universities. Most of HEIs offer two cycles of training, the first cycle is of three years and sanctioned by "a diplome de graduat". The second cycle is generally for two years honored by a "diplome de licence". The third cycle leads to "a diplôme d'études approfondies", whose duration varies between 2 and 3 years. In principle, the third cycle is organized in the three major universities of DRC (University of Kinshasa, University of Lubumbashi and University of Kisangani). Other HEIs create linkages with these three universities, in form of doctoral schools to be able to train their staffs for the third cycle.

Job market. According to recent data from the Ministry of Labour, the underemployment rate exceeds 50 % and the youth unemployment rate (15-24 years) exceeds 35%. The employment structure remains dominated by informal jobs, which accounts for almost 88.6 % of employments, of which, 59.7 % are in agricultural related fields. The labour force is estimated at 65 % of which 58 % comprises of the 15-34-year age group susceptible to migration. This trend is the same in urban as well as in rural areas. The unemployment rate (in the sense of the International Labour Office – ILO) is 3.7 or 11.38 % in the broad sense. Since 2001, despite the beginning of a period of economic recovery through a revival of bi-and multilateral cooperation and the implementation of macroeconomic programmes, satisfactory economic results have not helped to reduce poverty and unemployment. The growth rate (8.9 %) has been insufficient to reduce poverty (71.3 %) and to fill jobs whose level of creation is lagging behind the growth of the national economy.

Enabling environment. The Development Strategy for Primary, Secondary and Vocational Education for the five-year period 2010 - 2016 is in line with the guidelines of the World Education Forum held in Dakar in April, 2000. It emphasizes equity, efficiency, dialogue, partnership, participation and learning. This strategy incorporates both the formal, and, the

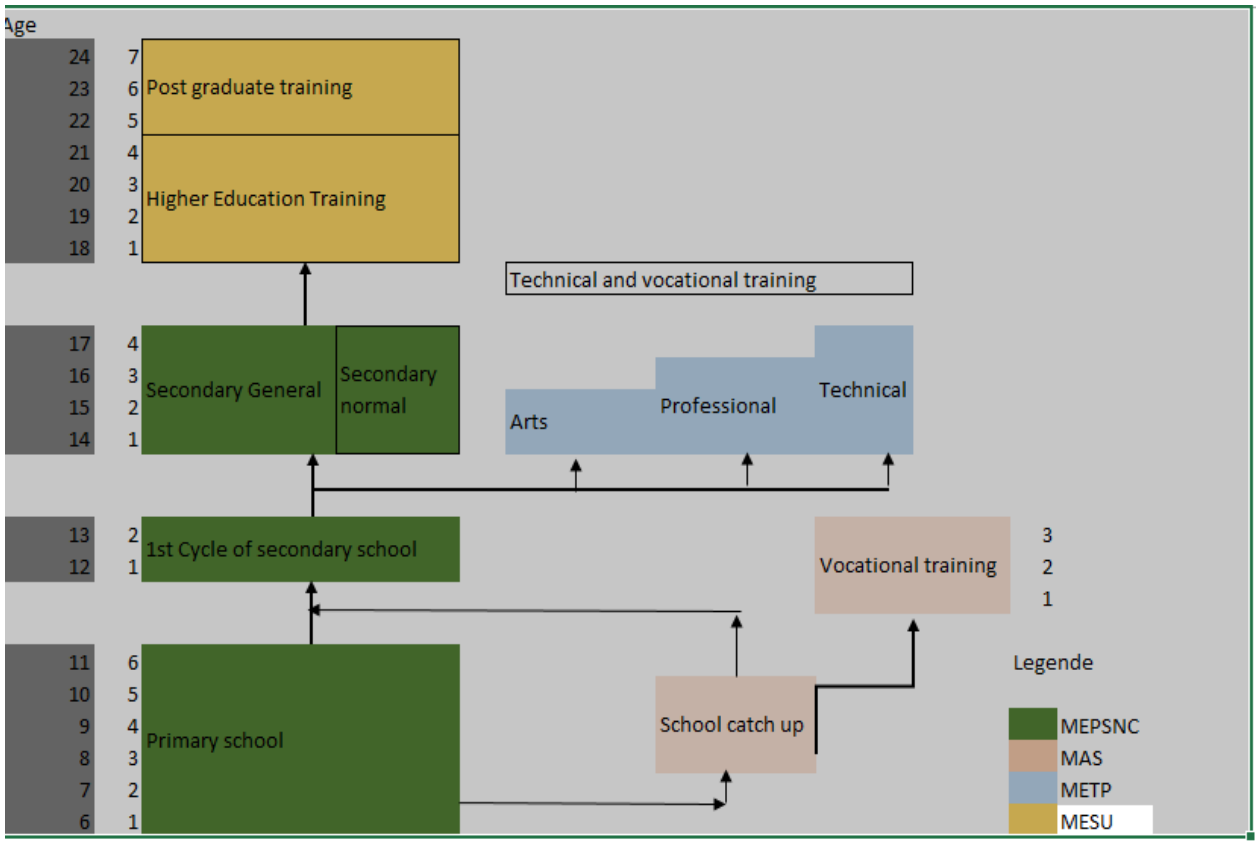

Figure 1. Structure of Education system in DRC
Source: MEPSNC/MAS/METP/MESU (2015)

technical and vocational education, and aims at strengthening the technical and vocational education. The Government of DRC planned to improve Primary Secondary Vocational Education by: (i) rehabilitating infrastructure, (ii) modernizing equipment, and (iii) updating the training programmes to better match with the national needs and the local labor market. The Government had also planned to build one Technical and Vocational school per educational province. The Government also indicated committment to clarifying the institutional mechanisms of the Ministries in charge of education and gradually increasing the share of the education budget with a view to reaching 25% of the national budget by the year 2016.

DATA COLLECTION AND STATISTICAL ANALYSIS. This study was restricted to only electronically available literature, the websites of the line ministries and those which were obtained through google search. Both English and French documents were searched and selected from the google engine. The key words used were, education in DRC, investment in Education, status of science, technology and innovation, and challenges facing education sector in DRC. The findings from the selected literatures were supplemented with data from the World Bank and UNESCO database. The validity of the collected data was cross checked using key informants in the key major cities. Trends in enrolment, number of academic and administrative staff and their distribution,

and investment (personnel, equipment, maintenance, operation costs) were established using obtained secondary data. Efforts were made to obtain data covering the period between 2005 and 2020 for consistency, avoiding the period of war where the statistics are very scanty. Status of Science, Technology and Innovation was characterized based on the existing Human capacity and infrastructure at HEIs, the public investment on R&D, existing institutional arrangements for public Research and Development, technological support and regulatory agencies, technological readiness and innovation capacity and policy instruments for research and development. Data on HEIs was plotted in ArcGIS version 10.4. Data on enrolments and financial allocation were fitted to regression lines to determine their temporal trends. Correlation between enrolments and financial allocation to education was computed in order to understand if these allocations were linked to the number of students trained.

RESULTS AND DISCUSSIONS

Distribution of Higher Education Institutions (HEIs) in DRC. Figure 2 shows the distribution of HEI across the different provinces of DRC. A total of 236 HEIs were identified, but only 120 were found on the website of the line Ministry (Ministere de l' Enseignement Superieur et Universitaire -MESU). This number is below those reported by other sources (e.g World Bank, 2005; CTSE, 2011).

