AFRICAN INNOVATION OUTLOOK III

2019

African Union

African Union Development Agency (AUDA-NEPAD)

NEPAD
TRANSFORMING AFRICA

SWEDEN

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PREFACE

The African Union has embraced the role of Science, Technology and Innovation (STI) as key drivers of economic development, and called upon Member States and RECs to embed STI in their development programmes. Investments in STI are important and, hence, the call by the AU Assembly of Heads of State and Government on countries to invest at least 1% of Gross Domestic Product (GDP) in the sector. The investments need to be monitored and measured together with the corresponding research, development, and innovative activities that are taking place at national and regional levels.

The African Science, Technology and Innovation Indicators (ASTII) Initiative originated from the first Ministerial Council on Science and Technology (AMCOST) meeting in Johannesburg in 2003, which resolved to "Develop and adopt common sets of indicators to benchmark our national and regional systems of innovation". In recognition of the importance of STI in the development discourse, the African Science, Technology and Innovation Indicators (ASTII) Initiative was therefore established to strengthen the capacity of AU Member states to adequately measure research and development, and innovation, taking place on the continent. The capacity strengthening work has been implemented for 12 years now, starting with 19 countries in 2007 and reaching 43 countries in 2019. The increase in the number of countries has not just been a result of "push" factors but also because there has been an increase in the "pull factors" whereby countries have called upon the AUC and AUDA-NEPAD to strengthen the capacity of their officials and experts and also support them in the conduct of national surveys.

This third report of the African Innovation Outlook (AIO-3) covers a period during which major developments have taken place in the African Union policy processes. In 2013, the African Union adopted the Agenda 2063 which is a 50-year vision of the aspirations of the idea of the "Africa We Want" in 2063. The vision is buttressed on an Africa that is committed to laying a strong foundation in science, technology and innovation. The first Ten Year Implementation Plan of Agenda 2063 has programmes which are aimed at promoting science, technology and innovation, as well as the application of STI in the economic development activities of the continent.

In 2014, the African Union adopted the Science, Technology and Innovation Strategy for Africa, 2014-2024 (STISA 2024), which has laid out pre-requisites, pillars, priority areas and investments that are required in order to meet the necessary development in STI. STISA has presented a delivery model that calls for pluralistic participation in the STI activities involving public and private sectors, as well as development communities. On the global scene, the Sustainable Development Goals were adopted in 2015. The 17 SDGs have STI embedded in each one of them, including the application of STI in the various SDGs, developing capacity in STEM and integrating science diplomacy in partnerships at national, regional and international levels. The AIO-3 has therefore, examined the future measurements that need to be considered when monitoring the development of STI on the continent.

During the 12 years that the ASTII Initiative has been implemented, countries and RECs have institutionalized the programme in their national innovation systems, albeit in varied degrees. We are pleased to note that ASTII interventions have contributed to the number of AU Member States that now have national STI indicators and statistics as a basis for developing their policies. We urge the countries not to relent because in building any data and statistics system, the quality of data and the level of analysis and application improve as countries carry out more of such surveys. It is our hope that soon there will be more countries that will publish their own national R&D and innovation reports. This is evidenced in the fact that some countries have taken up the challenge of producing reports which have become part of the national statistics.

The production of this third edition of AIO has been possible as a result of the core indicators submitted by national ASTII focal points represented by respective ministries responsible for STI or Education and training, national STI councils and commissions, national statistics offices, and institutes, or agencies. As was the case with 1st and 2nd AIO, a number of challenges emerged in producing this third edition of the Outlook and in implementing ASTII-II, and a number of lessons have been learned. We encourage countries to use this cumulative knowledge to improve the collection of STI measurements, analysis and usage to inform STI policy-making processes in Africa. The process leading to the production of this report indicates that there is still more work to be done in order to produce comparable statistics across the continent. In this regard extensive human capital development is recommended.

We are grateful for the positive collaboration with AU organs, member states, regional economic communities (RECs) and the United Nations Educational, Scientific and Cultural organisation (UNESCO) through its Institute for Statistics (UIS), which has allowed us to align STI measurement activities resulting in reduction in duplication of efforts. The technical backstopping provided by the United Nations University - Maastricht Economic and Social Research Institute on Innovation and Technology (UNU-MERIT), the South African Centre for STI Indicators (CeSTII), and the Lund School of economics and Management at the University of Lund, has been valuable since the inception of the ASTII Initiative. It is through this kind of interaction and collaboration that Africa will be able to develop indigenous capacities to address African STI-specific problems crucial that are critical for the socio-economic transformation of the continent.

Our sincere appreciation and gratitude are extended to the Government of Sweden, through the Swedish International Development Agency (Sida) for supporting the programme together with the various AU Member States. We thank the Republic of Equatorial Guinea for providing seed funding for establishing and hosting the African Observatory for Science, Technology and Innovation (AOSTI) in Malabo, who have contributed immensely to the report.

We are pleased to present the Third African Innovation Outlook to you all and thank the various individuals and institutions that have contributed to the production of the report.

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ACRONYMS

AIO	African Innovation Outlook
AMCOST	African Ministerial Conference on Science and Technology
AOSTI	African Observatory of Science, Technology and Innovation
APRM	African Peer-Review Mechanism
ASTII	African Science, Technology and Innovation Indicators
AU	African Union
AUC	African Union Commission
AUDA-NEPAD	African Union Development Agency
BUS	Business Enterprises
CESA	Continental Education Strategy for Africa
CeSTII	South African Centre for STI Indicators
CIS	Community Innovation Survey
COMEDAF	Conference of Ministers of Education of the African Union
COMESA	Common Market for Eastern and Southern Africa
EC	European Commission
ECCAS	Economic Community of Central African States
ECOWAS	Economic Community of West African States
Eurostat	European Statistical Office
FM	Frascati Manual
FoRD	Field of R&D
FTE	Full-time equivalent
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOV	Government
GOVERD	Government Expenditure on R&D
HC	Headcount
HE	Higher Education
HERD	Higher education expenditure on R&D
HRST	Human Resources Science and Technology
HSRC	Human Sciences Research Council
ICT	Information and Communication Technologies
IP	Intellectual Property
ISCED	International Standard Classification of Education
ISI	International Statistical Institute
LCU	Local Currency Unit
NEC	Not Elsewhere Classified
NEPAD	New Partnership for Africa's Development
NESTI	National Experts on Science and Technology Indicators
NPCA	NEPAD Planning & Coordinating Agency
OAU	Organization of African Unity

