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<th>Full Form</th>
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<tbody>
<tr>
<td>AEC</td>
<td>Atomic Energy Commission</td>
</tr>
<tr>
<td>AERI</td>
<td>Atomic Energy Research Institute</td>
</tr>
<tr>
<td>ARC</td>
<td>Agricultural Research Corporation</td>
</tr>
<tr>
<td>ARRC</td>
<td>Animal Resources Research Corporation</td>
</tr>
<tr>
<td>ARIPO</td>
<td>The African Regional Intellectual Property Organization</td>
</tr>
<tr>
<td>ARU</td>
<td>Agricultural Research unit</td>
</tr>
<tr>
<td>ASTI</td>
<td>Agricultural Science and Technology Institute</td>
</tr>
<tr>
<td>CPA</td>
<td>Comprehensive Peace Agreement</td>
</tr>
<tr>
<td>DST</td>
<td>Department of Science and Technology</td>
</tr>
<tr>
<td>ERI</td>
<td>Energy Research Institute</td>
</tr>
<tr>
<td>ESR</td>
<td>Economic and Social Research</td>
</tr>
<tr>
<td>FAO</td>
<td>Food &amp; Agriculture Organization</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GERD</td>
<td>Gross Expenditure on R&amp;D</td>
</tr>
<tr>
<td>GII</td>
<td>The Global Innovation Index</td>
</tr>
<tr>
<td>GMC</td>
<td>Gordon Memorial College</td>
</tr>
<tr>
<td>GLC</td>
<td>Government Linked Company</td>
</tr>
<tr>
<td>HDI</td>
<td>Human Development Index</td>
</tr>
<tr>
<td>HDR</td>
<td>Human Development Report</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>IEC</td>
<td>Innovation and Entrepreneurship Community</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>IR &amp; T</td>
<td>Inter-Relations &amp; Technology</td>
</tr>
<tr>
<td>IRCC</td>
<td>Industrial Research and Consultation Centre</td>
</tr>
<tr>
<td>ISI</td>
<td>Institute for Scientific Information</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
</tbody>
</table>
LRC    Livestock Research corporation,
MAPRI  Medicinal and Aromatic Plants Research Institute
MCR    National Council for Research
MOHE   Ministry of Higher Education and Scientific Research
NCR    National Centre for Research
NIC    National Information Center
NFRC   National Food Research Center
NSERC  National Solar Energy Research Center
NCTR   Nile Center for Technology Research
NEF    Near East Foundation
NIH    National institute for Health
NGO    Non-governmental organization
NRC    National Research center
R&D    Research and Development
RERI   Renewable Energy Research Institute
PCT    The Patent Cooperation Treaty
PGR    Plant Genetic Resources
SAEC   Sudan Atomic Energy Commission
SAS    Sudan Academy of Science
SDGs   Sustainable Development Goals
S&T    Science & Technology
SSTI   Sudan STI
SFM    Swedish Free Mission
STI    Science and Technology Institute
SRIPG  Sudanese Researchers Initiative Public Group
TMRI   Tropical Medicine Research Institute
UNIDO  United Nations Industrial Development Organization
USPTO  United States Patent and Trademark Office
UNESCO United Nations Educational, Scientific and Cultural Organization.
WHO  World Health Organization
COE  Centers of Excellence
COMSATS Commission on Science and Technology for Sustainable Development in the South.
Executive Summary

Science, Technology and Innovation (STI) are key drivers of economic and social development. The experience of successful developing countries shows that STI policies that are well integrated into national development strategies and combined with institutional and organizational changes can help in promoting health and wellbeing, increasing productivity, alleviating poverty, and enhancing industrialization and economic growth. STI can also help achieving water, food and access to energy and is central to the response to climate change and biodiversity loss.

The council of ministers of Sudan in Oct. 2016 has approved a new STI policy, which is on the process of being translated into strategies and plan of actions with clear priorities. In this study, a detailed description of the new Sudan STI policies, regulations and strategies will be included. MOHE has been mandated by the government of Sudan to lead this important issue for the future sustainable development of the country. The government also supports this mandate by attaching all research, development, technology transfer and innovation institutes under MOHE administrative structure, that were previously under ministry of Science, Technology and Innovation (MOSTI). MOSTI has been abolished in 2015. The MOHE has created new units called scientific research and innovation commission to assume the role of policy maker and to coordinate STI initiatives in the country. MOHE STI system and value chain includes basic research at university, applied research at R&D institutes i.e. NRC, technology transfer at TT institutes i.e. NFRC and NSRC, and finally innovation and incubators institutes i.e. ACT and SAS. Other main SSTI pillars and key players in Sudan are SRIC, ARC, LRC, NTC, and IRCC.
1. Introduction

Indeed, Science, Technology and innovation can play a critical role in each of the Sustainable Goals (SDG) and its 169 targets. This has been clearly emphasized in the recently published reports of the Scientific Advisory Board (SAB, 2016) of the secretary-general of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

These reports included many policy briefs on science for sustainable development and indigenous and local knowledge and science for sustainable development. SAB emphasizes that none of the 17 sustainable goals can be achieved without STI. They have also proposed that developing countries should allow an order of 3% of their GDP in order to make sound contribution to the targets of these goals. This in fact is needed in Africa more than any continent of the world. It must be emphasized that Africa is at the bottom of all continents of the world in their contribution to STI; a matter that has been emphasized in all of the UNESCO science reports including its recent 2016 science report entitled (UNESCO Science Report, Towards 2030).

There are now global trends and vision among international and regional organizations, non-governmental organizations, and economic groups that science, technology and innovation should be employed in the economy of countries, projects and development plans. Countries all round the world now intend to shift and make transition from resources-based economy to knowledge-based economy. This is to increase the added value of raw resources, goods and export diversification by focusing on engineering and innovative industries.
The chemical and pharmaceutical industry and materials, electronics, and many others are STI fields that highly contribute to national income, taking into account the increase and diversification of agricultural and livestock productions. With the processing of agricultural and livestock at national level with the appropriate technology can add great values and many national products can come out and be exported. These innovative ways should be associated in all services, communication, and others.

To achieve the desired technological renaissance, country must rely on its own human and natural resources and should be flexible to absorb and import technologies and innovations from other countries. Keeping up with the rapid developments in science and technologies allows the nation to reduce the export of the source of our wealthy raw materials, which is normally sold at low prices and it returns back in the form of innovated goods and equipment at higher prices, causing a substantial burden on states, governments and people.

By taking the right science, technology and innovation (STI) polices, limited resources can grow and meet the necessary and standard services that nations need in health, education and services of water and electricity and roads, among others. For a real change to STI culture, a few things need to be addressed and reviewed in this report. The report shows that proper planning is needed to harness science, technology and innovation to get benefits from our research outcomes, transfer and localize of technologies to achieve intended development and knowledge-based economy that the country is looking for.

These can be done by human resources development and infrastructure strengthening of scientific research centers/institutes of higher education universities. Localizing and transferring technology from leading and
counterpart countries could be one way to accelerate national development. There is also another technology transfer role on the national level. It could be an efficient mechanism to link academia and industry. This has to be associated with hard working on developing local technologies using local STI components. Focusing on applied research that serves the development and encouraging the private sector to invest in high-tech industries are strong factors that can boost STI in the country.