All the provinces had at least an HEI, though there was wide variation in the number of HEIs across provinces. Kinshasa, South-Kivu, North-Kivu and Katanga are well endowed in terms of number of HEIs. Kinshasa, South-Kivu and North-Kivu, have more than 25 HEIs each, and Katanga falls in the category of 16-25 HEIs. This is followed by Kongo Central which is in the category of 11-15 HEIs. The provinces of Haut Lomami, Kisangani and Equateur belong to the category of (5-10 HEIs). All other remaining provinces have less than 5 HEIs. Higher education in the DRC is a mix of public and private provision (Figure 3). The majority of private HEIs are run by religious institutions/churches, a few are associated with provincial governments or are run by private individuals, trusts, or societies. The highest number of public HEIs are found in Kinshasa (>25), followed by North Kivu, South Kivu and Mongala (16-25). Haut Katanga falls in the category of 10-15 HEIs. The rest of the provinces have less than 10 HEIs each. For private HEIs, Kinshasa still had the highest number (>25), followed by South Kivu (16-25), and then North-Kivu and Mongala with (10-15). Haut Katanga and Kongo Central followed within the category 5-10. The rest of the provinces had less than 5 HEIs each. Three major HEIs (University of Kinshasa, University of Kisangani and University of Lubumbashi) have the highest enrollment rates; and the three provinces have remained the main centres of HEI training in the country.

The HEIs include, among others, Universities and non-university institutions. The non-university institutions are generally professional institutions with a wide range of training disciplines including Pedagogical, business, medical, and Rural Development. Figure 5 shows the distribution of private and public HEIs across provinces and Figure 6 shows the percentage of the different categories of HEIs per type (private or public) and type of training offered. A relatively high proportion of HEIs are offering Technical training (IST) (52.1%), followed by Universities (31%). Pedagogical training (ISP) HEIs only represents 16.9% of the HEIs. Relatively, there are more public ISP and IST compared to the private ones, but more private universities than public ones.

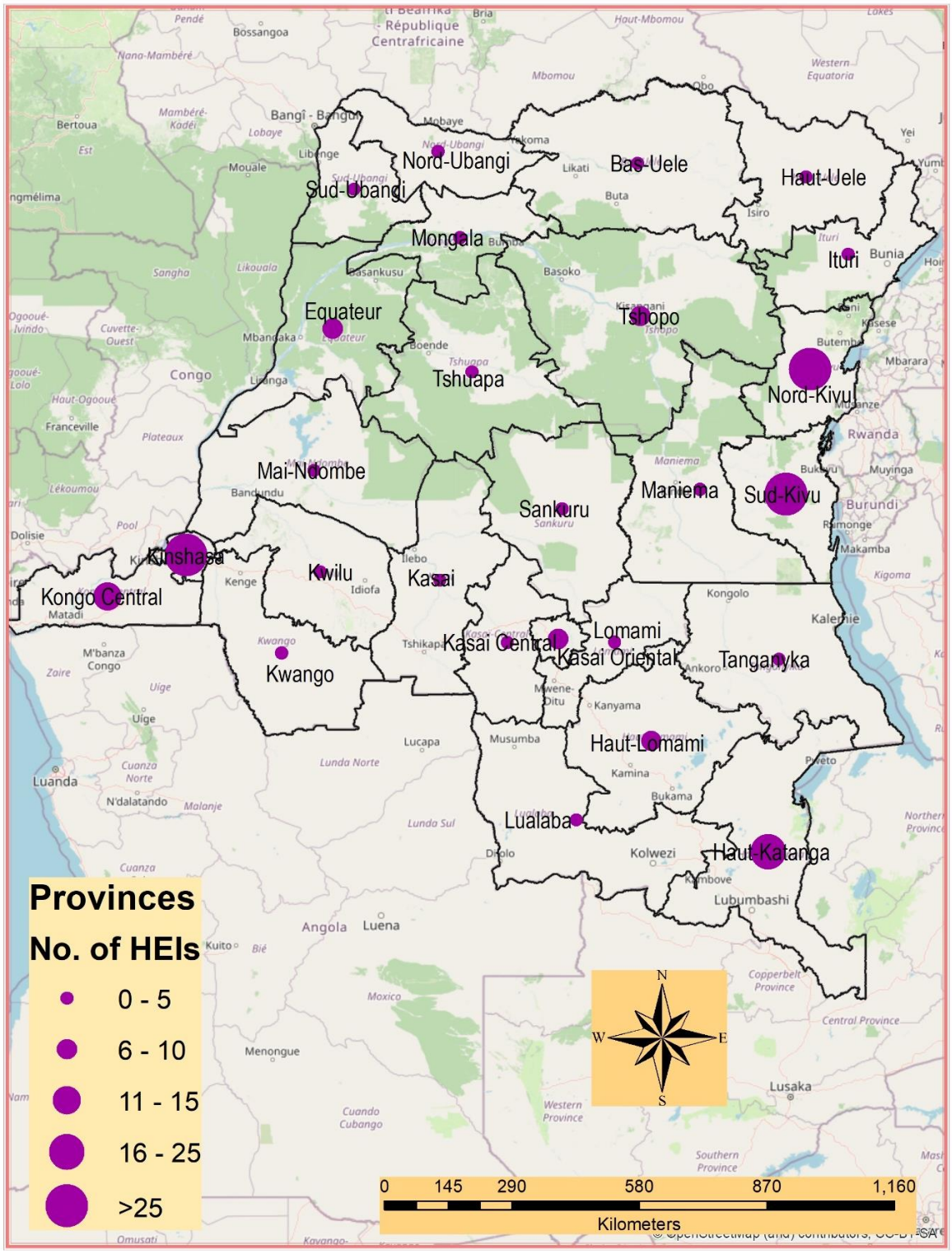

Figure 2. Distribution of Higher Education Institutions across the provinces
Source: Data from MESU

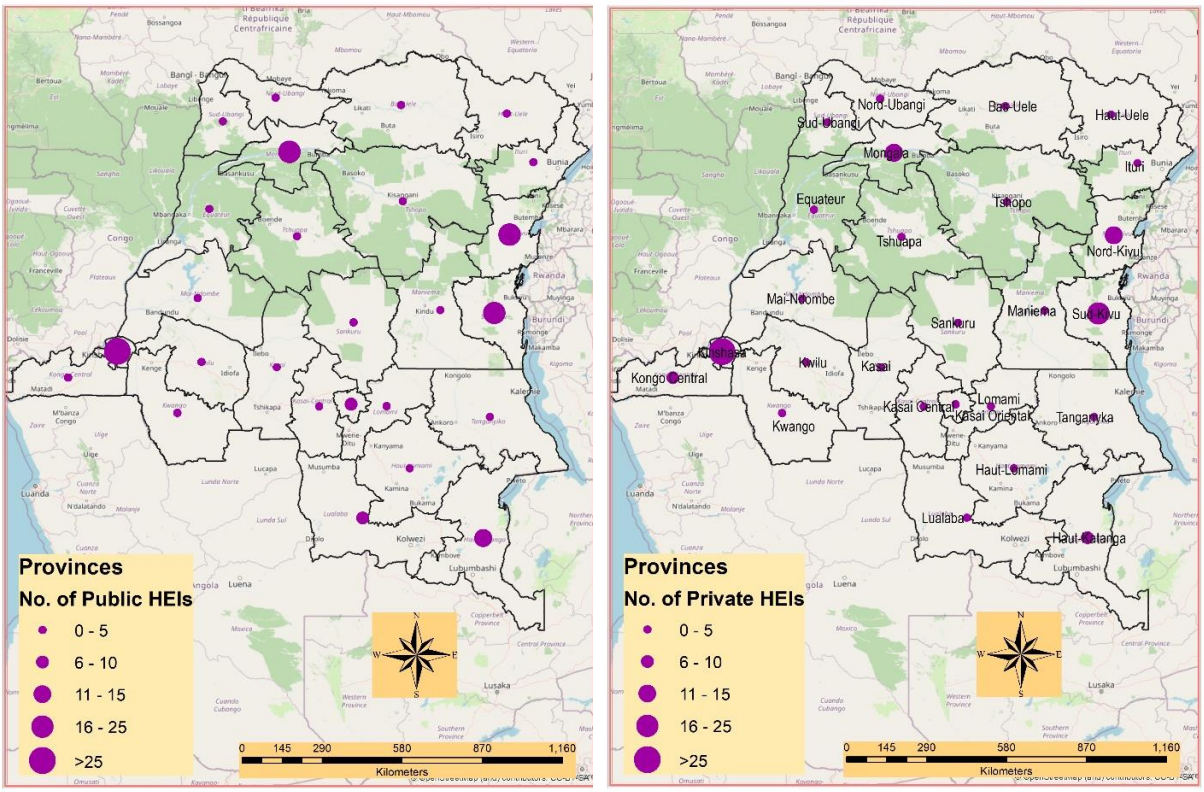

Figure 3. Distribution of Private and Public Higher Education Institutions in DR. Congo
Source: Data from MESU