OECD	Organisation for Economic Co-operation and Development
OM	Oslo Manual
PNP	Private Non-Profit
PNPRD	Private Non-Profit Expenditure on R&D
PPP	Purchase Power Parity
PPP$	Purchase Power Parity (International dollar)
R&D	Research and Experimental Development
REC	Regional Economic Communities
RPI	Research Policy Institute
SADC	Southern African Development Community
SHaSA	Strategy for the Harmonization of Statistics in Africa
Sida	Swedish International Development Agency
SNA	System of National Accounts
STC-EST	Specialised Technical Committee on Education, Science and Technology
STI	Science, Technology and innovation
STISA	Science, Technology and Innovation Strategy for Africa
UIS	UNESCO Institute for Statistics
UNESCO	United Nations Educational, Scientific and Cultural organisation

EXECUTIVE SUMMARY

INTRODUCTION

There is a general consensus that science, technology and innovation are at the heart of development, and that investment in this sphere is critical to ensuring long-term growth. To this end, in 2014, African Heads of State and Government adopted the Science, Technology and Innovation Strategy for Africa 2014-2024, (STISA 2024), as a framework for S&T and innovation development in the Member States. From a measurement perspective, STISA (2024) calls for the monitoring and evaluation of policies which have been implemented and, for this to happen, surveys of R&D and of innovation in Member States are needed. The African Union recognises that for Member States to achieve Agenda 2063 and STISA (2024), science, technology and innovation must be at the centre of the developmental agenda. Hence these frameworks articulate the African Union Agenda for harnessing STI to boost economic growth and improve the lives of African people.

The African Union Development Agency (AUDA-NEPAD) in collaboration with the African Union Commission, AU Member States, and other partners has implemented the African Science, Technology and Innovation Indicators Initiative (ASTII) since 2007. The activities which have been carried out include strengthening the capacity of survey teams at national level, back-stopping research, monitoring development and innovation surveys in a total of 43 countries, supporting the analyses of survey data and the publication of the African Innovation Outlook. The ASTII Initiative has published two volumes of the AIO published in 2010 and 2014 respectively, with this being the third edition.

The Third African Innovation Outlook (AIO-3) presents the status of Research and Experimental Development (R&D) and Innovation performance in Africa, focusing on the period from 2013 to 2016. The information is derived from R&D and Innovation surveys conducted periodically by African Union Member States as part of the African Science Technology and Innovation Indicators (ASTII) initiative. This Outlook builds on the experience and expertise developed in Member States over the years and provides improved insights based on lessons learnt from the previous editions.

At the commencement of the project, the first African Intergovernmental Committee on Science, Technology and Innovation Indicators met in Mozambique in 2007 and adopted the ***Frascati Manual*** (OECD 2002) and the ***Oslo Manual*** (OECD/Eurostat 2005) as guidelines for the collection and interpretation of data on R&D, as well as on innovation in the business sector. This avoided the considerable burden of developing new manuals but did not preclude the production of additional guidelines which addressed the specificities of the economies in Africa. The innovation policy, and how it is implemented, has been an ongoing discussion in the research community for the last decade.

It is important to understand the data on STI indicators and to monitor them, particularly as it demonstrates the progress that African countries are making to meet STI goals. In this regard, and as part of the ASTII programme, AUDA-NEPAD and its partners have developed and selected key indicators for tracking the implementation of STISA (2024), which aligns with the goals of Agenda 2063 and the Sustainable Development Goals.

The data and indicators on research and experimental development (R&D) support policy and decision makers to understand, monitor and effectively manage financial and human resources allocated to perform R&D activities, set sector-specific R&D investment targets, and design clear policy initiatives for R&D. Furthermore, the analysis also helps to identify institutions, or firms, which are performing well and need support -- the kind of support which shows how well aligned the R&D activities are to national development objectives and priority areas such as manufacturing, energy, health, ICT, agriculture, etc.

Innovation indicators provide information on the rate of innovation in the countries, sources of relevant ideas and information for innovation, objectives for innovation, and fundamental drivers of innovation at firm level. Additionally, it highlights the importance of support measures on innovation activities, reveal cooperation arrangements or strategic alliances for innovation, and identify key obstacles that discourage innovation. Both the informal sector and innovations in sectors other than Business enterprises will be the set of new layers to add to the existing foundation of data measurement in Africa. Some of these factors may be more pronounced in one country than another due to differences in the innovation policy environments. Aspects such as partnerships, cooperation, networking, and innovation support activities may show insights that can be addressed at national level, as well as regional level.

MAIN FINDINGS

The Outlook comprises the following five chapters:

Chapter 1: Background

This chapter provides an overview of the ongoing STI measurement programme and level of AU Member States' participation and contribution:

- During the 10-year period during which the ASTII Initiative has been in operation, 43 Member States have been trained in data collection and provision of indicators. Without differentiation between R&D or Innovation data submitted, 17 countries provided indicators in AIO-1 (2010), 21 countries in AIO-2 (2014) and 24 countries in AIO-3 (2019).
- The harmonisation of statistics on the continent has allowed the alignment of policies and STI monitoring and evaluation (M&E) systems to CESA16-25 (AUC, 2016) and STISA 2024 (AUC, 2014) through the measurement of short and mid-term objectives towards achieving the long-term continental vision: Agenda 2063.
- The new configuration of the governing body on matters related to STI under the AU umbrella also gives an impetus for change to a committed team of 10 Heads of State and Government supporting the role of Education and Training and Science, Technology and Innovation for inclusive and economic growth and sustainable development.

Chapter 2 : Research and Experimental Development

This provides the results of R&D performance surveys conducted in participating countries. The chapter specifically outlines the outcome of R&D surveys in the 23 countries that have participated in the programme, and highlights results for the AIO-3. The countries consist of Angola, Botswana, Burkina Faso, Burundi, Cabo Verde, D.R. Congo, Egypt, Eswatini (former Swaziland), Ethiopia, Gabon, Ghana, Lesotho, Mali, Mozambique, Namibia, Niger, Rwanda, Senegal, Seychelles, South Africa, Tanzania, Togo and Uganda.

With the R&D surveys published in AIO-1 and AIO-2, and now in AIO-3, there is a mapping of the R&D landscape and efforts in Africa. The results further present R&D expenditures (and the 1% target of GDP) and what this implies in terms of manpower (researchers and other personnel related to R&D).

R&D Expenditures

A big challenge with collecting, and above all analyzing, R&D data in Africa is that data supplied by countries are often not complete usually because the data do not cover all four sectors: Business, Government, Higher Education and Private Non-Profit institutions. An incomplete coverage of all sectors is a real challenge to the calculation of GERD intensity that we are progressively tackling by

further training sessions, the well-known 1% target, nor is it possible to calculate the number of R&D personnel in a country. In fact, reliable GERD data (in AIO-1, AIO-2 and AIO-3) only exist for 11 countries: Botswana (0.54% of GDP), Egypt (0.80%), Eswatini (0.32%), Ethiopia (0.62%), Ghana (0.38%), Kenya (98%), Mozambique (0.38%), Namibia (0.40%), Senegal (0.54%), South Africa (0.82%, latest figure), and Uganda (0.18%).