According to WIPO in the Global Innovation Index (GII) report for 2016 [27] Sudan has not been considered in the ranking. However, in GII 2015 [28], Sudan is ranked 141 and scored 14.95%. Table I below gives the major ranking for Sudan in GII 2015.

### Table 1: Sudan Ranking According to GII 2015

<table>
<thead>
<tr>
<th></th>
<th>Score 0–100 or value (hard data)</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Innovation Index (out of 141)</td>
<td>15.0</td>
<td>141</td>
</tr>
<tr>
<td>Innovation Output Sub-Index</td>
<td>8.0</td>
<td>140</td>
</tr>
<tr>
<td>Innovation Input Sub-Index</td>
<td>21.9</td>
<td>141</td>
</tr>
<tr>
<td>Innovation Efficiency Ratio</td>
<td>0.4</td>
<td>136</td>
</tr>
<tr>
<td>Global Innovation Index 2014 (out of 143)</td>
<td>12.7</td>
<td>143</td>
</tr>
</tbody>
</table>

2. **Introduction to Sudan STI Policies:**

Science, Technology and Innovation (STI) are key drivers of economic and social development. Sudan is considered a rich country in terms of natural resources and has vast opportunity for technological renaissance. These
resources are supported by large number of universities, colleges and R&D institutes i.e. about 135 universities, university colleges, and colleges and more than 200 R&D organizations. Recently a dramatic increase in the number of STI students has been secured by the governments i.e. about 166 thousand per year admitted to various levels of education, especially higher studies internally and externally.

The existence of infrastructure for some industries, such as GIAD, DAL and SAFAT [7] is being used as great base for STI initiatives. The impressive growing in the communication and information technology (ICT) sector also is one great lever for STI (i.e. 4thG was recently released in many territories in the country). On the other hand, the production of renewable energy facilities, through construction of many dams with high level of water storage in the Nile valley, opens the door for many international investments that would contribute technological renaissance of the country.

Sudan has taken care of the scientific and technology development early 70’s where detailed policies, plans and recommendations for scientific research, technology and innovation were developed at the national level in the National Research Council (NRC).

However, with the vast number of research activities at universities and national research centers adding to the new vision of STI with many new national and global factors, Sudan needs to crystallize new and fresh national policy for Science and Technology and Innovation. Renovation of these policies was tackled based on the Sudan president’s initiative, which proposed in 2009 to the United Nations Educational, Scientific and Cultural Organization (UNESCO) [6]. It was based on a few areas:
- To enhance the role of **knowledge** in the economy.
- To strengthen role of **partnerships** between research, development, and innovation at universities and R&D centers on one hand and between industries and services organizations at the other hand.
- To stress on the **impact** of the innovation in the sustainable development.
- To promote the demand on R&D and innovation at the state level and increase public STI awareness.
- To transfer knowledge into wealth through R&D and innovation.
- To develop scientific curriculum and convince some universities and institutes to include STI in its vision, and to be STI oriented, to transfer students from job seekers to opportunities generators. Change their attitude, even in the stages of pre-graduation and basic education, to be R&D oriented, initiative, creative, and innovative, entrepreneur and leaders.

Table 2 shows the history of STI initiatives in Sudan.

**Table 2: History of Sudan STI (SSTI) [1]**

<table>
<thead>
<tr>
<th>STI entity</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gordon Memorial College (GMC) was founded</td>
<td>1902</td>
</tr>
<tr>
<td>The establishment of Agricultural Research unit (ARU)</td>
<td>1904</td>
</tr>
<tr>
<td>ARU switched to the Agriculture Department</td>
<td>1919</td>
</tr>
<tr>
<td>The GMC college was affiliated with The University of London</td>
<td>1947</td>
</tr>
<tr>
<td>Gordon Memorial College was formally renamed University College Khartoum</td>
<td>1951</td>
</tr>
<tr>
<td>Khartoum University College turned to the University of Khartoum</td>
<td>1956</td>
</tr>
<tr>
<td>the establishment of the Agricultural Research Corporation</td>
<td>1968</td>
</tr>
</tbody>
</table>
2.1. Sudan STI (SSTI) Components:
The council of Ministers of Sudan approved a new SSTI policy which is on the process of being translated into strategies and plan of actions with clear priorities, The Ministry of Higher Education and Scientific Research has been mandated by the government of Sudan to lead this important issue for the future sustainable development of the country. The main components of the SSTI are:

i. Building a knowledge society by integrating science, technology and innovation with national development policies and strategy of economic reform in Sudan.

ii. A culture of science, technology and innovation at the grassroots level.

iii. Improve surveillance and foresight and forward-looking system, which includes observatory for STI

iv. Ward off the risk of environmental threats to the optimum use of natural resources.
v. Promote research in energy, modern technologies, bio-technologies, space sciences, renewable energies, and informatics areas.

vi. Focus on research programs and projects with a direct impact on development.

vii. Develop, localize and deploy technology in industry systems in the public and private sector organizations.

viii. Cooperation and participation in the relevant research organizations locally, regionally and internationally.

2.2. The Fundamental Anchors for SSTI:

i. Alleviating poverty, which is one of the Sustainable Development Goals (SDGs), could be achieved by improving productivity and reducing production costs based on research and development methodologies.

ii. Give priority to science, technology and innovation in the national strategic and action plans.

iii. Priorities identification for scientific and technological research in line with the 17 SDGs and directing resources accordingly, with emphasis on the problems caused by climate change and solutions while preparing the plans and programs of SSTI.

iv. Support scientific research that is oriented for maximizing outcomes from natural resources.

v. Encourage information and communication services providers to expand the coverage area to include rural and remote sparse areas and work to reduce the cost of information development.

vi. Strengthen the link between the society components in public and private sectors and build genuine partnerships between research, industry and
services organizations

vii. Encourage publications in prestigious international scientific journals and upgrading local scientific journals.

viii. Develop local’s capabilities in the foreign languages to easily absorb and adopt best practices in STIs.

ix. Intellectual property rights protection for researchers and research institutions.

x. Utilization of national experts in Diaspora in the field of Sudan science, technology and innovation (SSTI).

xi. Collaborate and share experiences with other countries in the regional and international environment.

xii. Strengthen cooperation with regional bodies and organizations of the relevant United Nations.

xiii. Support and strengthen the scientific and research institutions.

xiv. Development of science, technology and innovation curriculum in public education, undergraduate and graduate education.

2.3. SSTI Tools and Mechanisms

i. Review and update the structure of scientific research, innovation and technology development, plans, policies and stratifies.

ii. Establishment of new bodies that complete the SSTI cycle from grassroots researchers up to industry if needed.

iii. Develop a policy for research fund with allocation of at least 1% of the total Gross domestic product (GDP) to fund SSTI programs and projects looking forward to reach the desired ratio of 3% adopted by UN agencies.

iv. Develop incentive legislation for private sector to participate and invest
in development of technologies and human expertise (this includes legal, financial and incentives).

v. Initiate technological cities, incubators, and S&T parks.

vi. Promote scientific publications and stimulate researchers, research institutions, research groups, outstanding innovators and graduate students.

vii. Introduce of an attractive incentives and rewards (including financial) for projects and programs outcomes for SSTI.

viii. Injecting R&D and technology development fund in foreign loans and grants provided to Sudan government.