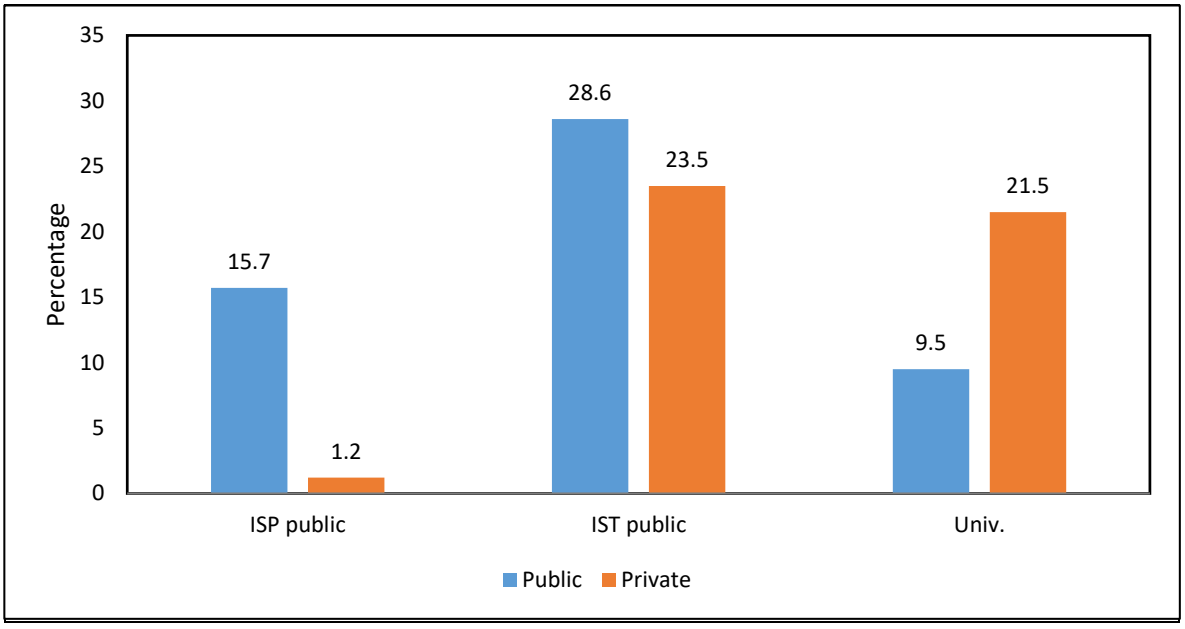

Figure 4. Percentage of private and public Higher Education Institutions in DR Congo
Source: CTSE (2011)

Number of students in the HEIs. The total number of students in the year 2014 is summarised in Figure 7. The biggest proportion of students were in public HEIs. Out of a total of 470,000 students reported across HEIs in DRC in 2014, only 30.4% were from private HEIs. The size of public establishments was larger than private establishments. There were 841 students per public institution against 323 students per private establishment. Since 2007, the total number of students have been growing gradually (gradient=31297 students/year, R^2=0.81, P=0.01). On average, 12083 students have been enrolled every year in private HEIs (R^2=0.87, P<0.01), and 19,214 students were registered every year in public HEIs (R^2= 0.54, P=0.04). Thus, the aggregated average annual student enrolment was 31,294 for the entire country (R^2=0.7; P=0.01). This represents about 13% of the student population in 2007.

The number of students varied with provinces. Kinshasa had the highest number of students followed by Haut Katanga. The province of Maniema had the least number of students.

Number of academic and administrative staff in the HEIs. Generally, the Teacher to student ratios are relatively low in most of the HEIs. The average Teacher to students ratio for the country as a whole was about 1:34, using an enrollment estimate of about 470,000 students. DRC performance was thus better than the sub-Saharan Africa average of 44 pupils per teacher (UNESCO, 2011).

The total number of teaching staff in the public HEIs was 13, 680 in 2010. Among them, only 4.1% were Professors and 3.5% were Associate Professors. About a quarter of them were lecturers or senior lecturers. The bulk of the staff were teaching assistants. Generally, lecturers (Chef de Travaux) and the teaching assistants have a "Licence" or have a "graduat". A greater proportion of the highly qualified academic staff were located in the public HEIs,

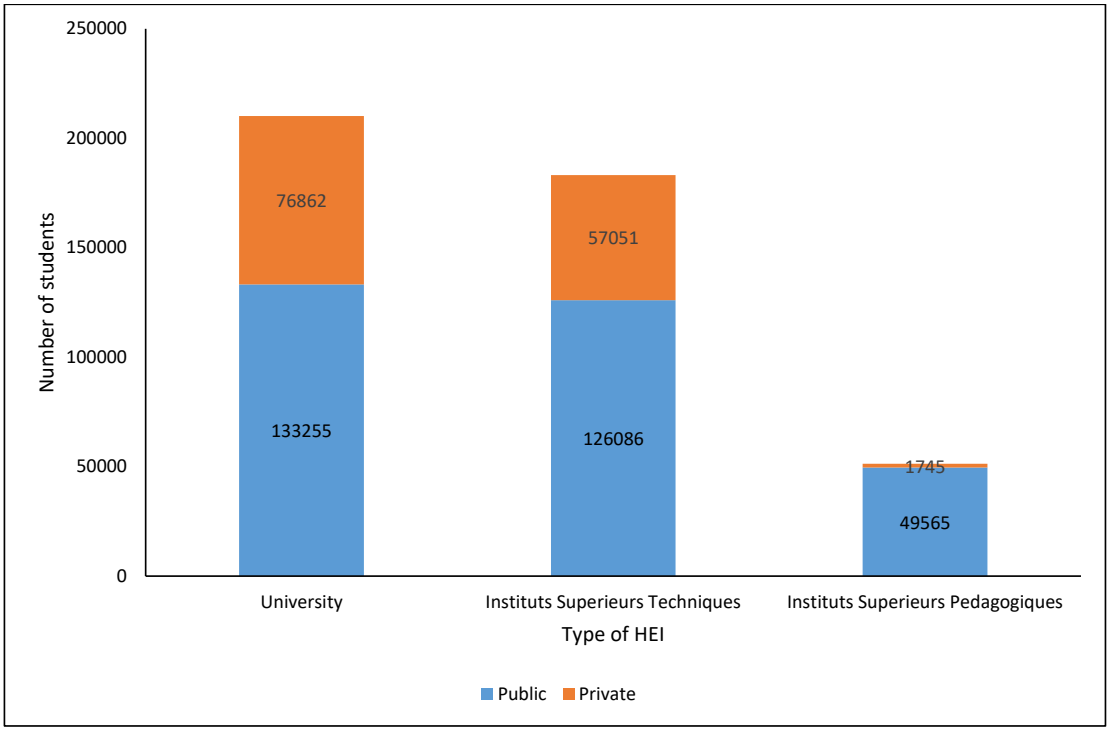

Figure 5. Number of students by type of Higher Education Institutions in DR Congo
Source: MEPSNC/MAS/METP/MESU (2015)

and particularly, in the three main universities of Kinshasa, Lubumbashi and Kisangani. The majority of professors were old or close to retirement age (World Bank, 2005).