Fortunately, many African countries do collect R&D data on the Government Sector (GOVERD) and the Higher Education Sector (HERD). Thus, there is a proxy for the "Public Sector" exclusively when the presence of private or confessional universities are inexistent, since most university research in Africa is carried out at State-run universities. R&D activities carried out in the public sector can accordingly be compared for 19 countries, data which in turn can be related to the public sector data for OECD countries and Latin America and Asia (see Table 2.8a). Such a comparison shows that, although GERD intensity data as a rule are over 2% of GDP in the OECD countries, in (contrast to less than 1% in Africa), the situation is quite different when we look at "Public Sector R&D" in different countries. Public sector spending on R&D is typically 0.64% of GDP in the OECD area. This could be compared to Africa (between 0.20% and 0.78%), and Latin America (Argentina 0.40%, Mexico 0.23% and Chile 0.21%). In other words, public spending on R&D in Africa has a very similar pattern, or intensity, as in most other countries.

An explanation of this contrast is that that business sector R&D is very important and by far the largest sector in the OECD countries, as well as in China and the Russian Federation. The only country in Africa with a strong R&D business sector is South Africa. In other countries where R&D activities in the business sector have been measured, the expenditures are surprisingly small, likewise in large countries such as Egypt (0.05% of GDP) and Ethiopia (0.01%).

R&D Personnel

These are employees engaged in undertaking R & D directly as well as those providing related services such as R & D managers and administrative staff. One important aspect of the R&D effort in Africa is the number of researchers and personnel engaged in research activities. It is important to analyze the number of the R&D personnel are doing research in order to get a picture of actual research being undertaken. However, it is often difficult to determine who, and how many, are doing actual research, as research assistants (such as doctoral students) tend to be counted as researchers. Thus, the challenge is that much of the R&D personnel are office and supporting staff, and this often distorts the picture when countries are compared. Another problem is that not all researchers do research all the time. Some researchers often dedicate considerable amount of time to teaching. That is why the ***Frascati Manual*** distinguishes between "headcounts" (HC) and "full time equivalents" (FTE).

Twenty-three (23) countries have submitted data on R&D manpower resources for AIO-3. Most of the R&D personnel in all 23 countries are found predominantly in the Government and Higher Education Sectors (that is the "Public Sector" exclusively when private universities are quasi-inexistent), on the average about 90%. In some cases, the R&D personnel are also found in the private non-profit sector (often financed by foreign assistance).

The number of researchers, as component of total R&D personnel varies considerably: from only 32% in Botswana to 88% in Senegal. On the average this is around 70%.

Researchers (FTE) per million inhabitants is an interesting indicator. It varies considerably: from 27 in Uganda to 435 in South Africa, 555 in Senegal and 715 in Egypt (and even 1568 in the Seychelles). In an international comparison, the researcher density in Africa is modest in relation to most OECD countries. For instance, Sweden 7593 researchers (FTE) per million inhabitants; Republic of Korea 7514; Germany 5036 and Japan 5305; but relatively competitive with Argentina 1233; Chile 533 and Mexico 244 (UIS Database on STI Indicators).

The personnel data in the R&D surveys also reveal differences by sex. There are quite remarkable discrepancies between African countries. On the average, 30 to 40% among the researchers are females. But it ranges from 9% in Togo and 13% in Ethiopia, to 44% in South Africa and 47% in Eswatini. Internationally, between 30 to 40% of the researchers are females. So, Africa stands out well in this comparison.

Chapter 3: Status of innovation performance

Chapter 3 provides the results of the Innovation surveys carried out in 10 AU member States where the findings are as follows:

- **To what extent are African firms innovative?** Innovation rates for all the 10 countries range from a low level of 3.9% for Cabo Verde to a high level of 91.7% for Uganda. It has been also reported that Eswatini, Ethiopia and Uganda had an average of 60% small firms out of the total business sector target population.

- **What are the different types of innovation?** Process innovations were higher at 33.4% followed by product innovations separately presented as goods (21.6%) and services (17.0%). Kenya and Uganda recorded the highest proportion of firms that undertook innovations related to workplace responsibilities (64%) in terms of organisational innovation while Uganda recorded the highest in terms of external relations (44%).

- **How do firms innovate?** In general, acquisition of machinery is the most cited expense in the process of innovation, followed by R&D expenditures and acquisition of external knowledge from others.

- **To what extent do innovative firms engage in R&D activity?** The findings show that most innovative firms in Namibia (52%) and Seychelles (55%) engaged in R&D activities to support innovation.

- **What are the impacts of innovation activities on firms?** The main impact of innovation is increased range of goods and services and improved quality.

- **Are firms using Intellectual Property Right?** The survey results show that trademarks were the most sought-after form of intellectual property rights for the firms in all the countries whether they were innovative or not, followed by industrial designs and copyrights.

- **What factors promote innovation?** The motivation within firms to undertake innovation activities was mainly to improve the quality of the product across all countries except for Eswatini where increasing the range of products is a major motivation element. Innovative firms had more employees with higher education qualifications per firm than non-innovative firms, except for Ethiopia and Lesotho where the numbers are even. Therefore, to be inspired for innovation, the source varies from one country to another. Data from Lesotho (63%), Uganda (45%), Kenya (44%), Angola (41.5%) and Eswatini (34.2%) show that these countries use internal sources of information to innovate.

- **What are the major factors that hamper innovation?** The data from Ethiopia reveals that barriers to innovation for large firms are different from that of small and medium firms. Although the cost factors remained important for large firms they are not seen as barriers to the same extent as in small and medium firms.

Chapter 4: New measurement in the horizons: suggests the way forward in measuring innovation in Africa.

A characteristic of most African economies is that their Gross Domestic Product is dominated by the public sector with a relatively weak business sector. There is therefore, interest to measure innovation in the public sector in addition to the business sector which

is the only one that is currently covered in the surveys. In addition, the household sector may have business activities which are in the formal or the informal economy and which can include innovation. A key difference between innovation in the business sector and in other sectors is the place of the market. For a product to be an innovation in the Business sector it must be "introduced on the market" (OECD/Eurostat 2005: 47, para. 150). As the market and selling at 'economically significant prices' are not characteristics of innovation in sectors other than the business sector the suggestion has been made (Gault 2012) that "introduced on the market" be replaced by "made available to potential users".

A generalized definition of innovation in System of National Accounts (SNA) sectors has been introduced in the fourth edition of the ***Oslo manual*** (OECD/Eurostat, 2018: 20-21) and could be applied for the measurement of innovation in the Public sector and the Household sector in Africa. The Chapter therefore makes the following recommendations:

- The principal activity for the future is the continuation of the R&D and the innovation surveys in order to provide the information needed to monitor and evaluate science and technology and innovation activities as part of STISA -2024 (AUC, 2014: 48).
- Going beyond what has been done since 2007, thought should be given to measuring innovation in economic sectors other than the Business sector. This is an ongoing global discussion and it would be opportune for experts from African countries to participate in it.
- Social innovation is being discussed globally and there are opportunities to participate in that discussion and to work with policy makers to arrive at definitions which make possible statistical measurement in Africa to support relevant social policy.