3. **Structure of Sudan Science, Technology and Innovation (SSTI)**

The republic of Sudan has a potential of strong and concrete STI structure, which is distributed over many ministries, that gives the STI system a unique diversity. The government distributes roles, responsibilities and hierarchy among STI organizations.

The structure is categorized to three main levels i.e. ministerial, corporation and institutes. There are several instances of individual departments being simultaneously responsible for policy setting, financing and implementation. At the ministerial level, most of the funding bodies were allocated a clear distinction between each other.

Other bodies for policies and implementation monitors are at the higher level of the STI structure. Figure 1 shows the Republic of Sudan STI structure. There are main four ministries stakeholders' i.e. ICT, Industry (including private sector), MOHE, and Agricultural and livestock ministries.
There is one body for SSTI policies, plans and strategies at MOHE, which is scientific research and Innovation commission. (SRIC). The main four SSTI key players are ARC and LRC at the ministry of agriculture and livestock, NIC at the ministry of ICT, NRC and universities at the MOHE, and IRCC at the Ministry of industry.

In some Sudanese universities, the vision and mission statements are developed to focus on SSTI goals i.e. Sudan university of Science and Technology (SUST), university of medical science and technology (UMST), Future University, and university of science and technology (UST).
Figure 1: Science Technology and Innovation infrastructure in Sudan (coordination between cross entities are usually done at ministries council)
3.1. Ministry of Agriculture Resources

*Agricultural Research Corporation (ARC)*, the vision of ARC is "to become a center of excellence in agricultural research by developing skilled manpower and conducting quality research" [10]. It generates an innovative technology and transfers technology to ensure sustainable crop production.

The mission of the ARC is "to plan, develop and implement research designed to produce technologies and systems that are required to ensure high and sustainable crop productivity, food security and export capacity". The ARC has main objectives that include the following:

i. To adopt country food and nutrition security and promote self-reliance and sufficiency.

ii. To improve agricultural productivity and livelihood of producers.

iii. To provide superfluous for export and increase the country GDP.

iv. To conserve natural resources through efficient exploitation.

v. To transfer the developed technologies to farmer’s fields and train them for increasing farmer's income.

Figure 2 shows ARC man power and human resources, where technical staff (usually are BSc holders) are giving direct support in the research activities however they are not researchers. Technicians (with Diploma) have advanced skills in certain areas that involved while conducting research. Labor with basic skills provide services to researchers.
Figure 2: ARC human resources in various institutes [2].

ARC comprises of 21 stations distributed over all states, 6 units include i.e. tissue culture unit, biotechnology unit, basic seed unit, gum Arabic unit, agro-forestry unit, etc and 10 institutes, where are running 13 national programs, 48 subprograms, 120 research projects [11]. The institutes are:

**Agricultural Plant Genetic Resources (PGR) Conservation and Research Centre** is one of the research programs of the Agricultural Research Corporation (ARC) in Sudan. Its mandate is to collect, store, evaluate and document local agricultural plant crops genetic resources. It was initiated in the early 1980s as a unit within the Horticultural Research Section of the ARC for local genetic resources conservation the of horticultural crops.
It has been developed into a separate program since 1995 when a process for program restructuring in the ARC was started. The program is being executed through the Plant Genetic Resources (PGR) unit.

i. Crop Protection Research Center  
ii. Forestry Research Center  
iii. Land and Water Research Center  
iv. Cereal Research Center  
v. Oil Crop Research Center  
vi. Horticultural Crop Research Center  
vii. Socio-economic and Policy Analysis Research Center  
viii. Dry land Research Center  
ix. Water Harvesting Research Institute

3.2. Ministry of Livestock, Fisheries and Rangelands

*Livestock Resources Research Corporation (LRRC)*, established in 1996 based on the veterinary research corporation (VRC) (established in 1913). LRRC currently contributes 43% of the total agricultural research and 29% of the total research in Sudan and has a vital role in raising awareness throughout Sudan States. Research activities are distributed on themes, programs and projects.

LRRC vision and mission are to activate the role of livestock in the fight against poverty and food security, and to employ scientific studies and research outcomes. Takes advantage of the various Sudan's natural resources and the diversity bioassay to reach a sustainable economic development, investment safe and preserving the environment.
To improve capacity building among researchers based on advanced STI mechanisms. It comprises of many institutes, including the following:

i. Veterinary Research Institute
ii. Animal Production Research Center
iii. Wildlife Research Center
iv. Fish Research Center
v. Veterinary laboratories States
vi. Animal Production Plants States
vii. Camel Research Center

Figure 3 shows LRRC labor and human resources, the diagram shows the accumulation number of staff in LRRC. The ratio between STI staff to non-STI staff is about 80%. Among the researchers, about 70% are PhD holders, which is considered a positive indication for SSTI plan. The researchers annually produce more than 100 various intellectual properties i.e. copyrights, patents, Trademarks, Trade Secrets, industrial designs, etc. [13]. Section 3.5 provides more details about Sudan IP system and registration.
3.3. Ministry of Industry (MOI),

MOI vision is to enable growth and productivity for local competitive industries. To help realize this vision, MOI Department has four key objectives: supporting science and commercialization, growing business investment and improving business capability, streamlining regulation and building a high performance organization. MOI created the supreme council for the technology transfer of engineering industry to help the community for transfer the important and new engineering technologies. The aim of this initiative is to plan for the national industry in the field of technology transfer and innovation that provides a broad range of services to the

Figure 3: LRRC human resources among various institutes [2].
Sudanese industrial sectors: Engineering Industries, Food & Agro Industries, Marble and Mining Industries, Textile etc., as well as cleaner production, productivity and quality enhancement as crosscutting sectors.

3.3.1. **Industrial Research and Consultancy Center (IRCC):**

Founded in 1965 with the assistance of the United Nations Industrial Development Organization (UNIDO) as a non-profit scientific governmental Organization as one of the vast SSTI initiatives. IRCC is the only R&D institute under the industrial ministry, which is initiated to promote SMEs business and focus on certain areas to diversify the economic capital and invest in programs that the private sector is reluctant to spend money on due to its high risk. In addition, it provides consultation services and feasibility studies to government linked (GL) industries, as well as non-government organizations (NGOs). The center is considered as the main advisor to the public and private industrial sector. It is also recognized as a center of excellence by Commission on Science and Technology for Sustainable Development in the South (COMSTATS) [17].

IRCC is active in applied research and more in product development, technology and production line design, and industrial process modeling. IRCC vision, "is to be a leader in R&D of innovative industrial technologies and to be significant contributor at the national level and has established strong relationships both local and international levels".

IRCC also hosts UNESCO Chair on Transfer of Technology (UNESCOTT) (No. 748), [26] established in 2006 at The Industrial Research and Consultancy Centre, Ministry of Science and Technology, Khartoum (Sudan). The principle activities are:
• Reinforcement of research capacities to efficiently undertake its programs, and in-service training programs in technology transfer;
• Development of qualified human resources and capacity-building to contribute to the implementation of the national action program;
• Undertake necessary public technology transfer awareness campaigns;
• Supervise appropriate training activities in concerned ministerial programs.

