Gender-based assessment of Science, Technology and Innovation ecosystem in Zambia

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ABSTRACT
In today’s fast changing world, science and technology are fundamental to sustainable socio-economic development of any nation. Sustainable development is anchored on the application of science and technology in the acquisition of knowledge, skills and technology that would build the capacity of the nation to meet its social and economic needs. In Zambia, over 51 percent of the population is female. Despite most of the populations in the sub-Saharan Africa having more women than men, women are underrepresented in almost all spheres of socio economic development. Worse STI, science engineering and technology has continued to record the lowest numbers of women participation. This desktop study involved review of documents from the Ministry of Higher Education, National Science Technology Council, Higher Education Authority, and Ministry of Gender. Careers in Science, Technology and Innovation (STI) and vocational training in Zambia is mostly dominated by males. Careers in engineering, agriculture, and medicine, technology and innovations continue to be male dominated. The Government of Zambia has recognized the importance of gender to promote science. Policies such as the Gender Policy, Higher Education Act, National Policy on Science and Technology, and Education Policy aim at ensuring gender based STI participation. The paper presents a STI analysis using a gender-based assessment of STI ecosystem in Zambia to gain a scientifically based understanding of the status of STI in Zambia upon which capacity development will be premised for now and in future. As of 2018, Zambia had nine public universities, 54 private universities and 29 vocational education and training institutions. The total enrolment in public universities was at 57,034, of which 55% were males and 45% female students. Public universities total enrolment stood at 34,935 students, 49% males while 51% were females. Training in STI is mostly offered in Government owned learning institutions due to the lack of capacity to buy equipment for science engineering and technology required for training.

Keywords: Gender, Higher education, Science, Technology, Innovation, Technical Education, Zambia

RÉSUMÉ
Dans le monde en évolution rapide d’aujourd’hui, la science et la technologie sont essentielles au développement socioéconomique durable de toute nations. Le développement durable repose sur l’application de la science et de la technologie à l’acquisition de connaissances, de compétences et de technologies qui renforceraient la capacité de la nation à répondre

Mots clés: Genre, Enseignement supérieur, Science, Technologie, Innovation, Enseignement technique, Zambie

INTRODUCTION

In the recent past, Science Technology and Innovations (STI) ecosystems have made significant contribution in enhancing public investment in research and development, human resource training and access to information and communication technology (UNCTAD, 2019). An ecosystem allows the use of knowledge in the production system to create value that no single entity could have created alone (Xu et al., 2018). The quality and number of a country’s scientists and technologists are an important resource for technological development of that country. Scientists, engineers and technologists transform national economies and societies by conducting research and development work whose output contributes to industrial development and national economic competitiveness (NSTC, 2015). It is a known fact that countries that have industrialised and developed have done so by anchoring their industrialisation agenda on the use science, technology and innovation (STI).

Xu et al. (2018) indicated that an innovation ecosystem consists of a knowledge ecosystem driven by research and development, and a business ecosystem driven by market forces. However, this can be achieved by the integration of all in technology transfer including participation of a broad spectrum of key stakeholders in research, industries, and national development. The use of innovation ecosystems require that specific attention be paid to the application of science, technology and innovation in developing nations and
sub Saharan Africa in particular if they are to achieve what the developed world have achieved in terms of development. The developed world has used science, technology and innovations to foster development and production. Research and development go hand in hand for increased production.

The use of STI in Africa is generally low due to limited capacity and technological resources for implementation of STI. The education system in Africa has been primarily influenced by UNESCO principle of Education for All (EFA) and notion of economic growth (Barret et al., 2019). The focus of EFA is life skills and twenty first century skills beyond literacy and includes problem solving and critical thinking through science, technology and innovation for national development.

In sub-Saharan Africa, the pathways linking STI has included the emphasis on Science, Technology, Engineering and Mathematics (STEM) and Information Communication and Technology (ICT) in the education system. This approach is hinged on the realisation of the importance of STEM as an approach and strategy for achieving sustainable national development.

Policies and frameworks have been developed consistent with national development visions but gaps exist between policy and practice during implementation. According to Barret et al. (2019) gaps in achieving STI include inclusion, equity and equality in the education sector for science, engineering and technology in terms of access to science and technology by different gender, and equipment facilities needed to contribute to national development. As such efforts have been made through development of policies to address gender parity, equality and improvement in STEM and ICT investments.

Study setting
Zambia is a middle income State located in Southern Part of Africa. The country has a surface area of about 752, 000 km$^2$ (MNDP, 2017; World Bank, 2017). The country is endowed with abundant natural resources including copper, vast arable land, huge amount of surface water, and forestry resources. The Zambian economy is predominantly based on the exploitation of these natural resources. The major economic resource and foreign exchange has been copper since the early 1900s. The country runs a free market economy where the means of production are in the hands of the private sector. In 1991, the country embarked on privatisation of State owned mining and manufacturing industries. However, this was not a successful transition as most of the privatised industries are no longer operational or have closed.