Chapter 5: Conclusion and recommendations

The data collected and compiled from the R&D surveys and innovation surveys should help governments understand how research and innovation can be useful at different levels and structures within a country. The data on STI indicators are central in having a coherent R&D and innovation system that delivers on economic progress of African countries.

The key findings in AIO-3 that were also previously reported in AIO-1 and 2 are that a limited number of firms have the capacity to do R&D in order to support innovation; universities and government research institutions are particularly low-rated as sources of information for innovation; and innovative firms invest more in machinery and equipment than in R&D activities. The first two findings are common to almost all countries in the world, while the third one is unique to African countries with policy implications.

The success of the ASTII Initiative is dependent on the active participation of countries through ownership of the programme as well as understanding the importance of the R&D and innovation data to the development processes of the Member States. Member States need to include indicators that monitor the contribution of STI in different sectors of the national economy using STISA (2024) indicators as the starting point. There is a great deal of work that needs to be done to put in place data management and analysis systems so that Member States have comparable statistics of good quality and coverage across the continent. Some recommendations have been presented in the chapter as to what should be done to improve the process of data collection.

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CHAPTER 1 : BACKGROUND

1.1 A Decade of Progress

The African Science, Technology and Innovation Indicators (ASTII) Programme has been implemented since 2007. Programme staff have undertaken a wide range of activities in collaboration with Member States, including strengthening the capacity of national survey teams and promoting surveys for research, development and innovation in 43 countries. Part of the survey results and analysis were published in two earlier editions of the African Innovation Outlook in 2010 and 2014 (AU-NEPAD 2010, NPCA (2014); Table 1.1), with this report being the third edition. These publications and country reports have been used in support of R&D and innovation policy development in participating countries (Siyanbola et al., 2014; MOE, 2017). The reports also serve as reference materials that highlight science, technology and innovation (STI) measurement in Africa (Daniel, 2013; Charmes, Gault and Wunsch-Vincent, 2016 & 2018; Muchie and Baskaran, 2019). The survey data submission from AU Member States are indicated below.

Table 1. 1 R&D Surveys data submission status from AU member States

Countries		AIO 2010		AIO 2014		AIO 2019	
		R&D	Innovation	R&D	Innovation	R&D	Innovation
1.	Algeria	-	-	-	-	-	-
2.	Angola	-	-	✔	-	✔	✔
3.	Benin	-	-	-	-	-	-
4.	Botswana	-	-	-	-	✔	-
5.	Burkina Faso	-	✔	✔	-	✔	-
6.	Burundi	-	-	-	-	✔	-
7.	Cabo Verde	-	-	✔	-	✔	✔
8.	Cameroon	✔	-	-	-	-	-
9.	CAR	-	-	-	-	-	-
10.	Chad	-	-	-	-	-	-
11.	Comoros	-	-	-	-	-	-
12.	Congo	-	-	-	-	-	-
13.	Congo D.R.	-	-	-	-	✔	-
14.	Cote d'Ivoire	-	-	-	-	-	-
15.	Djibouti	-	-	-	-	-	-
16.	Egypt	-	✔	✔	✔	✔	✔
17.	Equatorial Guinea	-	-	-	-	-	-
18.	Eritrea	-	-	-	-	-	-
19.	Eswatini	-	-	-	-	✔	✔
20.	Ethiopia	-	✔	✔	-	✔	✔
21.	Gabon	✔	-	✔	✔	✔	-
22.	Gambia	-	-	-	-	-	-
23.	Ghana	✔	✔	✔	✔	✔	-
24.	Guinea	-	-	-	-	-	-
25.	Guinea Bissau	-	-	-	-	-	-

Countries		AIO 2010		AIO 2014		AIO 2019	
		R&D	Innovation	R&D	Innovation	R&D	Innovation
26.	Kenya	✔	-	✔	✔	-	✔
27.	Lesotho	-	✔	✔	✔	✔	✔
28.	Liberia	-	-	-	-	-	-
29.	Libya	-	-	-	-	-	-
30.	Madagascar	-	-	-	-	-	-
31.	Malawi	✔	-	✔	-	-	-
32.	Mali	✔	-	✔	-	✔	-
33.	Mauritania	-	-	-	-	-	-
34.	Mauritius	-	-	-	-	-	-
35.	Morocco	-	-	-	-	-	-
36.	Mozambique	✔	✔	✔	-	✔	-
37.	Namibia	-	-	✔	-	✔	✔
38.	Niger	-	-	-	-	✔	-
39.	Nigeria	✔	-		✔	-	-
40.	Rwanda	-	-	-	-	✔	-
41.	SADR	-	-	-	-	-	-
42.	Sao Tome & Principe	-	-	-	-	-	-
43.	Senegal	✔	-	✔	✔	✔	-
44.	Seychelles	-	-	-	-	✔	✔
45.	Sierra Leone	-	-	-	-	-	-
46.	Somalia	-	-	-	-	-	-
47.	South Africa	✔	✔	✔	✔	✔	-
48.	South Sudan	-	-	-	-	-	-
49.	Sudan	-	-	-	-	-	-
50.	Tanzania	✔	✔	✔	✔	✔	-
51.	Togo	-	-	✔	-	✔	-
52.	Tunisia	-	-	-	-	-	-
53.	Uganda	✔	✔	✔	✔	✔	✔
54.	Zambia	✔	✔	-	✔	-	-
55.	Zimbabwe	-	-	✔	-	-	-
TOTAL		13	10	19	11	23	10

Source: AU-NEPAD (2010: 36), NPCA (2014: 22) and ASTII Phase-3 National surveys

1.2 A changing environment

When the ASTII Programme began, the first African Intergovernmental Committee responsible for Science, Technology and Innovation Indicators met in Mozambique in 2007 and adopted the ***Frascati Manual*** (OECD 2002) and the ***Oslo Manual*** (OECD/Eurostat 2005) as guidelines for the collection and interpretation of data on R&D and innovation in the business sector. While this led to the avoidance of considerable burden of developing new manuals, it did not preclude the production of additional guidelines that addressed the specificities of economies in Africa.

From the beginning of national accounting, R& D was regarded as an expense. However, with the revision of the System of National Accounts Manual in 2008 (EC et al. 2009), R&D was capitalized, and it joined other capital expenditures such as expenditure on machinery and equipment and on software. This is reflected in the seventh edition of the ***Frascati Manual*** (OECD 2015a).