3.3.2. Business Sector

**GIAD Group**: is a government-linked company for manufacturing and assembling vehicles, trucks and their accessories, with high innovative and technology platform, high quality and low cost. The company leads with high-tech and considered as corner stone in automobile innovation in the country.

**DAL Group**: invests in diverse and through broadband of services and manufactures businesses. DAL group contains collection of companies including DAL Motors, DAL Engineering, DAL Food, DAL Agriculture, Sutrac and Sudanese Liquid Air; as well as many other companies. The DAL Group has also founded the Khartoum International Community School [18].

3.4. Ministry of Higher Education and Scientific Research,

For countries like Sudan, strategies and policies of STI have to be considered in the context of their effectiveness to mainstream the national
efforts of the science community towards a more robust STI system. MOHE and its STI arms through national conferences with the help of other stakeholders from different ministries regularly updates the national research priorities (Appendix A), also it sets the national SDGs in terms of knowledge generation, capacity building and suaveness in applying innovative technologies. Also plans to upgrade STI policies to steer guide Sudanese economy towards an innovation-based economy.

Experts’ opinion indicates that the above mentioned goals would not be achieved unless the country adopts its STI policies as legislation that governs all R&D sectors across the different line ministries and that an autonomous funding system fosters scientific research and innovation at the national level with possibly of R&D activities at the regional level.

One of the main SSTI components in MOHE is human resources, where a great concern has been given to training and capacity building. A quite large number of Sudan universities and R&D staffs are trained overseas in high ranked universities around the world i.e. Malaysia, China, South Africa, UK, US, etc. Figure 4 shows the Number of funded staff overseas postgraduate scholarships. The graduated staff from Ph.D. and postdoctoral usually sign contract and agreement with universities for bonding for few years depending on the where the graduation performed. Most of the return staff are working in various universities and R&D institutes.
6.4.1. Universities

Since early 90’s, Sudan has great education revolution that led to have a large scientific infrastructure represented by more than 120 public and private universities, which help to accelerate the technological renaissance [7].

Since 90's the number of higher education students increased dramatically where the number of universities jumped from 5 universities to 120 universities distributed around all states. The large number of graduated students plays vital role to possess strong SSTI industry and contribute to close the gap of the market needs in STI and transform the community into knowledge based community and economy. Those graduates could serve the country and other Arab countries especially in Gulf area (about 10000 qualified researchers in the last 5 years left the country) and boost the SSTI
system and actively participate in achieving the 2030 Development Agenda [6].

<table>
<thead>
<tr>
<th>Academy Organizations</th>
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<tbody>
<tr>
<td>Public Universities</td>
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<tr>
<td>Private Universities</td>
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<tr>
<td>Technical Colleges</td>
</tr>
<tr>
<td>Private Colleges</td>
</tr>
</tbody>
</table>

Figure 5: The academy organizations under MOHE ministry (absorb only 25% of the total students) [2]

Figure 5 shows the academy institutes under MOHE ministry that are categorized as public universities, private universities, technical colleges and private colleges with average of more than 230 thousand students per year, and absorption capacity of only 25% from the total students [5]. One of the main problems in Sudanese universities is the staff immigration and expatriation where most of the staff immigrate to gulf region. Figure 6 shows the number of immigrated staff.
Figure 6: The number of immigrated staff.

Figure 7 shows the average student's intake per year in Sudanese universities. The number of postgraduate students is changing rapidly where about 20,000 postgraduate students in SSTI fields are pursuing their studies inside and outside Sudan. The number of students who take SSTI related programs (i.e. Engineering, computer, medicine and agricultural studies) is illustrated in Figure 8. It could be noticed that, recently, the intake in agriculture studies is quite small. This indicates that the agriculture field becomes unattractive for students, and government needs to put more resources to agriculture and livestock, especially Sudan is considered one of the richest countries in these two fields. The number of research staff is also growing quite fast as by 2016 the number of staff jumped to 18 thousand. Figure 9 shows the average number of staff in Sudanese universities.
Figure 7: Average student's intake per year for Sudanese universities in various levels [3].

Figure 8: Average student’s intake per year for STI related courses in Sudanese universities 2015 [2].
Figure 9: The average number of staff in Sudanese universities 2016 [3].

Figure 10: Number of foreign students enrolled in the Sudanese university from various countries, regionally and globally 2016 [4].
Figure 10 shows the number of foreign students enrolled in the Sudanese university. As result of education sector growing in Sudan, the trust in the Sudanese university quality is high and become competitive which leads the country to be a hub of education for all regional and neighbor countries [13].

As an indicator of research activities in universities, Figure 11 shows the number of funded projects per year by MOHE, and Figure 12 represents the amount of funds released from MOHE to universities for five years 2009 to 2016 in Sudanese Pounds (SDG).

![Figure 11: Number of research projects funded by MOHE per year from 2009 to 2016 in SDG [5].](image-url)
University of Khartoum (UofK): is the first and largest university in Sudan, which has been contributing to SSTI since early 1900's. This report takes UofK as a sample for Sudanese universities to present a general idea about all other Sudanese universities. It has about seventeen thousand undergraduate students in twenty-three faculties, schools and graduate research institutes. The annual admission rate is about four thousand students, 55% of whom are female.

There are six thousand graduate students i.e. postgraduate diploma, Master and PhDs. The University contains two thousand teaching staff, one thousand research fellows. Figure 13 and 14 show the number of academic staff and students in UofK, respectively. Promotion regulations and rules for the academic staff are usually performed at university level. In addition, evaluation should be done by mixed international or national evaluators, where three evaluators or examiners all should agree and accept the

Figure 12: Amount of fund released from MOHE to universities for five years 2009 to 2016 in SDG [6]
application or the promotion will not be approved. Most of the Sudanese Universities based their promotion on production of scientific research in a related subject area[25].

Figure 13: Academic staff in UofK [7]
6.4.2. Incubators

Incubators are one of the vital components in SSTI schemes, aiming to support technology-based and innovation-oriented entrepreneurs in the kick-off and early development stage of their business. They provide a flexible environment that helps and makes sure the business will survive and be protected, and offer many services such as workspace (on preferential and flexible terms), shared facilities, management training and a range of business support services. Being one of the government initiatives for SSTI, Sudan University of science and Technology (SUST) contains six incubators. The number of staff of these incubators is quite small. There is no clear strategy for them neither from the university nor from the government. The main incubators are:

![Number of Students in UofK](image.png)

**Figure 14: Number of Students in UofK**
• **Leather Incubator**: due to the richness of Sudanese livestock leathers with high quality standards, SUST has built this incubator for building capacity, innovate new products and designs.

• **Cement Incubator**: cement industry is one of the fastest growing businesses in Sudan; SUST has built an incubator and provide shared facilities and business support services with high-tech machines and methodologies that are imported from China in Sept. 2012.

• **Poultry Incubator**: Sudanese food quickly shifted from Wheat and lamb to rice and chicken due to the healthy white meat. For fast and easiness of building poultry business, SUST developed a very fast growing poultry business, and entrepreneurs for students and alumni.