Despite an abundance of natural resources, the country today imports most of its finished products as opposed to local manufactured products. Poor quality and limited innovation has greatly contributed to the preference for imported goods and services instead of local ones. There is little value addition and application of technology in the local industry. The Government has however come up with policies and interventions to improve the use of science and technology in the country. A major contributing cause of the poor performance of the manufacturing industry has largely been due to lack of application of science and technology, which has resulted in industries becoming uncompetitive with declining productivity (Ministry of Education, 2016; Higher Education Authority, 2017).

Zambia’s development agenda is outlined in realising the Vision 2030. Vision 2030 (2006-2030) aims to transform Zambia into a prosperous middle income nation by 2030 and to create a new Zambia which is a “strong and dynamic middle-income industrial nation that provides opportunities for improving the well-being of all, embodying values of socio economic justice.” The country aspires to build local economic growth through the education system that is capable of
transforming the natural resources through investing in science, engineering, technology investing and entrepreneurship. In order to achieve this vision education will need to play a greater role. Moreover, the growth of the industrial sector hinges on robust application of Science, Technology and Innovation (STI) and engineering.

**METHODOLOGY**

The study employed desk top review and key stakeholder discussions approach in the compilation and analysis of gender based STI ecosystem in Zambia. Key institutions targeted included science and technology based learning providers including Universities (both private and public), Technical Education and Vocational Training (TEVET) institutions and colleges, the Ministry of Higher Education, Higher Education Authority (HEA), and the National Science Technology Council (NSTC). The mapping of institutions used in the analysis is presented in Table 1. Due to the COVID-19 pandemic and restrictions prescribed in the guidelines by the World Health Organisation (WHO) and Ministry of Health, the study relied on website and online information to gather information and statistics (Table 1).

In some cases, emails and phone interviews were used to access information. National policy and legal frameworks were also referred to in the assessment. These included, National Science and Technology policy, Higher Education Act, National Gender Policy, Education Policy, Seventh National Development Plan and the Vision 2030 paper.

In this paper, data collected for female participation in higher education and STI activities to determine the trend was restricted to the period between 2014 and 2018. For the other statistics included in this paper the period covered is seven years. Some key informants from NSTC and HEA were also consulted on the status of STI situation in Zambia, women participation in decision making, challenges and opportunities.

**Table 1. Summary of data collection process**

<table>
<thead>
<tr>
<th>SN</th>
<th>Data and information collected</th>
<th>Method/activity</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gender policies, strategies and representation in higher education: challenges and opportunities</td>
<td>Literature review</td>
<td>Ministry of Higher Education, Ministry of Gender, TEVETA, Zambia Agriculture Research Institute, Peer review articles, Zambia statistics agency, National Council for Scientific Research, UNCATAD Website</td>
</tr>
<tr>
<td>2</td>
<td>Percentage of females in decision making, higher education organisations, Level of attainment, % of females enrolled and graduates in STEM fields, Education expenditure and % of women participating in STI.</td>
<td>Secondary data and descriptive statics analysis</td>
<td>Ministry of Higher Education and Ministry of Agriculture, Zambia StatistIcs Agency (Labour force surveys, 2014-2020) and Analysis of gender.</td>
</tr>
<tr>
<td>3</td>
<td>Mapping of existing Gender and STI initiatives, main actors and their contribution Women participation in STI initiatives</td>
<td>Documents analysis interviews</td>
<td>Annual Reports from the Ministry of Higher Education 2018 Key informants Websites</td>
</tr>
<tr>
<td>4</td>
<td>Challenges and opportunity for improving gender in STI Future for women participation in STI.</td>
<td>Compilation of secondary data and interviews.</td>
<td>Key informants from Ministry of Higher Education</td>
</tr>
</tbody>
</table>
Findings

Institutional setup of Science, Technology and Innovation in Zambia. Zambia got her independence in 1964. At the time the country’s economy was hinged on copper production. Subsequently, the country embarked on implementation of various macro-economic and development strategies. However, from 1964 to 1991, the economic and industrial performance in Zambia deteriorated significantly (GRZ, 1996). In an effort to revamp its economy, the country changed its economic policy framework in 1992 from a Central State controlled to a free market and liberalized economy, with greater emphasis on private sector participation in the economy. With many former State owned companies and economy in the hands of the private sector, the country’s manufacturing sector has collapsed, relying largely on imported goods and services.

The Government has realised that the major contributing factor to the poor performance of the industry has been the limited application of science engineering and technology in the utilisation of the country’s resources and wealth. Local industries had become unproductive with declining productivity under global trade and market environment. The Government has realised that sustainable economic development can be achieved through the use of science and technology guided by national policies in the education and other national development related sectors.