The ***Oslo Manual*** has always focused on innovation in the business sector, while acknowledging that innovation could occur in all sectors. The fourth edition of the ***Oslo Manual*** (OECD/Eurostat 2018) has innovations in other economic sectors. Thus, this latest edition of the AIO provides the basis for further empirical work on measuring innovation in the Public and the Household sectors. As this is a statistical activity, the sectors to be measured would be taken from the System of National Accounts (EC et al. 2009).

Innovation policy, and how it is implemented has been an ongoing discussion in the research community for the last decade. In Africa in 2014, Heads of State and Government adopted the Science, Technology and Innovation Strategy for Africa – 2024 (STISA, 2024) as a framework for S&T and innovation development in the Member States. From a measurement perspective, STISA (2024) included a section on the monitoring and evaluation of policies that have been implemented and for this to happen, surveys of R&D and of innovation in Member States (Iizuka et al., 2015) are needed.

The importance of monitoring and evaluation fits with the African Charter on Statistics and the Strategy for the Harmonization of Statistics in Africa (SHaSA) (AUC 2012, African Union Commission et al. (2010) as the Charter 'encourages African policy makers to use statistics as a base for policy formulation, monitoring and evaluation, and decision making' (AUC 2012:41).

1.3 Sharing existing knowledge and building future capacity

The definition of R&D has not changed in the seventh edition of the ***Frascati Manual*** (OECD 2015a) and the fact that expenditure on R&D is now a capital investment rather than an expense will be dealt with by statistical offices responsible for the system of national accounts in their countries. Expenditure, and human resource allocation for R&D, have been measured in all the economic sectors used in the ***Frascati Manual***; Business enterprise, Government, Higher education[1], and Private non-profit. The 'Rest of the world' sector is used when there are flows of resources into or out of the country where the statistics are being gathered. Virtually all R&D is performed in the formal economy, and in many countries in Africa, most R&D is performed in the Government and the Higher education sectors. The next task is to build on what has been learned in the last decade and continue to take account of the types of R&D that are undertaken in African countries and the rationale.

Innovation can also happen in all sectors of the economy and there is a case for going beyond the measurement of innovation in only the Business sector to include innovation in the Public and Household sectors. Innovation in the Business sector can occur in the informal economy as well as the formal economy, which has been the domain of measurement so far. Innovation takes place in the Household sector, also in the formal and the informal economies, and there is social innovation which involves households as well as groups with common interests, history or culture. It is in the informal economy and in social innovation that indigenous knowledge can play a role and that presents measurement challenges which if addressed, provide policy opportunities.

[1]The Higher education is not found in the System of National Accounts as a sector.

1.4 Production of the Third African Innovation Outlook

The ***Third African Innovation Outlook (AIO-3)*** presents the status of Research and Experimental Development (R&D) and Innovation performance in Africa by focusing on the period between 2013 and 2016. The information is derived from R&D and Innovation surveys conducted periodically by African Union Member States as part of the African Science Technology and Innovation Indicators (ASTII) initiative. This Outlook builds on the experience and expertise which have been developed in Member States over the years, and provides improved insights based on lessons learnt from the previous editions published in 2010 and 2014.

The ***African Innovation Outlook*** comes at an appropriate time when the African political leadership is increasingly aware and supportive of the importance of science, technology and innovation (STI) as critical drivers of economic development and at a time when African economies are recovering from subdued economic performance (AfDB, 2018). This is the first Innovation Outlook written using data collected after the adoption of the African Union Agenda 2063 (AUC, 2015) by Heads of State and Government. Agenda 2063 is a continental blueprint for guiding Africa's development processes for the next five decades and regards STI as a critical enabler to achieving its goals (Agenda 2063: ***The Africa We Want;*** para 72). In addition, the AIO-3 is also the first Outlook following the approval of STISA (2024) in 2014.

STISA (2024) calls on AU Member States to ***"Accelerate Africa's transition to an innovation-led knowledge-based economy".*** The strategy acknowledges that African countries are at different stages of economic and social development. Furthermore, STISA (2024) recognises that individuals, institutions and economic sectors are affected in diverse ways by the outcomes of R&D and innovation. The Strategy, therefore, is both a call and a guide for African countries to put in place the following critical considerations: (a) adequate research infrastructure; (b) enhanced technical competencies of human resources; (c) effective innovation and entrepreneurship supporting activities; and (d) conducive policy environment. These four pillars of development reinforce each other to enhance performance of the national research and innovation systems in all sectors of the economy and drive growth, productivity and competitiveness. Both R&D and innovation have the potential to significantly contribute to African economic growth and prosperity.

The data on STI indicators are important to understand, monitor and demonstrate the progress that African countries are making to meet the STI goals. In this regard, and as part of the ASTII programme, AUDA-NEPAD and its partners have developed and selected key indicators to track STI performance in general, and the implementation of STISA 2024 in particular. Furthermore, the Outlook provides STI-related indicators for tracking the implementation of STISA 2024 mapped to the goals of Agenda 2063 and the Sustainable Development Goals.

1.5 The structure of the AIO report

The AIO-3 has five chapters covering a Background, R&D performance, Status of Innovation Performance, Innovation measurements in the horizon and Conclusions and Recommendations.

Chapter 1 provides an insight on the ongoing STI measurement and level of AU Member States participation and contribution.

Chapter 2 provides the results of R&D performance survey conducted in participating countries.

Chapter 3 provides the results of the Innovation surveys carried out in 10 AU member States.

Chapter 4 suggests the way forward in measuring innovation in Africa. Both the informal sector and innovations in sectors other than Business enterprises will be the set of new layers to add to the existing foundation of data measurement in Africa.

Chapter 5 provides conclusions and recommendations.

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CHAPTER 2: RESEARCH AND EXPERIMENTAL DEVELOPMENT

2.1 Introduction

STISA (2024) calls on AU Member States to "Accelerate Africa's transition to an innovation-led knowledge-based economy" and acknowledges that the economic status of Africa has significantly improved over the last two decades. Under Goal 4 of the Agenda 2063 First Ten Year Implementation Plan, STI is envisaged to drive "Manufacturing/industrialization and Value Addition" at the national level. Hence there is a need to demonstrate the use of science, technology and innovation in poverty reduction, job creation, sustainable livelihoods and improved well-being of African citizens. The Agenda 2063 and STISA (2024) call on African countries to increase their gross domestic expenditure on research and development (GERD) to at least one per cent of their gross domestic product (GDP). Specifically, such investment is needed to build Africa's technical competencies, improve research infrastructure, innovation and entrepreneurship capabilities and create a conducive policy environment for accelerating "Africa's transition to an innovation-led knowledge-based economy". Evidence-based understanding of STI systems is important for research and innovation policy formulation and programme design. The African Science, Technology and Innovation Indicators (ASTII) initiative has made progress in supporting African countries to collect data on STI indicators and generate new indicators.