• **Furniture Incubator**: due to the richness of Sudanese culture with many varieties of local arts furniture business is growing quite fast especially after many Syrian and Turkish migrants migrate recently to Sudan. SUST provides stat-of-the-art furniture designs and styles.

6.4.3. R&D Institutes

*The National Centre for Research (NCR)*, the National Council for Research was founded in 1970 then replaced by NCR in 1991. NCR is a multidisciplinary organization that conducts scientific applied research for development in various priority STI areas e.g. materials technology, electronics, remote sensing, biotechnology.

Some of the center activities in the field of STI are: production of pulp and paper from local cellulosic fibrous raw material, research and development in improvement of local building materials, breeding drought resistant and quick maturing crops suitable for dry lands. It also conducts research,
surveys, awareness and control of endemic diseases e.g. Malaria, Bilharziasis, and Leishmaniasis [6].

**National Research Institute for Food Science (NRIFS):** the food science and technology face an increasing demand for safe, nutritious, convenient, and globally competitive food products. Food industry and product development is driven by consumers for safety, health, and sensory issues. NIFSR provides national leadership in food science and technology through research, development, collaboration and funding support with academy, industry, consumers, and other federal agencies.

NIFSR leads state-of-the-art research program and projects, and conducts leadership activities aimed at improving the processes, safety, and quality of foods.

**National Research Institute for Energy (NRIE):** is a leading research institute locally and regionally. This institute has been selected by ALESCO [22] to build solar panels in rural area. NRIE is the arm of the Sudan government in the implementation of national solar mission.

The institute contains solar energy cells factory that produces state of the art technology in field of solar energy. NRIE has many R&D and demonstration activities among rural area and capacity building of solar energy related technologies. Also it has facilities for testing, calibration, and certification in the field of solar technologies.
**Sudan Atomic Energy Commission (SAEC)** founded in 1996, formerly there were two entities Atomic Energy Research Institute (AERI) and the Atomic Energy Committee (AEC) and their role was to conduct research, coordination and services. The institute is working as a coordinator with many local and global agencies. SAEC objectives are: to participate as a country representation at both international and regional levels, in the field of atomic energy affairs.

Striving to develop the national atomic energy platform for civilian goals, in service of the plans and programs of economic development, it also ensures the safety of human beings, animals and the environment, in general, against radiation risks, and disseminate awareness of such risks among individuals. SAEC has three institutes:

- **Radiation Safety**
- **Nuclear Application for Biological Science**
- **Chemistry and Nuclear Physics**

**Social and Economic Research Department:** its main aim is the economic and social research. The role of the department can be categorized into two main areas, to collate process and disseminate socio-economic research and to be an early warning signal for the country in these areas. In addition, it is mandated to build capacity of scientific community in selected fields needed by the society.

**Africa City for Technology (ACT)**
Africa City of Technology (ACT) is a governmental institution, that has been set up to work for the diversification of the national economic development through initiatives of new markets, establishment of various spin-off companies in the areas of STI and technology transfer and to reduce risk or volatility by investing in a variety of assets as well as improved economic and social life.

ACT aims to give an opportunity for individuals to transform their ideas, creativity/innovation and inventions into reality and produce revenue and economic benefits to everyone, by providing new income sources. Also ACT is well prepared and equipped to create ideal or at least suitable environment for researchers and inventors to bring their idea in terms of world standard facilities and funds for their research.

Therefore, ACT plays a vital role to close the gap between technology makers/inventors and technology seekers. It translates these ideas and inventions into businesses. Government initiated ACT as an essential phase as strategic link between R&D institutes, universities and high-tech industries to increase the state's economic future through STI and change the resource- based economy into knowledge-based one.

One of the main ACT roles is to initiate smart partnership with the private sector to run innovative projects and alleviate the risk of investment, and to support this important sector to play a vital role in SSTI.

**Sudan Sciences Academy (SAS)**

SAS was established in 2004 as one of the big initiatives to implement STI policies, and contribute to the transformation into knowledge-based community. It acts as government advisors in S&T. It is called the federal
forum for advanced and pioneered research, development and innovation (R&D&I). SAS was also identified as full-fledged state university for postgraduate studies and state of the art capacity building, among others, STI staff in Sudan. It concentrates its activities in the areas that the country really needs in STI system.

Figure 15: The number of graduated students from SAS from 2008 to 2014 [6]
The alumni research quality of the Academy federal system is highly recognized nationally, regionally and internationally. The academy is striving to prepare qualified researchers crew, capable of carrying out outstanding research related to community and industry problems and attempting to realize its objectives in socio-economic development. Figure 15 shows the number of graduated students 2008-2014.

3.5. Ministry of Justice

3.5.1. Intellectual Property Management Offices:

Since the documents and reports of patents are among the most important sources of knowledge about the STI in the world, Sudan has an intellectual property rights (IPR) department, which was established in 1971 for IP protection and public awareness. Its aim is to register patents for Sudanese researchers based on Sudan justice ministry and World Intellectual Property Organization (WIPO) rules and regulations. In addition, it aims to encourage innovation culture among Sudanese researchers and citizens.

There are two IP offices in Sudan: Copyright Offices managed by Ministry of Culture and Information, Protection of Copyright and Related Rights, Literary and Artistic Works Council, and Industrial Property Offices managed by Registrar General of Intellectual Property, Ministry of Justice. Sudan depository libraries known as Registrar General of Intellectual Property [23].

Intellectual property and patents represent one of the important sources of scientific information, in addition to being a direct indicator of R&D innovation activities and effectiveness. The number of patent files recorded
in most Sudan states is very small. Sudanese researchers should pay attention to patents and intellectual property rights and get the support and encouragement to register their innovations and discoveries which allow production and services industry on one hand, and allow institutions to take advantage of their inventions and convert them into goods and services on the other hand [17].

Sudan is a member of the Paris Convention, ARIPO (Harare Protocol), WIPO and PCT. The department dedicate special efforts to encourage forging investments based on strong rules of IP rules and regulations.

3.5.2. Intellectual Property and Litigation in Sudan:

Trade Marks (Law 1969): For Trade Marks IPs, Sudan is a member of the Paris Convention, and the Madrid Agreement and Protocol [23]. Although Sudan is a member of The African Regional Intellectual Property Organization (ARIPO), it has not signed the Banjul Protocol [25]. Applications for Trade Marks (TM) filed in Sudan as national applications and, in appropriate circumstances, could claim convention priority in terms of the Paris Convention. As Sudan has not signed the Banjul Protocol, the Sudanese Trade Marks Act of 1969 does not provide recognition of trade mark applications filed via ARIPO.

Patents (Law 1971, patent regulation law 1981): For Patents IPs, Sudan is a member of the Paris Convention, ARIPO (Harare Protocol), and the PCT. Patent protection is available via a national filing or via an ARIPO application including Sudan. Sudan has not yet implemented the Harare Protocol (which regulates patent and design filings in ARIPO).
Accordingly, there is uncertainty regarding the enforceability of rights obtained through the filing of an ARIPO application designating Sudan.