In 1996, the Government developed the National Science and Technology Policy to foster the use of science in the utilisation of natural resources and achieving sustainable national development. In Zambia Science and Technology work is carried out largely by the National Council for Scientific Research (NCSR), private and public universities, line ministries principally, Agriculture, Food and Fisheries, Environment and Natural Resources, Mines and Minerals Development, Health, and Science Engineering, Technical and Vocational Colleges (TEVETA) and with funding predominantly from the Government and cooperating partners including the UN agencies. Despite this set up funding for research and development by both Government and private sector has, however, been limited and this has greatly contributed to the poor performance of the application of Science and Technology in national development. There is also a weak linkage between the country’s research institutions, the Government and industry.

In the higher education sector and university education in particular, the Government created the Higher Education Authority (HEA) in accordance with section 6(h) of the Higher Education Act No 4 of 2013. The mandate of the authority is to ensure quality and standards in education to increase access to higher education in the country. The Act further ensues that institutions pursue excellence and promote the full realization of the potential of learners while creating conditions for lifelong learning. On STI, the Act envisages strengthening the effect of academic learning and scientific research so as to enhance social and economic development.

The Act aspires that higher institutions conduct critical research necessary and responsive to national needs. Such research will entail participation of both males and females. The Act has further provided for an increase in the number of universities in Zambia including both private and public (Table 1). Having an increase in number of institutions has its own challenges in ensuring full participation and access to higher education for both male and female. The cost of tuition fees has been too high and not affordable to the majority of Zambians. Further, operations cost by university management has made universities prefer social and humanities programmes to sciences and technology including engineering. This
is because training in science and technology requires significant investment in laboratory and other equipment.

**Zambia Education Framework**

The education framework in Zambia is anchored on two main Ministries, the Ministry of General Education (MOGE) and the Ministry of Higher Education (MOHE). The Ministry of General Education caters for pupils in early child education, (ECE), primary education grade 1-7 and secondary education grades 8-12. The mandate of the ministry includes promoting skills development, science, and technology and innovation education in primary and secondary school in Zambia. The education curriculum for primary education and secondary school education is developed by the Curriculum Development Centre (CDC). The development of curriculum in science related subjects is not easy and effective as it for the non-science subjects. The Zambia Education Curriculum Framework 2013 identified challenges including; limited resources for teaching of science and technology, lack of equipment, gender disparities coupled with cultural biases and attitude for female not to participate in science and technology, and few female trained teachers as role models for female in science field. (GRZ, 2013).

On the other hand, the Ministry of Higher Education was established through Government Gazzete No. 836 of 2016 to formulate policy and regulate University Education, Vocational Education and Training, as well as to promote the application of Science, Technology and Innovation for socio-economic development. Higher education in Zambia refers to any structured and systematized learning offered by formal learning institutions that award certificates, diplomas, and degrees acquired after secondary or high school (Mkandawire and Ilon, 2019). Higher education institutions includes universities, colleges, institutes, trades, seminaries, and specialized job training institutions. All the Technical Education and Vocational Training (TEVET) institutions and other collages are under the Ministry of Higher Education. Formerly, Technical and Vocational Training (TEVET) was anchored in the Ministry of Education, Science, Vocational Training and Early Education (MESVTEE).

Under the Ministry of Higher Education, there are nine public universities, 54 private universities and 29 vocational education and training institutions.

**Table 2. Number of Higher Education Institutions in Zambia**

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
<th>2017</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Public Universities</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>Private Universities</td>
<td>16</td>
<td>54</td>
</tr>
<tr>
<td>3</td>
<td>Colleges of Agriculture</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>TEVETA Colleges</td>
<td>284</td>
<td>295</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>317</td>
<td>378</td>
</tr>
</tbody>
</table>

Source: https://www.agriculture.gov.zm

According to the census of 2018, the total enrolment in public universities was 57,034, of which 55% were male and 45% female students. Public universities total enrolment stood at 34,935 students, 49% and 51% female (Masaiti and Simuyaba, 2018). Further, in 2019, the Ministry of Finance 2019 Annual Economic Report indicated that the total student population in both public and private universities increased by 5 percent to 99,222 from 94,250 in 2018. Of the total student population, 39,689 were female students.

**National Science and Technology Policy**

The Government of Zambia developed the National Science and Technology Policy in 1996. The mission of the NSTC policy is to promote and exploit science and technology as an instrument for developing an environmentally friendly indigenous technological capacity in sustainable socio-economic development in order to improve the quality of life for Zambia.
The goals of NSTC policy include:-
• enhancing linkages between technology research institutes, the private as well as the public sector in order to encourage demand-driven research and development;
• developing and sustaining a national scientific and technological capacity and providing highly skilled human resource for increased productivity in the economy;
• fostering national and international linkages for enhanced technology transfer; and
• Facilitating the acquisition, adaptation and utilization of foreign technology.