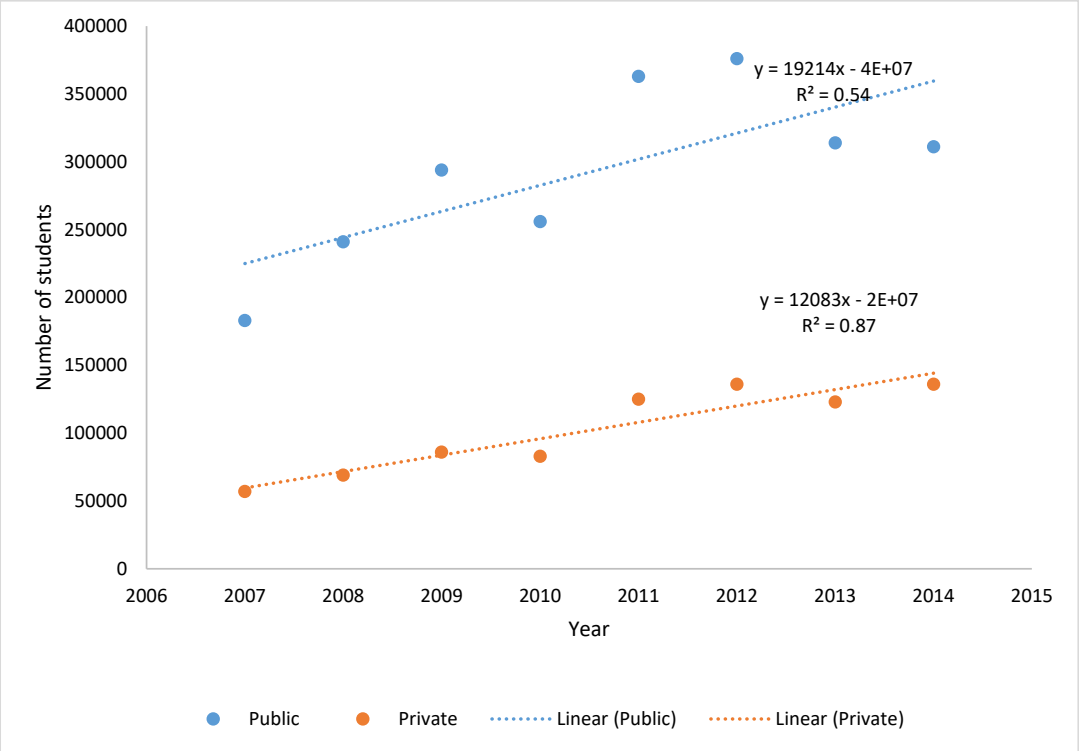

Figure 6. Trends in student enrolment for both public and private Higher Education Institutions
Source: MEPSNC/MAS/METP/MESU (2015)

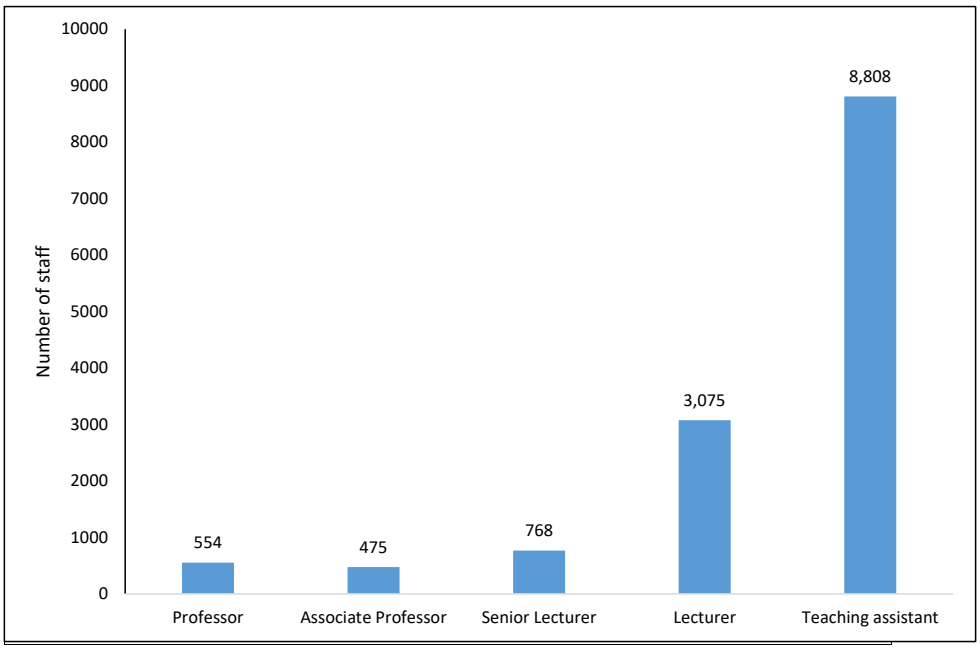

Figure 7. Academic staff of both public and private Higher Education Institutions
Source: CTSE (2011)

Governance of Higher Education Institutions

At the level of HEIs. The total number of administrative staff in the different HEIs was estimated to be 12,144 (Figure 8) in the public HEIs and 2,767 for the central administrative unit at the line Ministry (Figure 10) (World Bank, 2005). This makes the administration staff almost double the size of academic staff in the public HEIs. The total number of Directors was estimated to be 910 with 1,232 Heads of Divisions. This number of Directors and Heads of Divisions almost doubles that of academic staff beyond the rank of senior lecturer in the public HEIs; and relatively higher than the same group in all the HEIs. The majority of the academic staff were men; only 899 staff were female in 2010, representing 6.5% of the academic staff in all the HEIs.

The administrative bodies of all the HEIs are also dominantly in the hands of men. Women are also very much the minority within the Faculty / Section Councils and their Faculty Offices and among the positions of responsibility at all levels. The same was true for Department Councils and the positions of Heads and Department Secretaries.

Governance at the Ministry level. The Line ministry with the mandate of steering the governance of the HEIs in DRC, had periods of fusion and fission with the Ministry of primary, secondary and professional education (Figure 10). The periods of fission between the two Ministries include the period of 1960-1980, 1992/93 and 1997-2000. The splits and fusions aimed at improving the efficiency of the Ministry (ies) to make education accessible and deliver quality education to all DRC students. The tenants of the split Ministries believe that they represent two different realities and that they need different approaches in terms of management. While those who believe in unicity of