Data and statistics on research and experimental development (R&D) assists policy and decision makers to understand, monitor and effectively manage financial and human resources allocated to perform R&D activities, set sector-specific R&D investment targets, and design clear policy initiatives for R&D. More importantly, the analysis helps to undertake the following: identify institutions, or firms that are performing well, require support, the type of support, and asses the alignment of R&D activities to national development objectives and priority areas such as manufacturing, energy, health, ICT, agriculture, and so forth.

R&D activities can be classified into three types, namely basic, applied, and experimental development research. Despite these categories, nothing stops experimental development from informing basic research from directly translating into final products for the market or processes and business models for internal use by firms. The results of R&D expenditure by a type of R&D as a percentage of gross domestic product (GDP)[2] are critical for understanding the role of R&D in socio-economic development.

2.2 Methodology and overview of R&D Datasets

The R&D surveys were conducted according to the guidelines in the ***Frascati Manual*** (OECD, 2002). Definitions of both research and experimental development (R&D) and its subsequent components such as basic research, applied research and experimental development are also elaborated in this section.

R&D is defined as the creative and systematic work undertaken in order to increase the stock of knowledge, including knowledge of humankind, culture and society, and to devise new applications of available knowledge (OECD, 2015: 28, para 1.32). R&D activity is the sum of actions deliberately undertaken by R&D performers in order to generate new knowledge (OECD, 2015: 46, para 2.12). Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view (OECD, 2015: 29, para 1.35). Applied research is original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific, practical aim, or objective (OECD, 2015: 29, para 1.35). Experimental development is systematic work, drawing on knowledge gained from

[2]The Gross Domestic Product (GDP) is the total market value of all final goods and services produced in a country in a given year, equal to total consumer, investment and government spending, plus the value of exports, minus the value of imports

research and practical experience and producing additional knowledge, which is directed to producing new products, or processes, or to improving existing products or processes (OECD, 2015: 29, para 1.35).

The R&D surveys collected data on expenditures and personnel from 23 countries (Table 2.1). The data collection process focused on measurement in four broad sectors of which three have a counterpart in the Systems of National Accounts (SNA) institutional classification: Business enterprise, Government and Private non-profit. One sector is defined on the basis of meeting user needs for units engaged in Higher education and overlaid on the others (OECD, 2015: 97, para 3.50). There are five (5) main sources for R&D funding: Business enterprise, Government, Higher education, Private non-profit and the Rest of the World. Funding from the Rest of the World includes the category international organisations, which is defined to include supranational organisations (OECD, 2015: 132).

Out of the 23 countries, only seven have fully covered the four sectors indicated above. Comparisons among countries should be done with caution as not all countries adopted the same sampling methodologies, especially as pertains to survey in the business sector. Some countries did not extrapolate data (e.g. Burundi, Gabon and Ghana) while others did (e.g. Eswatini, South Africa and Uganda). AU Member States carried out surveys based on R&D data for latest available year. Some have their financial years spanning two years. For the sake of analysis and interpretation, the period with the first two quarters was considered as the reference year (reference period for R&D data collection; Table 2.1). For instance, any country with a financial written like “Year1/Year2” will be given “Year1 as reference.

The R&D data presented covers R&D expenditure and R&D Personnel. ***The Frascati Manual*** (2002 and 2015) presents GERD as the total intramural expenditure on R&D performed in the national territory during a specific reference period (OECD, 2015: 111, para 4.7). ***Intramural R&D expenditures*** are all current expenditures plus gross fixed capital expenditures for R&D performed within a statistical unit during a specific reference period, whatever the source of funds (paragraph 4.10) (OECD, 2015:112). R&D Intensity is the ratio of GERD divided by GDP (OECD, 2015: 144, para 4.162).

BERD is the measure of expenditures on intramural R&D within the Business enterprise sector during a specific reference period (OECD, 2015: 208, para 7.35). BERD Intensity is the ratio of BERD divided by GDP as percentage.

GOVERD is the measure of expenditures on intramural R&D within the Government sector during a specific reference period (OECD, 2015: 243, para 8.36). GOVERD Intensity is the ratio of GOVERD divided by GDP as percentage.

HERD is the measure of intramural R&D expenditures in the Higher education sector during a specific reference period (OECD, 2015: 269, para 9.53). HERD Intensity is the ratio of HERD divided by GDP as percentage.

PNPERD is the measure of intramural R&D expenditures within the Private non-profit sector during a specific reference period (OECD, 2015: 292, para 10.21). PNPERD Intensity is the ratio of PNPERD divided by GDP as percentage.

All data found in this report were collected by the participating African countries, except for population data and respective GDP taken from the ***World Economic Outlook 2014*** (IMF, 2014). Purchasing power parity (PPP$) has been used to convert the various currencies into a common currency as described in Box 2.1.

Box 2. 1 Methodology of Purchase Power Parity (International dollar) – PPP$

The Purchasing power parities (PPPs) are the rates of currency conversion that try to equalise the purchasing power of different currencies, by eliminating the differences in price levels between countries. The basket of goods and services priced is a sample of all those that are part of final expenditures: final consumption of households and government, fixed capital formation, and net exports. This indicator is measured in terms of national currency per US dollar. (https://data.oecd.org/conversion/purchasing-power-parities-ppp.htm)

To convert socio-economic indicators from Local Currency Unit (LCU) to PPP requires the division of the amount in LCU of a specific year by the Implied PPP conversion rate (also called National currency per current international dollar) of the same year. For instance, Angola had in 2014 (reference period of the R&D survey) a GDP in million LCU estimated to 12,917,422 with an implied PPP conversion rate of 73,50. Thus, GDP in PPP$ Million (current international dollar - millions) will be 12,917,422 divided by 73.50 or $175,540 Million in PPP. Those figures are from the ***World Economic Outlook*** (IMF, 2014)[3] with 2005 as base year.

Table 2. 1 Characteristics of AIO-3 datasets submitted from R&D surveys in 23 countries