The actualisation of this policy is done under the supervision of the Ministry of Higher Education and the implementation by various institutions including, National Science Technology Council (NSTC), Universities, Technical Education and Vocational Training Colleges (TEVET).

National Science Technology Council. The

National Science and Technology Council (NSTC) is a statutory body established by the Science and Technology Act No. 26 of 1997. The main function or mandate of the Council is to “promote science and technology so as to improve the quality of life in Zambia”. The vision of NSTC is to promote the use of Science, Technology and Innovation for industrial development in Zambia. In order to realise this vision, NSTC has the following strategic objectives:

Promotion of science, technology and innovation to increase scientific knowledge, enhance product development, through increased uptake of research results by industry, in compliance to STI standards, improved science centres and development of science; and strengthen stakeholder linkages to enhance science, technology and innovation sector coordination for national developmental sectors.

Figure 1. Selected African countries with women representation in politics by 2018. Source: Okedele (2020)
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Status of STI ecosystem and women participation

Women participation in decision making and political arena. In order to foster participation of women in STI, decision making organs, the Government plays a critical role in encouraging gender mainstreaming. Some African countries have adopted the quota system with a minimum of 30% of women representation in political positions as stipulated by the Southern African Development Community (SADC) Protocol of 2008 (Okedele, 2020). The Protocol aims to provide for the empowerment of women, to eliminate discrimination and achieve gender equality by encouraging and harmonising the development and implementation of gender responsive legislation, policies and programmes and projects. Gender quota system focus on women engagement into politics and decision making in member (SADC) countries. The protocol advocates for the representation of women in parliament to be at least 30%. Women participation has been recognised and achieved at national policy level in Angola, Mauritius, Mozambique, Namibia and Zimbabwe whereby an affirmative action has been taken to increase women representation (Figure 1) to a minimum of 30%. In Zambia, the governance system does not follow the quota system hence women representation has been under represented.

By the end of 2018, Rwanda had the highest representation of women in parliament at 63.8%, South Africa 41.8%, Mozambique 39.6%, and Angola 36.8% while Zambia had 18% representation (Gender Links, 2017: Okekedel, 2020).

Based on the August 2016 general elections, Zambia is ranked the 4th lowest performing country in the region with slight improvement in women representation in parliament, 18 in 2011 to 25 in 2016 (Figure 2). At cabinet level, there was more than 50% improvement with 12 women in cabinet in 2010 and to 25 in 2016. This is an indication that Zambia can do better in this area if the quota system is applied.

The low participation of women in decision making can be attributed to a number of factors such as;

- Low education level
- Low literacy levels and society’s perception of the role of men and women,
- Lack of financial resources as most women in Zambia depend on male counter parts,
- Traditional work burden despite some of the women being in paid formal employment,
- Religiously, power and authority is believed to belong to men hence hindering women from participating in decision making

However, in order to sustain equality in decision making, the Zambian Government has proposed the inclusion of a minimum of a 30% quota system and proportional representative. Political parties have been tasked to develop and adopt gender policies and action plans that will increase women participation in decision making (GSWLG, 2018).

Zambian STI development and gender mainstreaming

According to the Vision 2030 agenda for Zambia, the nation’s ambition to become a middle income and industrialised economy, there is need to invest in science and technology. In addition, Zambia’s Seventh National Development Plan 2017-2021 is a roadmap which has also recognised the cardinal role of science, engineering and technology in national development (GRZ, 2017). The Seventh National Development Plan includes strategies to enhance science and technology by developing programmes to prioritise research in education institutions to promote productivity, innovation and
competiveness in the economy. Additionally, there is need to promote research and innovation to steer the creation of new products and new ways of producing existing products efficiently by the industry and agriculture sector. Science and technology therefore becomes of paramount importance. The National Science and Technology Council is one of the key mandated institutions to promote science and technology development in the country.

In the National Science and Technology Council of Zambia 2019-2021 Strategic Plan, Zambia aspires to transition from being a raw material producer and exporter to a value-adding, knowledge-intensive and industrialised economy (NSTC, 2019). The adoption of science, engineering and technology plays a critical role in achieving this aspiration. The Government of Zambia has developed many legal frameworks and policies. In general this starts with the education policy and higher education polices.

Recognising gender imbalances in Zambia, the National Gender Policy was developed. It aims at ensuring the attainment of gender equality in the development process by redressing the existing gender imbalances including in education and socio-economic opportunities. It also provides for equal opportunities for women and men to actively participate and contribute to their fullest ability and equitably so as to benefit from national development (GRZ, 2014). The policy is an overall benchmark for gender mainstreaming in national development. The decisive intention of this Policy is to create a Zambian society which has achieved the Vision of ‘A nation where there is gender equity and equality for sustainable development’. The Government has realised the cardinal role of Science and technology for girls as opposed to the usual trend whereby this has been dominated by their male counterpart. The Government has since built Technical Schools for Girls in each of the country’s 10 provinces since 2016.