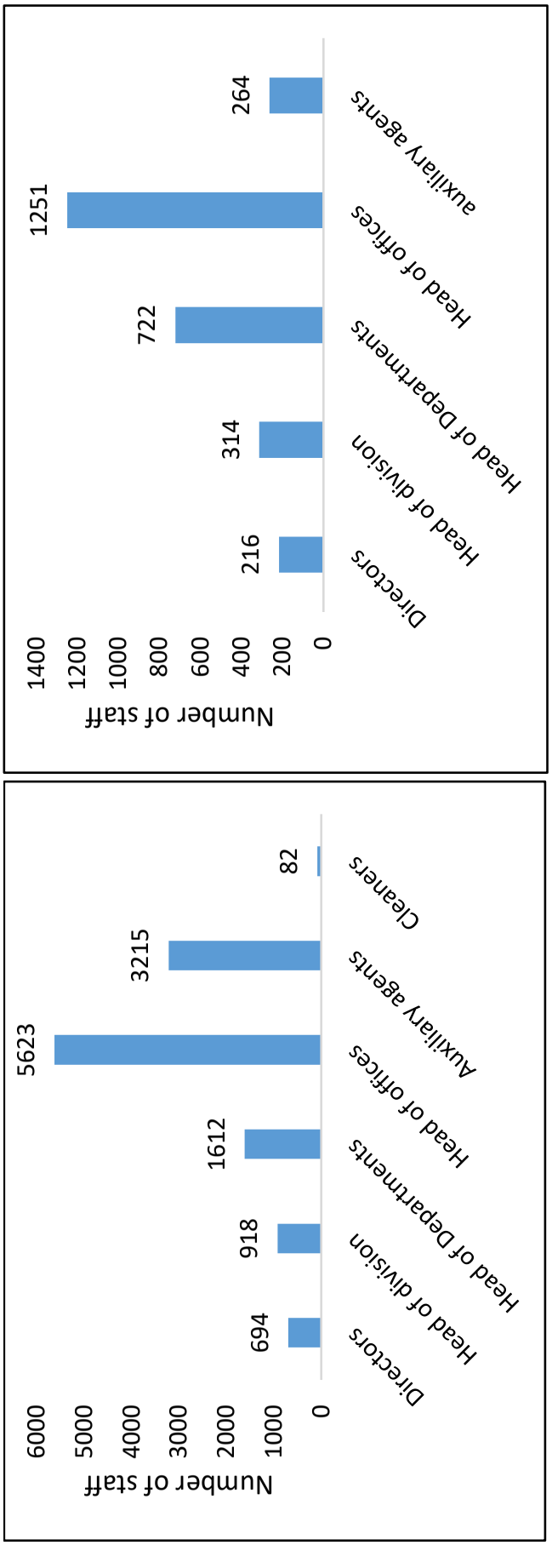

Figure 8. Administrative staff in public HEIs (left) and at the Ministry (right)
Source: World Bank (2005) and MEPSINC/METP/MESU, 2015

administration of education ministries argue that integration of these ministries provides more benefits in streamlining regulations and reducing operation costs – in fact, it was observed that fusion of Ministries of education always happened during periods of financial constraints. The fusion of the two line ministries coincides with the drastic decline in the country's economy in the 1980s (CENADEP, 2009). This is attributed to various reasons – external and internal. From 1965 to the mid-1970s, the country was politically stable, with low monetisation of the deficit and lower inflation (Nachega, 2005). The brutal slowdown in economic activities and the soaring of inflation in developed countries in 1973-1974, associated with the increased fuel price affected drastically the export of raw materials from developing countries including DRC whose economy was heavily dependent on mineral exports. This was aggravated by the "Zairianisation" process in 1974, the 1979 fuel crisis and the closure of the Benguela runway because of the war in Angola (Nachega, 2005). The country then only relied on debts as the only way to obtaining supplies of goods and services and fresh capital from abroad. The overdependence on a few commodities for its foreign exchange earnings, namely copper, cobalt, diamonds and coffee; economic difficulties of the State-owned company Gécamines associated with lack of maintenance of its equipment (Maton, 1991), and the internal political instability pushed the country's economy to its lower limits in the period 1993-1994. DRC pursued a structural adjustment programme since 1983, but this programme has been interrupted several times. The period 1997/2000 coincided with war of liberation of DRC and the Presidency of Laurent Kabila under difficult conditions.

Status of Science, Technology and Innovations in DRC

Existing human capacity and infrastructure. Science, Technology and Innovations are increasingly recognised as critical for the transformation of economies, reduction of poverty, attainment of Sustainable Development Goals (SDGs) and integration of the country into the global knowledge economy. "L' L'association congolaise pour l'avancement de la science, de la technologie

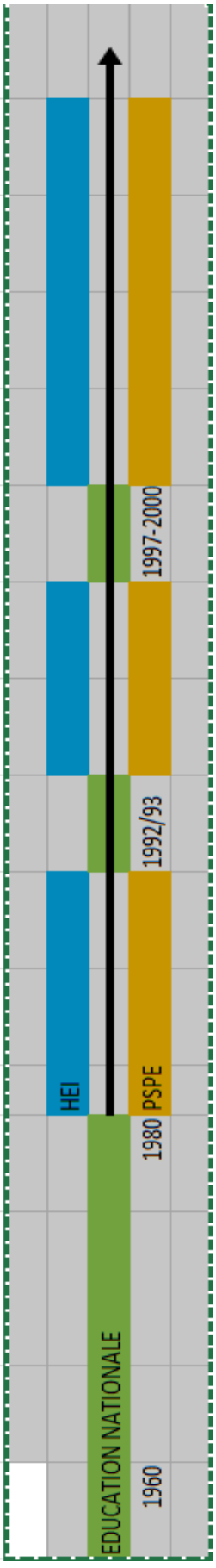

Figure 9. Periods of fission and fusion between MPSPE and MESU (green Fusion, bleu, white and orange Fission of ministries)

et de l'industrie (ACASTI), believe that in the last three decades, R&D has been marginalised in the DRC. Researchers and innovators have access to very limited resources to engage into research and thus, innovate. According to the UNESCO data base, there is limited capacity for R&D in DRC. The country had 199.68 researchers per million inhabitant in 2009. Only 8.7% of them were female. The majority of them were government employees and/or from HEIs, and a small proportion were from Private non-profit organisations. The majority of government employees in research belong to research centres including Institut National d'Etude et Recherche Agronomique-INERA, "Conseil National de Sécurité Nucléaire-CNSN, Comité National de Protection contre les Rayonnements Ionisants- CNPRI, Conseil National du Travail, Congo Research Group, Centre de Recherches Geologiques et Minieres-CRGM, Institut de Recherche en Sciences de la Sante-IRSS, Centre de Recherche en Hydrobiologie-CRH, Centre de Recherche Agro-Alimentaire and Observatoire Volcanique de Goma-OVG. However, INERA remains by far the largest government research centre in the country, and employs close to half the country's agricultural researchers. It operates 12 research centers and stations across the country focusing on locally relevant adaptive research covering crop, livestock, forestry, and fisheries. These institutions have suffered a lot of brain drain. Despite the facts that young people are being recruited in many of these institutions, the majority of the staff remain old, the administrative staff are plethoric, and limited retooling exercises have been conducted.

Most of existing infrastructure at HEIs and government research centres, including laboratories and libraries are old and poorly maintained (CTSE, 2010; Foster *et al.,* 2011), and cannot accommodate the increasing number of students. Online laboratory practicals cannot be adequately conducted because of the limited internet connectivity, and limited access or lack of electricity in several HEIs. Yet the country possesses one of the biggest hydro-electrical potential, and produces sufficient electricity for the country, however, its distribution and management has remained a major challenge.

Data on public investment in R&D in the country is very scanty, since there is no mechanism of collecting and managing this information. However, UNESCO estimated that DRC spent between 0.5-1 % of her GDP on R&D in 2015. It is also important to note that there are no mechanisms to collect data on research (type, relevance, quality, effectiveness) being conducted by the different stakeholders across the country.

Institutional arrangements for Public Research and Development. There is generally weak linkages among the main institutional actors in the national system of innovation namely; universities, public R&D institutes, private enterprises, financial institutions, technology support agencies, and policy makers in undertaking research and development activities. This is mainly because of the dysfunctional science governance system, lack of networking and inter-sectoral cooperation, limited influence of academic and professional associations and lack of public resources allocated to R&D. In addition, research priorities are only clearly defined for Research Centres. Generally, HEIs do not have a research agenda. Students can only do what they can afford with family resources.

Policy Instruments for Research and Development. Different R&D and STI policy guidelines are scattered in different sectoral policy documents including the National plan for agriculture and the policy on National Education. However, a draft STI policy was developed in 2010 and is awaiting to be finalised. In addition, the 2014 policy

Framework n ° 14/004, recognises that the use of Science and Technology is a sine qua none factor of the economic development of the DRC. The policy emphasises enhancing institutions governance, improvement of infrastructure, promotion of science and technology training, and strengthening collaboration between R&D institutions. The country has also ratified the agenda of the Southern African Development Community (SADC) and the Agenda 2063 of the African Union.