No	Country			Business		Government		Higher Education		Private Non-Profit	
		Financial period	Reference year	R&D Expenditure	R&D Personnel	R&D Expenditure	R&D Personnel	R&D Expenditure	R&D Personnel	R&D Expenditure	R&D Personnel
1	Angola	2014	2014	–	–	✓	✓	✓	✓	–	–
2	Botswana	2013/2014	2013	✓	✓	✓	✓	✓	✓	✓	✓
3	Burkina Faso	2013/2014	2013	–	–	✓	✓	✓	✓	✓	✓
4	Burundi	2011/2012	2011	–	✓	–	✓	–	✓	–	✓
5	Cabo Verde	2014	2014	–	–	–	✓	–	✓	–	–
6	DRC	2015	2015	–	–	✓	✓	–	–	–	–
7	Egypt	2015	2015	✓	✓	✓	✓	✓	✓	✓	✓
8	Eswatini	2015/2016	2015	✓	✓	✓	✓	✓	✓	✓	✓
9	Ethiopia	2013/2014	2013	✓	✓	✓	✓	✓	✓	✓	✓
10	Gabon	2014	2014	–	✓	–	✓	–	✓	–	✓
11	Ghana	2015	2015	–	–	✓	✓	✓	✓	–	–
12	Lesotho	2015	2015	–	–	✓	✓	✓	✓	–	–
13	Mali	2015	2015	–	–	✓	✓	✓	✓	✓	✓
14	Mozambique	2014/2015	2014	✓	✓	✓	✓	✓	✓	✓	✓
15	Namibia	2013/2014	2013	✓	✓	✓	✓	✓	✓	✓	✓
16	Niger	2013	2013	–	–	✓	✓	✓	✓	✓	✓
17	Rwanda	2013/2014	2013	–	–	✓	✓	✓	✓	✓	✓
18	Senegal	2015	2015	–	–	✓	✓	✓	✓	✓	✓
19	Seychelles	2015	2015	–	✓	✓	✓	✓	✓	–	✓
20	South Africa	2014/2015	2014	✓	✓	✓	✓	✓	✓	✓	✓
21	Tanzania	2013/2014	2013	–	–	✓	✓	✓	✓	–	–
22	Togo	2015	2015	–	–	✓	✓	✓	✓	–	–
23	Uganda	2014	2014	✓	✓	✓	✓	✓	✓	✓	✓
	TOTAL			8	11	20	23	19	22	13	16

[3]International Monetary Fund, World Economic Outlook Database, October 2014 (http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/weoselgr.aspx),

2.3 R&D Expenditure

R&D expenditure represents the total amount spent on research and development by a national statistical unit in a financial year within or outside its unit. R&D expenditure helps to address the following policy issues:

i. How much is allocated to R&D?
ii. In which sectors are R&D Expenditures performed?
iii. What is the share of Public Expenditure on R&D?
iv. What are the sources of funding?
v. Which types of R&D activities are performed?
vi. What is the focus area for R&D activities? and
vii. Indirectly, what are the levels of domestic and international interactions and collaborations across and among sectors and fields of R&D?

2.3.1 How much is allocated to R&D?

Of the 23 countries, 7 (30.4%) had provided data for all sectors hence GERD as percentage of GDP and GERD per capita have been computed (Table 2.2).

Table 2. 2 Gross Domestic Expenditure on Research and Development (GERD)

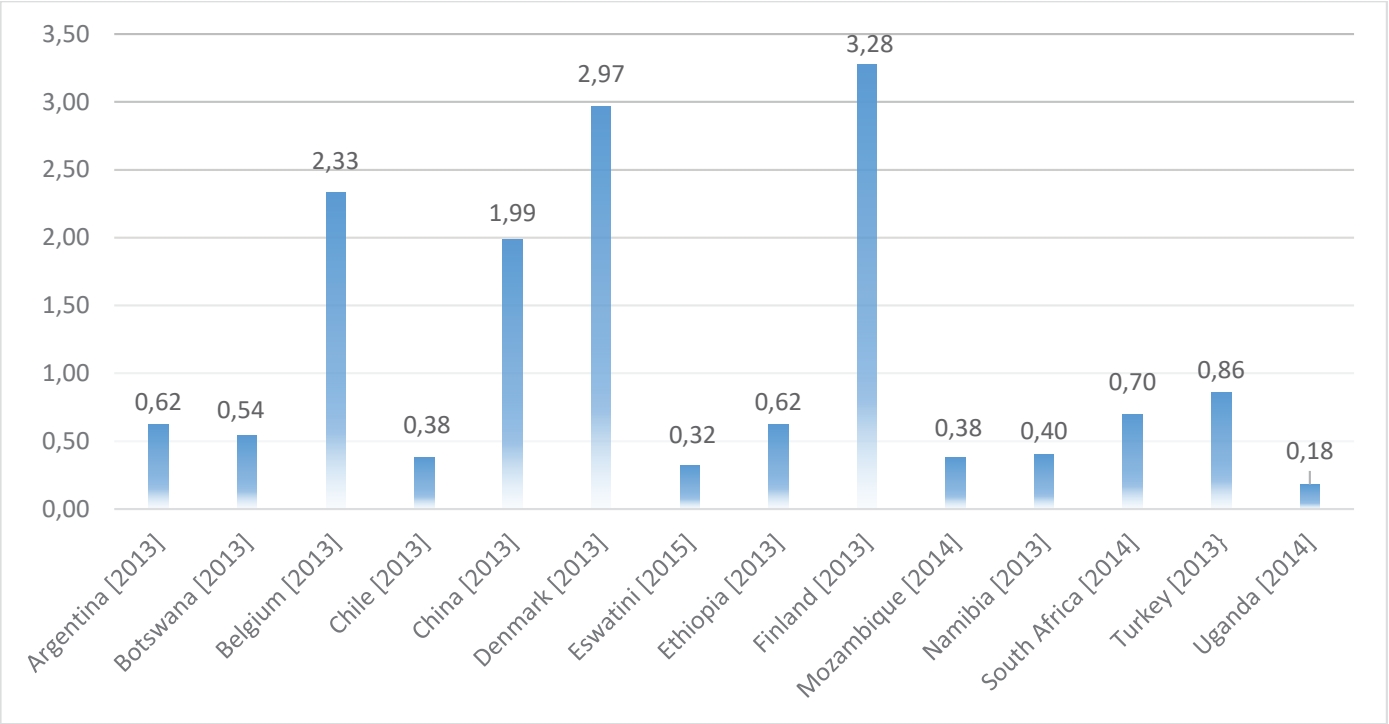
Countries	GERD (PPP$ M)	GERD (% of GDP)	GERD per capita (PPP$)
Botswana	171.54	0.54	77.62
Eswatini	29.05	0.32	2.20
Ethiopia	780.10	0.62	7.81
Mozambique	112.64	0.38	4.01
Namibia	88.76	0.40	36.53
South Africa	4803.55	0.70	86.88
Uganda	116.76	0.18	2.91

The data provided by countries with full sectoral coverage shows that there is no AU Member State which reached the 1% target of the GDP required to be invested in R&D. When GERD is expressed as a ratio of GDP, three countries, South Africa, Ethiopia and Botswana reported an R&D intensity of more than 0.5%. On the other hand, Mozambique, Namibia, Swaziland and Uganda had R&D intensity of less than 0.5 (Figure 2.1). GERD per capita is showing a significant variation among these countries ranging from 2.20 to 86.88 PPP$.

In comparison with some selected OECD data of 2013, ASTII Phase 3 figures show that investment in R&D remains very low in contrast to some European countries such as Belgium, Denmark and Finland. The R&D intensity target for the European Union (EU) was set to 3% by 2020 . The trend observed after the coverage of all 4 R&D performing sectors in 7 African countries looks similar to the performance to two Latin America countries (Argentina and Chile), and also Turkey in the Middle East. In 2013, China invested 1.99% of its GDP into R&D but the most current information from OECD shows that in 2017 the GERD intensity had increased and reached 2.14%.