Figure 2. Comparison of numbers of women elected to parliament and serving as cabinet Ministers in Zimbabwe
Source: CSO. 2018
STI in Higher Education Institutions in Zambia

The number of tertiary STI education institutions in Zambia between 2017 and 2020 is presented in (Table 2). The number of higher education institutions in Zambia increased from 317 in 2017 to 378 in 2020. Currently, Zambia has nine public universities, 54 private universities, 15 colleges and schools of agriculture and 295 TEVETA colleges. The general enrolment in these institutions is provided in Table 3. The University of Zambia is the leading public university in the country with a total enrolment of over 24,676 students segregated by gender as 13,406 males and 11,270 females, respectively as of 2018 (Masaiti and Simuyaba, 2018.)

Private universities on the other hand have low enrolment but with numbers steadily on the rise (Table 4). It should be observed that the number of females in public universities is generally lower than that of their male counterpart. As for private universities offering science and technology, City University of Science and Technology, and Africa Research University have more female students.

<table>
<thead>
<tr>
<th>University Name</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Zambia</td>
<td>13,406</td>
<td>11,270</td>
<td>24,676</td>
</tr>
<tr>
<td>Copperbelt University</td>
<td>8,010</td>
<td>3,650</td>
<td>11,660</td>
</tr>
<tr>
<td>Nkrumah University</td>
<td>4,710</td>
<td>4,173</td>
<td>8,883</td>
</tr>
<tr>
<td>Mulungushi University</td>
<td>2,644</td>
<td>2,107</td>
<td>4,751</td>
</tr>
<tr>
<td>Chalimbana University</td>
<td>1,442</td>
<td>3,279</td>
<td>4,721</td>
</tr>
<tr>
<td>Mukuba University</td>
<td>1,023</td>
<td>1,320</td>
<td>2,343</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>31,235</td>
<td>25,799</td>
<td>57,034</td>
</tr>
<tr>
<td><strong>Percent</strong></td>
<td>55%</td>
<td>45%</td>
<td></td>
</tr>
</tbody>
</table>

Levels of qualification attainment by gender. The levels of attainment in the education system from secondary to higher education is dominated by more males than females (Table 5). In 2017, at secondary level, half (32.7%) of females compared to 67.3% of males attained secondary school qualification certificates. The trend is not different at higher levels of education. However, at Postgraduate level, the number of females has been significantly lower (22%) compared with that of male counterparts (77%) of who graduated with master’s degrees. Most recently in 2019, 26% of females compared with 74% attained master’s degrees.

Gender in STI for Higher Education Institutions in Zambia. During the period 2017 and 2019, Zambia had about 317 and 378 STI oriented institutions of higher learning offering sciences, engineering, agricultural and technological courses.

Table 3. Student enrolment by gender and university institution (Public Universities)

<table>
<thead>
<tr>
<th>University Name</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lusaka Apex University</td>
<td>2,834</td>
<td>4,299</td>
<td>7,133</td>
</tr>
<tr>
<td>University of Lusaka</td>
<td>3,454</td>
<td>3,295</td>
<td>6,749</td>
</tr>
<tr>
<td>DMI St. Eugene University</td>
<td>2,754</td>
<td>2,244</td>
<td>4,998</td>
</tr>
<tr>
<td>Rusangu University</td>
<td>2,052</td>
<td>2,027</td>
<td>4,079</td>
</tr>
<tr>
<td>Zambia Open University</td>
<td>1,595</td>
<td>1,925</td>
<td>3,520</td>
</tr>
<tr>
<td>Cavendish University</td>
<td>1,579</td>
<td>1,270</td>
<td>2,849</td>
</tr>
<tr>
<td>Chresco University</td>
<td>636</td>
<td>970</td>
<td>1,606</td>
</tr>
<tr>
<td>LIUTEB</td>
<td>766</td>
<td>707</td>
<td>1,473</td>
</tr>
<tr>
<td>Northrise University</td>
<td>434</td>
<td>291</td>
<td>725</td>
</tr>
<tr>
<td>Zambia Catholic University</td>
<td>288</td>
<td>419</td>
<td>707</td>
</tr>
<tr>
<td>City University of Science and Technology</td>
<td>371</td>
<td>159</td>
<td>530</td>
</tr>
<tr>
<td>Africa Research University</td>
<td>183</td>
<td>98</td>
<td>281</td>
</tr>
<tr>
<td>Trans-African University</td>
<td>132</td>
<td>60</td>
<td>192</td>
</tr>
<tr>
<td>Evangelical University</td>
<td>28</td>
<td>28</td>
<td>56</td>
</tr>
<tr>
<td>Southern Valley University</td>
<td>17</td>
<td>9</td>
<td>26</td>
</tr>
<tr>
<td>African ChriSTlan University</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>17,130</td>
<td>17,805</td>
<td>34,935</td>
</tr>
<tr>
<td><strong>Percent</strong></td>
<td>49%</td>
<td>51%</td>
<td></td>
</tr>
</tbody>
</table>