Technology support and regulatory agencies. One of key component of the national innovation systems are mechanisms of enhancing standard, quality and metrology (Mugabi, 2011). In DRC, control of the compliance to standard is done by the Congolese Office of Control - OCC. OCC is generally poorly equipped. However, to ensure that the OCC delivers good services to its customers, a partnership agreement exists between OCC and the Bureau Veritas BIVAC BV. The Ministry of the Environment and Rural Development (MEDR) is in charge of the implementation of the Environmental Policy, particularly the conduct of environmental and social assessments, through the Congolese Environment Agency (ACE).

Technological readiness and innovation capacity. Technological readiness represents the ability of an economy to adopt existing technologies for its industries' productivity enhancement; while innovation capacity is the ability of a country to expand the frontiers of knowledge and create new technology (Mugabi, 2011). Indicators of technological readiness include, among others, firm-level technology absorption, laws relating to information and communication technologies, FDI and technology transfer, personal computers per 100 inhabitants, and internet users and mobile phone subscribers.

Because of a relatively long period of instability, and unfriendly taxation system, only a few firms operate effectively in the country. According to the Group Special Mobile Association (2019) report, DRC mobile connectivity score in 2019 was 25.8, while mobile coverage reached 44.58% penetration rate in the country, with just over 40% of the population covered by a 3G connection (Jenal and Cunningham, 2019). The regulatory fees was 31%. The mobile connectivity score and the penetration rate are among the lowest in the region while the regulatory fees are among the highest on the continent (GSMA, 2017). For example the penetration rate in Zambia, Rwanda and Uganda stands at 78%, 68% and 68%, respectively. Major roads connecting the different parts of the countries are damaged at several points. Electricity supply is unreliable and sporadic in several parts of the country, despite the enormous energy potential that the country possesses. Several other factors may contribute to failure of innovations in the countries. According to Jenal and Cunningham (2019), lack of adequate market-supporting institutions to overcome various market failures and trust issues, coupled with coordination and search costs, may incentivize many to mainly trade in simpler goods and services. However, it is also important to note that the telecommunication industry has the potential to strive. The mobile payment services is booming (Gilman *et al*., 2013) – over 37 million mobile phone have been subscribed to and the Fibre Optics network is being finalised (GSMA, 2017).

Financial investment in Education. The resources made available to the education sector as a ratio of GDP is presented in Figure 11. Public expenditure on education amounted to just over 462 billion Congolese francs (CDF) in 2012. This represented 1.8% of the country GDP, and 63.8% increase compared to the 2005 expenditure. The annual expenditure on education has been increasing annually (p=0.03) by about 40.47 billion CDF (the equivalent of 0.1% of the GDP). In 2014, the expenditure on education increased by 18.7% compared to

its value of 2010 (MEPSINC/METP/MESU, 2015).

During the process of endorsing the new sector plan, the Government committed to bringing the share of its budget allocated to education to 20% by 2018 and to maintain it at that level until 2025 (MEPSINC/METP/MESU, 2015). This will requires doubling the financial resources devoted to the sector, from 1.3 billion USD in 2016 to 2.8 billion USD, in 2025. This strategy proposes an allocation of 69% of the resources to the payroll due to the increase in staff and measures for the gradual implementation of free education, including improving the rates of support for teachers and increasing their salary level now indexed to changes in per capita GDP. The mobilisation of additional public resources for education presupposes that the ministries concerned are better equipped to negotiate more favorable budgetary decisions that are more in line with international standards.

The trend in public expenditure allocated to Ministries, including the different line Ministries of education, over the period 2005-2012 is displayed in Figure 11. Only the expenditure under MESU significantly increased during that period. Percentage expenditure under MEPSP and other Ministries (OM) has declined slightly, while under MAS, the percentage expenditure remained constant over the years. A good correlation was found only between the expenditure under MEPSP and the number of pupils (R^2=0.62, and p=0.06). It is also important to note that the percentage expenditure for MESU has been oscillating between 0.4 and 0.6% and remained at 0.5% from 2013 to 2015.

The biggest proportion of the expenditure is dedicated to paying the personnel (Table 1). Purchasing of goods and subventions and transfers accounted for about a third of the expenditure. The amount allocated on personnel has increased annually by 4.02% at the expense of all the expenditures which have been declining over the years. Since 2007, Personnel and purchase of goods costs followed a quadratic shape with opposite concavities.

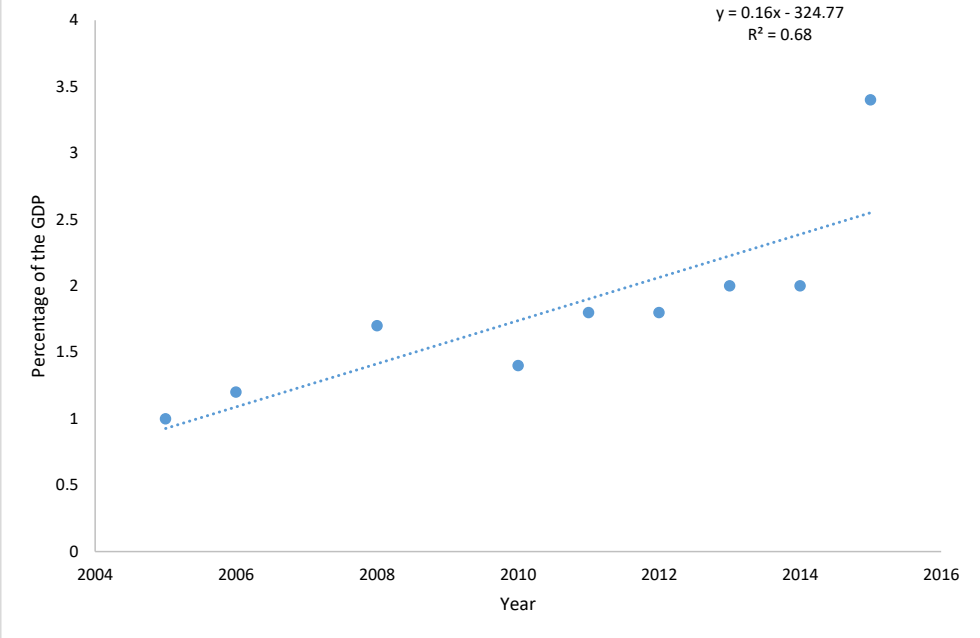

Figure 10. The trend in the proportion of GDP allocated to education in DRC (2005-2015)
Source: UNESCO (2015) and MEPSINC/METP/MESU (2015)