Although it is possible to file PCT national phase applications in Sudan, the national law has not yet been amended to cope with the PCT. Therefore, it is not clear whether enforceable rights will be obtained via PCT national phase filings in Sudan.

**Design (Law 1974):** For Design IPs, Sudan is a member of the Paris Convention and the ARIPO (Harare Protocol). Design protection is available by national filing or via an ARIPO application designating Sudan. As mentioned above, Sudan has not yet implemented the Harare Protocol (which regulates patent and design filings in ARIPO). Accordingly, there is uncertainty regarding the enforceability of rights obtained through the filing of an ARIPO application designating Sudan.

**Copyright (Literary and Artistic Works Act of 2001):** for Copyright IPs, Sudan is a member of the Berne Convention [22]. The Act provides protection, without any formality, to any original intellectual work in the field of literature, science or arts, and whatever the manner of expression, including i.e. books, magazines, periodicals, sculpture, drawing, painting, decoration, dramatic, musical works, etc

**Plant Breeders' Rights:** Currently, no legislative provision for plant breeders’ rights or other sui generis protection for plants is available in Sudan.
4. NGOs and Supporting Bodies

4.1. Sudanese Researchers Initiative Public Group (SRIPG)

Founded in 2009, the main aim of the group is to establish a hub for the Sudanese researchers in a web-based platform, to motivate the Sudanese folks to share knowledge and to be involved in R&D. This platform helps young and junior researchers to discuss their ideas openly.

SRIPG is a research community oriented initiative; it contains about 92,403 researchers from different disciplines and various backgrounds. It looks like a forum and pool for innovative ideas, publications, seminars, awareness and other related topics [16].

4.2. Innovation and Entrepreneurship Community (IEC)

Started as an arm of IEEE Sudan subsection, which was known as IEEE Sudan Entrepreneurship Center (ISEC), IEC was launched in April 2013, with an objective to support the entrepreneurial activity in Sudan [14].

5. ICT Industry Success Stories

ICT sector is very well developed by the development of rapid global telecommunications industry and information technology sector. It has direct effects on other sectors and all aspects of social life. This rapid development of ICT sector plays a vital role in the establishment of knowledge-based community, by the development of services and applications. This sector contributes by about 11% to the total GDP [19].
Telecommunications and information technology sector contributes significantly to expand the national GDP and ensure a better standard of living. This is achieved by diversifying its sources and enhance the innovative capacity and create jobs and therefore supporting the state treasury, done through attracting foreign investment and encouraging free and transparent competition through the provision of services and applications to keep pace with international standards and specifications.

In accordance with the laws, NTC secures that by licenses granting for certain services. The sector market share is managed by a number of operators, service providers and corporate technical support. Actually, there are four leading operator companies in the field of telecommunications [12].

5.1 National Telecommunication Corporation (NTC)

One of the main players in telecommunications and information technology sector is the national telecommunication corporations (NTC) whose vision is to provide a communication and information technology services to lead the renaissance of the state and society sustainable development. Its mission includes the following points:

- Build an infrastructure and introduce the front of the art technology and capacity building;
- Control competition and regulate telecommunications and information technology sector;
- Contribute effectively to the state and society renaissance and build a knowledge-based society through ICT;
- Contribute to the achievement of excellence in providing services to stakeholders;
• Take care of innovations and inventions and transfer technology to improve users’/citizens’ experiences in the field of ICT.

ICT sector continues to grow steadily in the past five years where it reaches populated geographic coverage areas (84%) and the penetration ratio is increased from 50% to 74% of the total population, where the number of mobile phone users reaches more than 79% of the populated areas.

The communication network is extended through fiber optic networks, which fibers length becomes more than 32000 kilometers to support Internet traffic and that the number of its subscribers reached about 12 million subscribers. Figure 16 shows the optical Fiber length from 2011 to 2015. Table 3 shows the Internet customer from 2011 to 2015 [9].

Figure 17 shows Internet penetration in various states in Sudan, which shows that penetration rate 29% in urban areas while in rural areas it is 9.6. It is clear that the Sudan rural areas have a big gap in access to information and internet due to that the NTC took the initiative to get seed funding for infrastructure development and to provide very cheap internet access.

This growth produced a very good infrastructure, opened the door for variety of services and applications and increases customer experience. ICT sector action plan for the coming four years is as follows:

• Coverage and facilitating services
• Smart Government
• Software development
• Validation and insurance information
• Internal and external coordination and cooperation
Figure 16: Optical Fiber length in km

### Table 3: Number of Internet Customer in Sudan for Fixed and Cable Connections [7]

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<tr>
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<tbody>
<tr>
<td>Canar</td>
<td>30,425,500</td>
<td>312,941</td>
<td>315,681</td>
<td>32,297</td>
<td>30,950</td>
<td>27,487</td>
</tr>
<tr>
<td>Fixed</td>
<td>237,064</td>
<td>171,337</td>
<td>78,597</td>
<td>94,868</td>
<td>94,264</td>
<td>91,467</td>
</tr>
<tr>
<td>Total</td>
<td>541,319</td>
<td>484,278</td>
<td>394,278</td>
<td>127,165</td>
<td>125,214</td>
<td>954,118</td>
</tr>
</tbody>
</table>

### Table 4: Number of Internet Customer in Sudan for Mobile Service Providers [7]

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<tbody>
<tr>
<td>Zain</td>
<td>1,300,000</td>
<td>2,700,000</td>
<td>4,600,000</td>
<td>4,800,000</td>
<td>5,500,000</td>
</tr>
<tr>
<td>MTN</td>
<td>740,000</td>
<td>1,000,000</td>
<td>2,600,000</td>
<td>3,484,289</td>
<td>3,800,000</td>
</tr>
<tr>
<td>Sudani</td>
<td>300,000</td>
<td>750,000</td>
<td>2,000,000</td>
<td>2,000,000</td>
<td>2,350,000</td>
</tr>
<tr>
<td>Total</td>
<td>2,400,000</td>
<td>4,400,000</td>
<td>9,200,000</td>
<td>10,500,000</td>
<td>11,650,000</td>
</tr>
</tbody>
</table>

Figure 17: Internet Penetration around the country [8]

On the other hand, Sudan has an officially recognized national cybersecurity strategy. Sudan also has officially recognized national cybersecurity frameworks to implement internationally recognized cybersecurity standards through the Information security law and the regulation on measures for information security.

5.2 National Information Center

The National Information Center (NIC) is created according to the Law issued in 1999 and amended in 2010. NIC in Sudan provides comprehensive information about all ministries and other public institutions. The NIC is mandated to conduct all information technology (IT) projects in the country and has the vision to implement e-governance in Sudan.
The main objectives and activities of NIC include:

1. Create Sudan national information network.
2. Contribute to the development of the global network of information systems in coordination with the competent authorities in Sudan.
3. Responsible of public information policies, regulations and strategies for the development of IT industry and its applications.
4. Supervision on training and capacity building for public employees in the field of information in Sudan.
5. Supervision and funding information projects in all governmental units.

5.3 Nile Center for Technology Research (NCTR)

Established in 2007 as an applied research and development (R&D) in the areas of ICT, high-tech, microelectronic, communication and navigation systems and GIS, NCTR contributes by providing three high class R&D centers in UofK, SUST, and karary universities [10].