Source: Masaiti and Simuyaba (2018)
Table 5. Attainment of qualifications from Secondary to Tertiary Education level 2017 -2019

<table>
<thead>
<tr>
<th>Education Qualification attained</th>
<th>2019 Male</th>
<th>2019 Female</th>
<th>2018 Male</th>
<th>2018 Female</th>
<th>2017 Male</th>
<th>2017 Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary School Certificate</td>
<td>67%</td>
<td>33%</td>
<td>69.5%</td>
<td>30.5%</td>
<td>67.3%</td>
<td>32.7%</td>
</tr>
<tr>
<td>Certificate/diploma</td>
<td>58%</td>
<td>42%</td>
<td>59.3%</td>
<td>40.7%</td>
<td>60.4%</td>
<td>39.6%</td>
</tr>
<tr>
<td>Bachelor's Degree</td>
<td>62%</td>
<td>38%</td>
<td>67.8%</td>
<td>32.2%</td>
<td>68.2%</td>
<td>31.8%</td>
</tr>
<tr>
<td>Master's Degree</td>
<td>74%</td>
<td>26%</td>
<td>81.8%</td>
<td>18.2%</td>
<td>77.5%</td>
<td>22.5%</td>
</tr>
</tbody>
</table>


With regards to STEM field’s programmes, the enrolments are still dominated by male students. As indicated in Figure 3, only 37.3% of the female students were enrolled in Natural Sciences, Mathematics and Statistics, 25.2% in Information and Communication Technologies and 29.5% in Engineering, Manufacturing and Construction in 2018. These numbers were significantly lower compared to those of males.

According to the National Gender Policy (2014) access to tertiary education for females in Zambia still remains low due to limited places available in higher education institutions, high poverty levels and early marriages. For instance, in 2011, the combined total enrolment of the four Public Universities, i.e., University of Zambia, Copperbelt University, Mulungushi and Nkumah was 28,448 of which 17,332 males and 11,116 females. This imbalance is a reflection of what occurs in industries once these graduates.

In the management of higher education institutions, women are also underrepresented at Vice Chancellor and Deputy Vice Chancellor level. From 2015 to 2020, only 8% and 14% of women held the position of Vice Chancellor and Deputy Vice Chancellor, respectively, in both private and public universities. This shows the level of women under-representation at the higher education level management level. The numbers of females graduating in STEM programmes have not been consistent. Information and Communication Technology (ICT) has been low compared to in natural sciences, mathematics and statistics. However, engineering, manufacturing and construction has attracted more females, followed by natural sciences, mathematics, while Information and Communication Technologies attracted the lowest. Figure 4 shows the numbers of female graduates in (STEM) related fields during the period 2014 to 2018 in Zambia.

Higher Education Enrolments by Gender. In general terms enrolment between males and females at various levels of education differ significantly whether at secondary school, certificate and diploma, bachelor’s degree and postgraduate qualification. Overall, Science, Technology, Engineering and Mathematical Sciences (STEM) have very low female participation. Further, the number of women...
who attained Higher Education - Masters and PhD in this field is quite low. Similarly, only 14%, 25% and 29% respectively were female. This was not quite the case in fields like education and business-related programs where females constituted 48% and 49.2% respectively. In technical education sector, TEVET institutions admit less than 2% of the output from basic and secondary education and the Government plans to increase it to above 15% (AfDB, 2013).

**Government Investment in Science Technology and Innovation (STI).** The Government of Zambia plans to increase investments in science, technology and Innovations through budgetary allocation in the education sector. As an example, the 2016 Higher Education expenditure stood at 93% for University Education, 51% for Skills Development and another 51% for Science, Technology and Innovation (Figure 5).

The 2018 budget for the Ministry of Education had an approved total budget of K1.9 billion (Ministry of General Education, 2018 Annual Report). The major funded activities in the ministry included University Education (72.6%), STI (6.4%) and 18.3% for skills development (Figure 5 and Table 6).

![Figure 4. Total Number of female graduates in STEM fields 2014 -2018](source: Ministry of Higher Education 2018)
in the education sector. As an example, the 2016 Higher Education expenditure stood at 93% for University Education, 51% for Skills Development and another 51% for Science, Technology and Innovation (Figure 5).