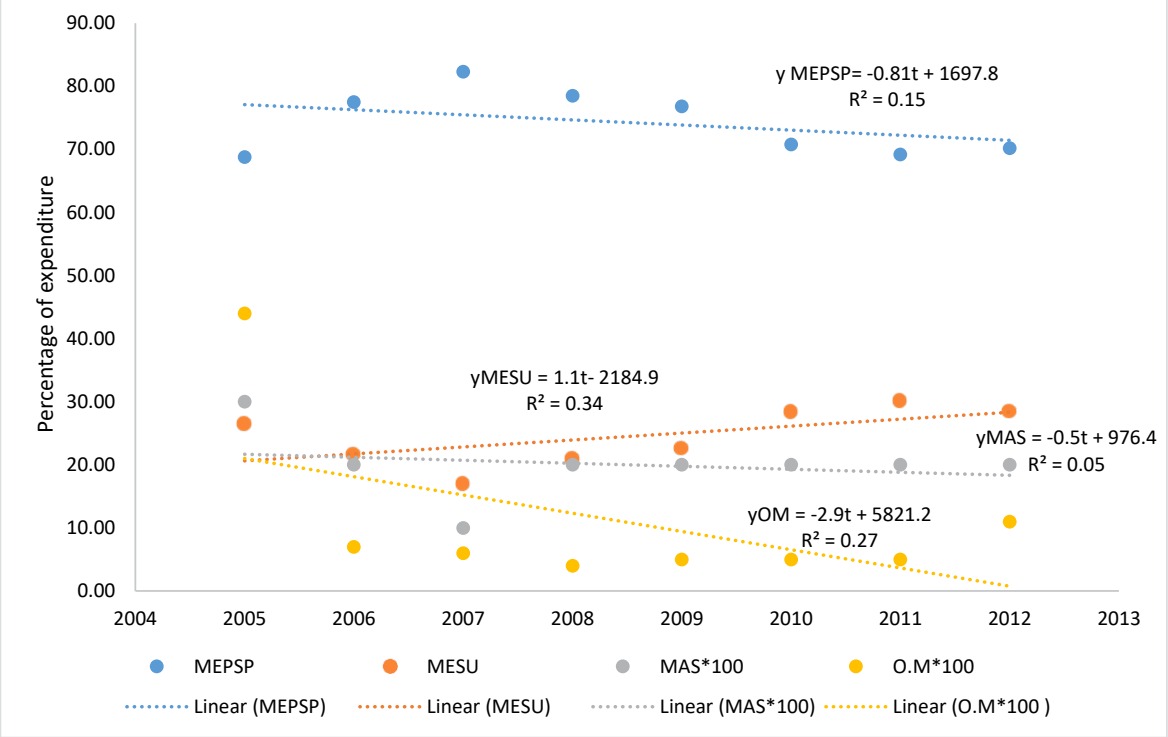

Figure 11. Percentage of expenditure allocated to Ministries for the period 2005-2012
Source of raw data: UNESCO (2015)

Table 1. Operation costs in MESU

Operational costs	2005-value (%)	Average (2005-2012)	Annual increment (%)
Personnel	64.7	90.6	4.02
Purchase of goods	24.7	6.9	-2.59
Subventions and transfers	10.6	2.2	-1.07
Social expenditures	0	0.3	-0.42*
Total	100	100	-0.06

* This was computed from 2007 values.
Source: UNESCO (2015)

Figure 12 below shows the percentage expenditure per type of HEIs in 2012. Relatively high percentage (35%) is allocated to pedagogical HEIs (Training teachers of secondary schools), followed by Universities, and the least was allocated to research (12%) institutions. Universities and Technical HEIs received each about the quarter of the budget.

However, the country is still considered to carry a significant risk of debt distress. According to Bou-Habib and Kebede (2016), it is vulnerable to the drop in exports and the increase in borrowing costs. Since the cancelling of the US $ 7 billion, as very heavily indebted poor country in 2010, the country has continued to borrow (Lapole Kanga, 2013). The risk incurred

is that the income generated will be lower than the amount of the debt service (Essl *et al*., 2019). Table 2 shows the cumulative cost of operations since 2005. Between 2005 and 2012, the cumulative costs of operations amounted to 106.48 billion franc. The biggest portion of the operations costs was spent on the equipment, repair and rehabilitation and studies. Salary and construction were only allocated 0.16% and 4.3% of the total operations costs, respectively. The distribution of operations costs favored more the MEPSP compared to MESU and other Ministries.

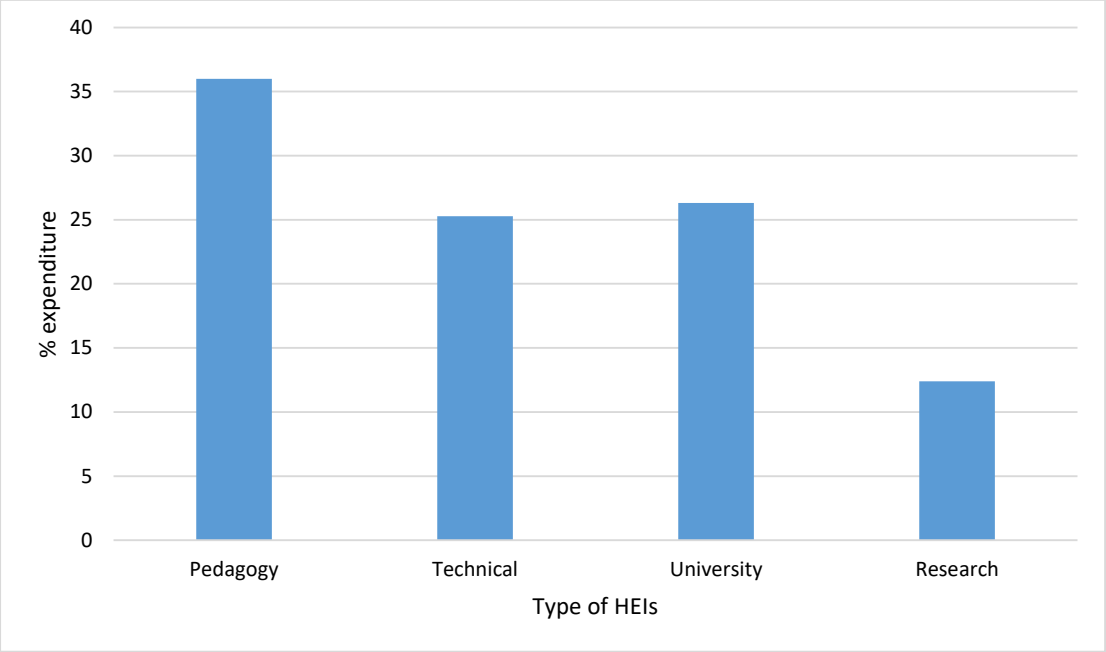

Figure 12. Percentage expenditure of public funds to the different type of HEIs
Source: CTSE (2011)

Table 2. Total operations costs from 2005-2012 (in billions of CF)

Operations	MEPSP	MESU	MAS	Other Ministries	Total
Construction	4.56	0.03			4.59
Salary	0.178				0.18
Rehabilitation/repairs	26.92	5.62		0.01	32.55
Studies	19.98			0.03	20.01
Equipment	42.61	6.42	0.07	0.05	49.15
Total	94.25	12.07	0.07	0.09	106.48

Source: UNESCO (2015)

Despite recent efforts to improve budget allocation to education, public education still is underfunded compared to most other countries in the region, with only 10.9 % of the government budget allocated to education and the implementation budget of 1.8 % of GDP in the sector. The SSA countries average is 17 % of total budget allocation, and 4.6 % as a share of GDP (World Bank, 2015). This places the DRC among the countries with the most poorly funded education sectors. Although substantial gains have been made in generation of revenue through family cost sharing, the finance of the latter are extremely stretched, particularly because of the socio-economic conditions which characterise the different households in the country. Consequently, additional resources for higher education are most likely to come from creative partnerships with private sectors, south-south and south-north collaborations and other innovative methods of revenue raising (Saint, 2009).

Challenges facing HEIs and STI in DRC

Tremendous increment in student enrolment in HEIs. Most of the public HEIs are overcrowded, because of the growing enrolments associated with both increased population and parents' expectations. The HEI enrolment rate is among the highest in the region, and it is likely to increase as the country stabilises politically and socio-economic conditions improve. In their current state, both public and private sector HEIs cannot meet the demand, if 50% of the current population of pupils in the last year of secondary school would like to pursue their studies. Most of the public HEIs are old and poorly maintained; while the private HEIs have generally small capacity.

Limitations of Inherited systems. DR Congo inherited the education system from the colonialists and the Belgian's tradition of 'free university education for all. Universities in DR Congo have been generally charging very low tuition fees as tertiary education is widely perceived as a 'public good'. Subsequently, several private HEIs are unable to adequately operate. This has pushed many parents to raise concerns over the quality of education provided, and thus well-resourced parents send their children outside the country. On the other hand, public HEIs are overwhelmed by the increased number of students with no proportional support from the government. Despite the fact that the Belgians have tried to overhaul and standardise their system to the European system of education, the DRC education system has remained intact, with timid attempts towards internationalisation. The mechanism for changing curricula and introducing new courses is cumbersome and is sometimes dysfunctional. The "Commission Permanente des Etudes" of the Ministry of Higher Education which finally approves changes in the curricula take a long time to meet. This was a legacy of the past when centralisation was the main objective of the DRC educational policy. As a consequence, HEIs look for shortcuts and secure temporary recognition from the line Ministry to open new programmes.