The main aim of the center was to promote and fund research for university staff and encourage them for reforming their research from basic to applied research.

Many impressive solutions come out from the NCTR R&D activities especially on information security, where Sudanese encryption algorithms were developed and applied in many strategic corporations, to make sure that none of sensitive systems is hacked and to be protected from vandalizes.

One of the great successful NCTR projects was the e-bill or e15 system that was implemented in the Ministry of finance (MOF).
6. Africa Initiatives for STI

In 2014, the African Union in its summit of heads of States and Governments has placed Science, Technology and Innovation (STI) at the top of its agenda and recognized STI as multi-functional tools and enablers for achieving Africa’s socio-economic development and growth. Accordingly, a 10-year Science, Technology and Innovation (STI) Strategy for Africa (STISA-2024) has been developed. The Mission of STISA-2024 is to “Accelerate Africa’s transition to an innovation-led, Knowledge-based Economy”. The strategy calls for the diversification of sources of growth and sustenance of Africa’s current economic performance, and in the long-run, lifting large sections of Africa’s population out of poverty. The strategy further defines four mutually reinforcing pillars that are prerequisite conditions for its success. These pillars are: building and/or upgrading research Infrastructures; enhancing professional and technical competencies; promoting entrepreneurship and innovation; and providing an enabling environment for STI development in Africa.

The Ministry of Higher Education and Scientific Research believes that STI goals can be better achieved in a faster and stronger way if a solid partnership is created with its sister ministries in the region especially in Africa.

Sudan STI policies are highly effected and aligned with African STI policies, due to the one African STI vision adopted by African Union (AU). There are many organizations that were initiated in Africa for STI to boost Africa’s economic growth [11].

6.1. African Science, Technology Innovation Indicators Initiative (ASTII)
**Overall Goal:** contribute towards the improvement of the quality of science, technology and innovation policies at national, regional and continental levels

**Goals:** To strengthen Africa’s capacity to develop and use Science, Technology and Innovation (ASTII) Indicators.

**Objectives:** To develop and cause the adoption of internationally comparable STI indicators; to build human and institutional capacities for STI indicators and related surveys; to enable African countries to participate in international programs for STI indicators; to inform African countries on the state of STI in Africa [10].

**ASTII Projects:** Have two correlated projects:

- The development and adoption of a common STI indicators framework throughout the continent,
- The establishment of the African Observatory for STI (AOSTI), which was founded in 2009.

**6.2. African Ministerial Conference on Science and Technology (AMCOST)**

This meeting is held every two years to follow up on the implementation of Consolidated Plan of Action (CPA) through the Africa’s Science and Technology. The CPA is an Africa platform that rules and guides the development of science and technology throughout the continent. CPA goal is to gather data and statistical information of the continental STI indicators and KPI. ASTII programme is considered as one of the CPA flagship projects. The main achievements of AOSTI:
• Endorsed the compilation of indicators for scientific research, technological development and innovation activities.
• Established an intergovernmental committee, which agreed on a common framework for compiling S&T and innovation (STI) indicators.
• Developed and produced indicators for research and experimental development (R&D) and innovation.
• Published the first African Innovation Outlook.

6.3. Other Initiatives
• Scientific, Technical and Research Commission (STRC)
• African Union Network of Sciences (AUNS)
• Pan African Intellectual Property Organization (PAIPO)
• African Observatory for Science, Technology and Innovation (AOSTI)
• African Scientific Research and Innovation Council (ASRIC)
• The African Union Biodiversity Program
• Access and Benefit Sharing of Genetic Resources (ABS),
• The Global Monitoring for Environment and Security (GMES) & AFRICA
• African Union Research Grant Programme
• AU Kwame Nkrumah Scientific Awards Programme
• AU Science, Technology and Innovation Strategy for Africa 2024 (STISA 2024)
• EU-Africa Cooperation in STI
7. References


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[29]

8. Appendices

Appendix A: MOHE’s Research Priorities 2016 - 2017
1. Manufacturing of Local Resources
2. Water harvesting
3. Renewable Energy
4. Power Systems Planning
5. improve energy transmission and distribution
6. foundations and building materials
7. Mining Research
8. Wastewater
9. types of cancer-causing Sudan and the challenges of the services provided
10. nutritional problems and their determinants middle of mothers and children
11. microbes' resistant to antibiotics and rationalize consumption
12. neglected diseases
13. Upgrade Sudanese personal behavior and maintain their value
14. Encyclopedia Sudanese cities
15. improve quality and productivity and reduce the cost of strategic crops
16. maximizing the yield of horticultural exports series
17. Combat Desertification
18. population mobility.
19. language teaching policies in Sudan
20. dimensions of economic and social Mining in Sudan and its impact on the environment.
21. value-added metals
22. sustainability of production and the welfare of the animal under the climatic variables.
23. eugenics ruminants and the development of fish production and wildlife.

APPENDIX II: List of Sudanese Universities

Table 5: List of Sudanese Universities

<table>
<thead>
<tr>
<th>Institution</th>
<th>Location</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahfad University for Women</td>
<td>Omdurman</td>
<td>Private</td>
</tr>
<tr>
<td>Al Fashir University</td>
<td>El Fasher</td>
<td>Public</td>
</tr>
<tr>
<td>AlMughtaribeen University</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>University</td>
<td>Location</td>
<td>Type</td>
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<tr>
<td>------------------------------------------------</td>
<td>---------------------------------</td>
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</tr>
<tr>
<td>Al-Neelain University</td>
<td>Khartoum and other locations</td>
<td>Public</td>
</tr>
<tr>
<td>Al Zaiem Alazhari University</td>
<td>Khartoum</td>
<td>Public</td>
</tr>
<tr>
<td>Bayan College for Science &amp; Technology</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>Blue Nile University</td>
<td>Ad-Damazeen</td>
<td>Public</td>
</tr>
<tr>
<td>Canadian Sudanese College</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>Dalanj University</td>
<td>Dalang</td>
<td>Public</td>
</tr>
<tr>
<td>El Imam El Mahdi University</td>
<td>Kosti</td>
<td>Public</td>
</tr>
<tr>
<td>Elrazi University</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>Future University of Sudan</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>Garden City College For Science And Technology</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>International University of Africa</td>
<td>Khartoum</td>
<td>Public</td>
</tr>
<tr>
<td>Karary University</td>
<td>Omdurman</td>
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<td>Khartoum College of Medical Sciences</td>
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<td>Private</td>
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<td>Nahda College</td>
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<td>Private</td>
</tr>
<tr>
<td>National College of Khartoum (NCK)</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>National College for Medical &amp; Technical Studies</td>
<td>Khartoum</td>
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<td>National Ribat University</td>
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<td>Nile Valley University</td>
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<tr>
<td>Omdurman Islamic University</td>
<td>Omdurman</td>
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<td>Open University of Sudan</td>
<td>Khartoum</td>
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<td>Public Health Institute</td>
<td>Khartoum</td>
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<td>Red Sea University</td>
<td>Port Sudan</td>
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</tr>
<tr>
<td>Sudan University of Science and Technology</td>
<td>Khartoum and other locations</td>
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</tr>
<tr>
<td>University of Bakht Al-Ruda</td>
<td>Al-Dewaym</td>
<td>Public</td>
</tr>
<tr>
<td>University of Bahri</td>
<td>Bahri</td>
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</tr>
<tr>
<td>University of Dongola</td>
<td>Dongola</td>
<td>Public</td>
</tr>
<tr>
<td>University of Al Qadarif</td>
<td>Al Qadarif</td>
<td>Public</td>
</tr>
<tr>
<td>University of Gezira</td>
<td>Wad Medani</td>
<td>Public</td>
</tr>
<tr>
<td>University of Kassala</td>
<td>Kassala</td>
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</tr>
<tr>
<td>University of Khartoum</td>
<td>Khartoum</td>
<td>Public</td>
</tr>
<tr>
<td>University of Kordofan</td>
<td>Al-Ubayyid</td>
<td>Public</td>
</tr>
<tr>
<td>University of Medical Sciences and Technology</td>
<td>Khartoum</td>
<td>Private</td>
</tr>
<tr>
<td>University of Nyala</td>
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</tr>
<tr>
<td>University of Science and Technology - Omdurman</td>
<td>Omdurman</td>
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</tr>
<tr>
<td>University of Sennar</td>
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<tr>
<td>University of Shendi</td>
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<tr>
<td>University of the Holy Quran and Islamic Sciences</td>
<td>Omdurman</td>
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</tr>
<tr>
<td>University of West Kordofan</td>
<td>Al-Foula</td>
<td>Public</td>
</tr>
<tr>
<td>University of Zalingei</td>
<td>Zalingei</td>
<td>Public</td>
</tr>
<tr>
<td>Upper Nile University</td>
<td>Malakal</td>
<td>Private</td>
</tr>
<tr>
<td>Wad MedaniAhlia College</td>
<td>Wad Medani</td>
<td>Non-profit</td>
</tr>
</tbody>
</table>
Appendix III: Sudan Statistics for STI indicators