The 2018 budget for the Ministry of Education had an approved total budget of K1.9 billion (Ministry of General Education, 2018 Annual Report). The major funded activities in the ministry included University Education (72.6%), STI (6.4%) and 18.3% for skills development (Figure 5 and Table 6).

**Zambian Labour force in STI.** The low participation of females in STI does not only end at tertiary level education but is further reflected in the labour market. Science, engineering and technology oriented careers are male dominated. There are however more females (52 percent) than males (48 percent) employed in the Agriculture, Forestry and Fisheries Industry (Gender Status Report 2014). Overall, the number of females working in the fields of STI in Zambia still remains very low below levels. (Figure 6).

In the agriculture sector, males dominate agriculture staffing, trained agriculture extension officers, fisheries officers, among others, constituting 64% compared to 35% for females in 2019 (Figure 6). However, the participation of non professional females or women accounts for over 70% of agriculture production labor force in the Zambia.

According to the Labour force Survey of 2014, out of 2,864 skilled employees in the agriculture, forestry and fisheries sectors, about 56% employed were women compared to 41% men (CSO, 2014). Despite this gender positive statistic, only a small percentage of females are in managerial positions.

According to Beintema and Di Marcantonio (2009), female farmers play a significant role in African agriculture representing between 60 and 80 percent of the labor force. Contrustingly on the scientific front, such as in agricultural scientific research and technology, men dominate. There are few female scientists, professors, and academicians in scientific research and technology. There is unfortunately limited information about female’s participation in science and technology in Zambia. Much of the concern of the policy focus has been on issues of women empowerment, gender based violence and victim support. Gender disaggregated data are needed in various aspects and sectors for sound policy information.

Source: Estimates of Revenue and Expenditure for 1st January to December 2017 (Volume 2)

**Figure 5. Budgetary allocation for Education Sector**
Information Communication and Technology in Zambia

In the 21st century, the use of information and communication technology is very critical. Computers and technology are no longer a luxury but a necessity for national development. Like in other STI fields, females participation in ICT in Zambia still lags behind significantly in comparison to men. This is despite that ICT is considered an important mechanism in delivering the socio-economic needs of both men and women (ZICTA, 2014). The use of ICT in socio-economic activities, which seek to encourage and enhance equal participation of men and women, is crucial in national development. Although Zambia adopted the Information and Communication Technology (ICT) Policy in 2007, which provided for mainstreaming of ICT usage in developmental programmes, very few women and girls have adequate access to ICTs especially in rural areas mainly due to limited ICT literacy and funding. Statistics for 2013 indicated that out of a total of 8,240,753 mobile phone subscribers, only 40 percent were women.

Government effort on mainstreaming STI in Tertiary Education. In the bid to increase access to higher education including in STI fields in the country, the Government of Zambia in 2016 established the Higher Education Loans and Scholarship Board (HELSB). The board was established through the Act No. 31 of 2016 to provide loans and scholarships to students who require financial assistance or who are recognised for academic excellence. The criteria of the loan is that the applicant must be admitted to, or registered as a student at a higher education institution within Zambia for a course of at least one academic year's duration. Further, a student is eligible for consideration for a scholarship if the student satisfies such conditions as the Minister may prescribe by statutory instrument. Before 2016, the Bursaries Committee was responsible for offering scholarships to students at the University of Zambia and Copperbelt University. The demand for financial support has always been on the increase as indicated in Table 7.

By 2018, a total of 20,649 loans were awarded to students in universities, out of which 12,212 (59%) went to males and 8,437 (41%) went to females out of over 35,000 applicants (MOHE, 2018).

By 2019, the higher education loans was restricted to public universities namely, Copperbelt University, Kapasa Makasa, Mulungushi University, Mukuba, Kwame Nkuruma and University of Zambia.
Figure 6. Percentage of males and females participating in agriculture, science, health and Information Communication and Technology
Source: CSO (2019)

Table 7. Award of students loans in Higher Education Institutions

<table>
<thead>
<tr>
<th>Year</th>
<th>Awards</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>3884</td>
</tr>
<tr>
<td>2013</td>
<td>4437</td>
</tr>
<tr>
<td>2014</td>
<td>5741</td>
</tr>
<tr>
<td>2015</td>
<td>4585</td>
</tr>
<tr>
<td>2016</td>
<td>6499</td>
</tr>
<tr>
<td>2017</td>
<td>5723</td>
</tr>
<tr>
<td>2018</td>
<td>6106</td>
</tr>
</tbody>
</table>

Source: Higher Education Loans and Scholarship 2019-2021 Strategic Plan

Challenges of mainstreaming Gender in STI
The low participation of women and girls in science and technology in Zambia is of great concern. Some of the identified challenges hindering participation of women STI include the following:

Access to tertiary education. The low number of females accessing tertiary education has been a challenge. This is depicted in Figure 3 as well participation in STI in Figure 6.