In many HEIs across the globe, programmes are revised frequently, generally every five years, to take into account the needs of the stakeholders and especially the demand from industries and the job markets. In DRC only a few public HEIs are authorised to run postgraduate programmes because of the limited HEIs capacity in the country. This coupled with brain drain, has hindered progress and building capacity for many HEIs. Most of the catholic HEIs, for example, use the institutional linkages with HEIs in Belgium and HEIs with comparative advantages to build their own capacity.

Under-investment in Research and Innovation. R&D has been marginalised for the last two decades in DRC. The higher education system has remained largely private but supported by extremely limited public budgets

that demoralise the personnel and can not foster growth in the system. From a system dominantly private and heavily supported by public funds at independence, the higher education in the DRC has shifted to a mixed public-private system almost entirely privately financed. The Government funds staff salaries in public HEIs and not research and the much-needed rehabilitation of R&D infrastructure is largely dependent on volatile donor support (BEFS, 2013). Private HEIs rely on students fees for salary of staff and infrastructure development.
Although HEIs employ a much higher (and younger) proportion of PhD-qualified scientists compared to the National Agricultural Study and Research Institute (INERA) and other government agencies, few of them have the time or resources to focus on research. An increasing number of private HEIs and nongovernment organisations have also become involved in agricultural R&D in recent years, but their capacity is limited. Linkages with industries, financial institutions, and other key potential partners that could have promoted R&D and science, technology and innovation have remained very poor. This is attributed to the inherent poor capacity of HEIs, the dysfunctional science governance system, limited influence of academic and professional associations, lack of public resources allocated to R&D and the long period of instability which has scared potential investors (CTSE, 2010).

Gender participation in schools and work. Women in the DRC have not attained a position of full equality with men, particularly in HEIs. In spite of the different national legislative provisions and international conventions which the DRC has adopted, the level of female representation in the different HEIs governance positions is very low; and the proportion of women lecturers and professors is also very low. In fact, women occupy only 2.8% of waged jobs, which are concentrated in farming, the informal sector, and commerce (Baharanyi *et al*., 2014).

Confusing policy and legal framework. The mismatch between policy and sector goals is evident. There are no clear mechanisms including financial commitment for the increased number of students in HEIs. Although targeting enhancing the quality of higher education, there is no mechanisms for controlling the proliferation of HEIs which are not viable, and does not provide a clear strategy to achieve the targets. The National education policy Framework no. 14/004 of February 2014, emphasises that the country relies on the use of Science and Technology for its economic development. However, the country does not have a Science, Technology and Innovation (STI) policy, and there is no mechanism provided in terms of strategy and financial arrangements for achieving the targeted objectives. A draft STI policy was proposed by the Ministry of STI in 2010 but is yet to be finalised.

Lack of academic freedom. In most of the HEIs, the leaders are appointed resulting in jeopardising the institutional governance efficiency. HEIs do not have autonomy of the programmes they run, and to some extent, the student recruitment. Even where such institutional control is not formally in place, academic freedom is constrained by the broader political restrictions on freedom of speech, and the Government's propensity to marginalise, arrest, or threaten those who criticise the regime. It is important to note that academics only thrive when they are given the liberty to pursue original and timely issues, and the space to provide critical analysis. Their work, in turn, challenges society to grow and improve.

Disorganised student recruitment process. DRC made a shift from elite training to mass training. During this shift, the recruitment process was significantly altered. The key university entry criteria is having at least 50% pass mark in the State examination (Examen d'Etat) and having resources to pay for tuition

fee. Finding a student who specialised in pedagogy in secondary school doing medicine or engineering at university is not a rare case in DRC. This student will certainly experience various challenges at university.

Limited trainings in emerging disciplines. The lack of lecturers for new disciplines and non-availability of books in the libraries are among the major challenges. In some HEIs, lecturers develop their course modules and sell them to the students. Lack of laboratories in most HEIs has had a deleterious effect on the quality of instruction in the sciences and medicine. Fees from students are insufficient to cover the cost of laboratory materials especially in the natural sciences. Sharing of laboratory and libraries between HEIs has been the main mechanism used to improve access to laboratory facilities in several parts of the country, hence minimising the cost of investing in equipment. Sharing of human resources has also been practiced in the country; but this has contributed to lengthening the academic year in HEIs and indirectly raising the costs of education for students.

CONCLUSIONS AND RECOMMENDATIONS

DRC has a large and growing higher education system, which includes public institutions and private largely dependent on family funding. Due to demographic pressure, the enrolment is rapidly increasing in both public and private HEIs, reducing significantly the government resources allocated to train a student. This is likely to overwhelm the entire HEIs if preventive measures are not taken considering the socio-economic environment of the students' families.

Despite recent efforts to improve budget allocation to education, public education has remained underfunded compared to most other countries in the region, with only 10.9% of the government budget allocated to education and the implementation budget of 1.8% of GDP in the sector. In addition, the sector is facing various challenges including, limited academic autonomy in selecting leaders and designing the curricula, proliferation of HEIs, and a plethora of administrative staff both in the ministry and in the HEIs. Congolese women and girls do not benefit from equitable representation in the HEIs in the DRC at all levels. There is inequality in access to higher education, academic careers and managerial functions as a pyramid that tapers from the bottom to the top. Overall, R&D and STI have been marginalised for the last decades, and the national innovation system is dysfunctional. Based on the above findings, there is need to:

- Ensure adequate funding of the education system and its future expansion. This funding should aim at reducing the unit cost of operations and increasing functional equipment in order to make a viable higher education system. This will also require diversification of funding sources;
- Develop medium to long term plans to resolve the HEIs structural and governance challenges that threaten to compromise the quality of the training provided by the HEIs. The quality of HEIs students not only depends on the quality of the HEIs academic staff and the quality of the learning conditions at HEIs but also the quality of the pre-university training. There is, therefore, a need to enhance the learning conditions in the pre-university schools, standardise the training at these levels, promote more practical learning than theories, and, more thinking than memorising;
- Build capacity of HEIs academic and administrative staff, through south-south and north –south partnerships. However, taking into consideration the current quasi isolation of the country at international level, there is a need to push for more south-south collaborations. There are various HEIs in the different regions of the continent which could offer adequate training to human resources in DRC. To this effect,

RUFORUM(see ww.ruforum.org)m as a network of universities for capacity building offers multiple opportunities for the country;
- Strengthen the capacity of the "Commission Permanente des Etudes" of the Ministry of Higher Education, to be able to perform its tasks, especially those related to programmes evaluation and accreditation;
- Create a credible quality assurance system, which would have authority over both public and private institutions;
- Strengthen the STI infrastructure and use of innovation systems approach to enhance the technological readiness and innovation capabilities of the country;
- Institutionalize the collection and management of statistics on HEIs, R&D, and Science, Technology and Innovation (STI) with a view of producing indicators for Research and Development (R&D) and Innovation
- Stregthen the STI infrastructure in the country
- Mount targeted programmes to increase female students recruitment at all levels of the education system; and,
- Create and strengthen partnerships between major stakeholders in the national innovations systems for enhanced R&D and STI within the country.

ACKNOWLEDGEMENT

Funding for this study was provided by the Transforming African Agricultural Universities to meaningfully contribute to Africa's growth and development (TAGDev). Thanks are also due to Bagula Espoir, George Tanzito, Evariste Byamunobe Mulongecha, Swedi Lukozi, Delu Lusambya, and Bonficace Yamungu, Esther Sebuliba, Josephine Nampijja and Mungu Lemba for data collection. However, the views expressed in this paper are those of the author and not of the institutions and individuals mentioned.

STATEMENT OF NO-CONFLICT OF INTEREST

The author declares that there is no conflict of interest in this paper.

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