**Social Indicators**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population, total (2014)</td>
<td>38,764,090.0</td>
</tr>
<tr>
<td>Population growth (annual %) (2014)</td>
<td>2.1</td>
</tr>
<tr>
<td>Population density (people per sq. km of land area) (2014)</td>
<td>21.3</td>
</tr>
<tr>
<td>Rural population (2014)</td>
<td>25,730,440.0</td>
</tr>
<tr>
<td>Rural population density (rural population per sq. km of arable land)</td>
<td>0.0</td>
</tr>
<tr>
<td>Rural population (% of total population) (2014)</td>
<td>66.4</td>
</tr>
<tr>
<td>Birth rate, crude (per 1,000 people) (2013)</td>
<td>33.5</td>
</tr>
<tr>
<td>Death rate, crude (per 1,000 people) (2013)</td>
<td>8.4</td>
</tr>
<tr>
<td>Mortality rate, infant (per 1,000 live births) (2013)</td>
<td>51.2</td>
</tr>
<tr>
<td>Mortality rate, under-5 (per 1,000 live births) (2013)</td>
<td>76.6</td>
</tr>
<tr>
<td>Life expectancy at birth, total (years) (2013)</td>
<td>62.0</td>
</tr>
<tr>
<td>Labor force, total (2013)</td>
<td>11,946,115.0</td>
</tr>
<tr>
<td>Labor force, female (% of total labor force) (2013)</td>
<td>29.4</td>
</tr>
</tbody>
</table>

**Poverty Indicators**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of rural poor (million, approximate) (2014)</td>
<td>14,620,733.4</td>
</tr>
<tr>
<td>Rural poverty headcount ratio at national poverty lines (% of rural population) (2009)</td>
<td>57.6</td>
</tr>
<tr>
<td>Poverty headcount ratio at national poverty lines (% of population) (2009)</td>
<td>46.5</td>
</tr>
<tr>
<td>Income share held by lowest 20% (2009)</td>
<td>6.8</td>
</tr>
</tbody>
</table>

**Education**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>School enrollment, primary (% gross) (2012)</td>
<td>70.0</td>
</tr>
<tr>
<td>Literacy rate, adult total (% of people ages 15 and above) (2012)</td>
<td>73.4</td>
</tr>
</tbody>
</table>

**Health**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health expenditure, total (% of GDP) (2013)</td>
<td>6.5</td>
</tr>
<tr>
<td>Physicians (per 1,000 people) (2010)</td>
<td>0.3</td>
</tr>
<tr>
<td>Improved water source, rural (% of rural population with access) (2012)</td>
<td>50.2</td>
</tr>
<tr>
<td>Improved sanitation facilities, rural (% of rural population with access) (2012)</td>
<td>13.4</td>
</tr>
<tr>
<td>Prevalence of HIV, total (% of population ages 15-49) (2013)</td>
<td>0.2</td>
</tr>
</tbody>
</table>
### Agriculture and Food

- Food imports (% of merchandise imports) (2011): 18.0
- Food production index (2004-2006 = 100) (2013): 115.4
- Cereal yield (kg per hectare) (2013): 589.5
- Fertilizer consumption (kilograms per hectare of arable land) (2012): 10.6

### Environment

- Land area (sq. km) (2014): 2,376,000.0
- Forest area (% of land area) (2011): 23.2
- Arable land (% of land area) (2012): 8.9
- Irrigated land (% of cropland): 0.0

### Economic Indicators

- GDP (current US$) (2014): 73,815,376,184.6
- GDP per capita growth (annual %) (2014): 1.0
- Inflation, consumer prices (annual %) (2014): 36.9
- Agriculture, value added (% of GDP) (2014): 29.2
- Industry, value added (% of GDP) (2014): 20.4
- Manufacturing, value added (% of GDP) (2014): 8.4
- Services, etc., value added (% of GDP) (2014): 50.4
- General government final consumption expenditure (% of GDP) (2014): 6.7
- Household final consumption expenditure, etc. (% of GDP) (2014): 78.5

### Trade

- Merchandise exports (current US$) (2014): 4,035,000,000.0
- Merchandise imports (current US$) (2014): 10,760,000,000.0
- Balance of merchandise trade (US$ million) (2014): -6,725,000,000.0
- Foreign direct investment, net inflows (BoP, current US$) (2014): 1,277,366,367.0

### Government Finance

- Revenue, excluding grants (% of GDP): ..
- Expense (% of GDP): ..
- Total debt service (% of exports of goods, services and primary income) (2013): 3.5
- Net official development assistance and official aid received (current US$) (2013): 1,163,120,000.0
<table>
<thead>
<tr>
<th>Source(s): Source: World Bank Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technology and infrastructure</strong></td>
</tr>
<tr>
<td>Mobile cellular subscriptions (2014)</td>
</tr>
<tr>
<td>Fixed line and mobile phone subscribers (per 100 people)</td>
</tr>
<tr>
<td>Personal computers (per 100 people)</td>
</tr>
<tr>
<td>Internet users (per 100 people) (2014)</td>
</tr>
</tbody>
</table>

Deposit interest rate (%) 
Lending interest rate (%) 
External debt stocks, total (DOD, current US$) (2013) 22,415,539,000.0