Lack of financial support. Generally a higher percentage of female students drop out from the education system compared to their male counterpart. According to CSO (2018), 39%
females drop out of the education system in urban areas while in rural area 45 % of female students drop out. This is due to a myriad of factors such as, early marriages, preference for males by parents and sponsors, and cultural attitudes that women focus on house and family chores rather than career progress.

**Limited job opportunities for STI graduates.** Currently Zambia has few manufacturing and processing industries. This has negatively affected the prospects for employment in engineering, construction, agriculture and energy sectors. A few opportunities are prioritized for male applicants such as work in rural areas where females would not prefer to work in.

**Inadequate gender statistics and few role models in STI Careers.** Currently women representation in parliament stand at 19%, with even fewer women employed as engineers and Vice Chancellors in Universities. This in away has contributed to girls to opt for service based careers such teaching, nursing, commerce and hospitality sectors. In addition, there is inadequate sex disaggregated data to capture the status of women in various STI fields. Most information is focussed on negative effects of Gender based violence rather than the positives on empowerment and improvements in female participation. This gives females a perception of being victims and vulnerable rather than having the potential to lead and contribute to national development.

**Negative attitude of females to science and technology courses and programmes.** Female students have negative perception about taking courses in mathematics, science and engineering. Moreover, limited laboratory infrastructure, places and programmes implies only few students will be enrolled in science and technology programmes which invariably results in fewer places for female students. Pure science classes and technical subjects have been perceived as male oriented (NSTC, 1996). Further, limited numbers of female role models as teachers and lecturers have promoted this myth about science as a male dominated career options.

**STI Strategies and Gender mainstreaming in Zambia**

Affirmative action by the Government of Zambia led to the creation of the Ministry of Gender to promote gender related issues in development. In promoting science, technology and innovations, the Government of Zambia is implementing the following strategies:

- Reviewing of educational curricula in schools, colleges and universities to make it gender sensitive for female participation.
- Establishment of special funds and scholarships for female education in the science and technical fields through the High Education Loans and Scholarship Board (HELSB)
- Promotion of science and technology subjects in girls’ schools such as making the subjects compulsory, and girls’ technical secondary schools have been created in all provinces of the country.
- Establish and/or strengthen career counselling programmes to address problems which hinder girls’ progression in Science and Technology.
- Provision of incentives to female teachers in science and technology and those willing to work in rural areas to work as role models.

**CONCLUSION AND RECOMMENDATIONS**

Science, Technology and Innovation plays a crucial role in meeting the internationally adopted Sustainable Development Goals (SDGs), approved by the United Nations General Assembly in 2015. In Zambia, STI gender ecosystem shows that the participation of female in science technology and innovation is still low as in other SADC countries and Africa in general. Starting from the lowest
position of secondary school to higher education university level and in political leadership, females are grossly underrepresented. However, there are on-going efforts through the National Science and Technology Council to encourage participation of females in STI. Also, the Ministry of Higher Education through the Higher Education Loans and Scholarships Board encourages participation of females in STI by sponsoring more female applicants for science, technology and engineering programmes. The Government of Zambia has in fact developed policies and strategies to encourage female participation such as through constructing girls’ technical schools throughout the country and giving incentives for female participation in STI subjects, and appointing females into Government positions.

**Recommendations**

- The Higher Education Loans and Scholarship Board (HELSB) should come up with strategies to promote female applicants secure scholarship and loans in science, technology and engineering programmes. This would increase female students’ enrolments and number of females in tertiary education sector and labour force.
- Gender mapping and statistics in STI systematically compiled and used to promote quality in Higher Education instead of focusing on gender based violence (GBV) which is currently the main focus of gender mainstreaming. Therefore participation of females in Science, Technology, Engineering and Mathematical Sciences (STEM) and STI should be prioritized.
- Promote more women leadership in science and technology and innovation oriented careers so that women act as role models for young females, i.e., as Vice Chancellors, Professors, Principals and in Industry, etc. Currently, the census for staffing in Higher Education is underway to provide capacity and status of staff and qualifications in tertiary education.
- Promote the Science-Policy interface. While many policies have been developed on gender, there is little effort in actualising such interventions on the ground. Government should come up with additional STI instruments to actualize the needed interventions, for example, creating small STI pilot projects to solve community problems and to promote the science-policy interface in national development.
- Create platforms for STI disseminations such as National workshops, seminars, conferences and create opportunities for dialogue with the female scientific community.
- Enhance transnational/regional and multidisciplinary approach on integrating STI in socio-economic development aspects including policy formulation. Additionally, encourage intra-Country scientific cooperation and collaboration across African region and developed world to promote technology transfer and knowledge exchange.
- Harness regional and and continental platforms to build capacity in STI in Africa.

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**STATEMENT OF NO-CONFLICT ON INTEREST**
The authors declare that there is no conflict of interest in this paper.

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