[4]OECD Data - Gross domestic spending on R&D (https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm)
[5]The Europe 2020 strategy adopted in 2010 maintains a long-standing objective, namely, for the EU to devote 3.00 % of gross domestic product (GDP) to R&D activities; this is one of the five key targets of the Europe 2020 strategy. (https://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure)

Fig. 2. 1 GERD as percentage of GDP



Source: ASTII Phase-3 survey and OECD data (https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm)

2.3.2 In which sectors are R&D Expenditures performed?

Table 2.3 provides GERD by sector of performance in percentage from seven countries. Mozambique (43%), Namibia (46%) and Uganda (47%) invested more in R&D activities in their respective public research institutions, mainly considered as government sector, while only South Africa has invested 46% of its GERD in the business enterprises sector. From data published in 2010, Ethiopia HERD was 6.5 times higher than in 2014 (NPCA, 2014: 30). Universities still remain areas of highest concentration of research activities in the countries ranging from 28.0% in South Africa to as high as 74.0% in Ethiopia.

Table 2. 3 GERD by Sector of Performance (Percentage)

Countries	BUSINESS (%)	GOVERNMENT (%)	HIGHER EDUCATION (%)	PRIVATE NON-PROFIT (%)
Botswana	18.0	13.0	51.0	18.0
Eswatini	1.0	37.0	36.0	26.0
Ethiopia	1.3	24.5	74.0	0.2
Mozambique	0.5	43.0	37.4	19.1
Namibia	11.0	46.0	35.0	8.0
South Africa	46.0	23.0	28.0	3.0
Uganda	4.0	47.0	46.0	3.0

2.3.2.1 Business Expenditure on Research and Development (BERD)

Business expenditure on R&D and associated variables are provided in Table 2.4. Firms often finance their own R&D activities to generate new knowledge, processes, and technologies that can be used to come up with product innovations (new goods and services). BERD intensity ranged from as low as 0.002% for Mozambique to a high of 0.323% for South Africa. Apart from South Africa, where the business sector was also financed by other sectors, in other six countries no significant funding was received from other sources.

Table 2. 4 Business Expenditure on R&D (BERD)

Countries	BERD (PPP$ M)	BERD (% of GDP)	BERD per capita (PPP$)
Botswana	30.33	0.10	14.4
Egypt	467.17	0.047	4.98
Eswatini	0,31	0.003	0.28
Ethiopia	10.02	0.01	0.11
Mozambique	0.53	0.002	0.02
Namibia	10.14	0.05	4.17
South Africa	2205.70	0.32	39.9
Uganda	5.06	0.008	0.13

The low percentage may indicate that (1) the business sector does not invest much in its own R&D activities or does not get funded from external sources; (2) a small population of businesses performed R&D activities; and (3) there are no effective framework conditions (e.g. R&D incentives, policies (innovation, education, training, industry, technology transfer), financing, regulations, etc.) to encourage interactions across sectors.

2.3.2.2 Government Expenditure on R&D (GOVERD)

The results for government expenditure on R&D (GOVERD) performed in 20 countries are shown in Table 2.5. GOVERD is relatively high in most African countries with South Africa and Egypt spending more than $1 billion on R&D performed by public institutions. The proportion of GOVERD as a percentage of GDP for the 20 countries ranges from as low as 0.01% for Lesotho to a high of 0.27% for the Republic of Tanzania. Large African economies such as Egypt (0.26%) and South Africa (0.16%) are in 2nd and 7th place, respectively. Angola had a very low GOVERD per capita in 2014 compared to Botswana. Given the major role that governments play in funding R&D performance and facilitating a conducive policy environment for R&D, they should set targets for GOVERD intensity aligned with the national research and development agenda.

Table 2. 5 Government Expenditure on R&D (GOVERD)

Countries	GOVERD (PPP$ M)	GOVERD (% of GDP)	GOVERD per capita (PPP$)
Angola	20.14	0.01	0.27
Botswana	22.53	0.07	10.19
Burkina Faso	22.51	0.08	0.56
D.R Congo	10.16	0.02	0.13
Egypt	2480.00	0.26	26.44
Eswatini	11.71	0.13	8.87
Ethiopia	190.84	0.15	1.91
Ghana	91.35	0.08	3.31
Lesotho	0.44	0.01	0.20
Mali	55.66	0.19	3.19
Mozambique	48.46	0.16	1.73
Namibia	40.76	0.18	16.77
Niger	4.62	0.03	0.23
Rwanda	6.36	0.03	0.55
Senegal	81.69	0.23	5.45
Seychelles	4.69	0.19	52.11
South Africa	1123.49	0.16	20.32
Tanzania	231.67	0.27	4.30
Togo	4.89	0.04	0.66
Uganda	54.98	0.08	1.37

2.3.2.3 Higher Education Expenditure on R&D (HERD)

The higher education expenditures on R&D (HERD) for 19 countries are presented in Table 2.6. The higher education systems (and institutions) in these countries are not similar and this affects how R&D is performed. The high HERD is an indication of the relatively large higher education systems for countries such as Egypt, South Africa, Ethiopia, Tanzania and Senegal when compared to the rest of the countries. Although South Africa's HERD was second to that of Egypt, its HERD intensity was only 0.2% and was placed in the 8th position out of the 19 countries.

Table 2. 6 Higher Education Expenditure on R&D (HERD)

Countries	HERD (PPP$ M)	HERD (% of GDP)	HERD per capita (PPP$)
Angola	22.66	0.013	0.81
Botswana	86.75	0.27	39.25
Burkina Faso	37.91	0.14	2.09
Egypt	4569.27	0.48	48.72
Eswatini	11.36	0.10	8.61
Ethiopia	577.42	0.56	5.78
Ghana	308.77	0.265	11.19
Lesotho	2.96	0.05	1.36
Mali	0.99	0.003	0.06
Mozambique	42.17	0.14	1.51
Namibia	31.07	0.14	12.78
Niger	8.57	0.05	0.43
Rwanda	14.72	0.08	1.27
Senegal	170.97	0.48	11.41
Seychelles	0.49	0.02	5.44
South Africa	1365.19	0.20	24.69
Tanzania	367.77	0.43	6.83
Togo	23.52	0.215	3.17
Uganda	53.70	0.08	1.34

2.3.2.4 Private Non-Profit Expenditure on R&D

The results of 12 out of 23 countries are presented in Table 2.7. The private non-profit expenditure on R&D (PNPERD) as a percentage of GDP is the lowest compared to the other sectors. The intensity ranged from as low as 0.001% for Ethiopia to a high of 0.19% for Mali.

Table 2. 7 Private Non-Profit Expenditure on R&D (PNPERD)

Countries	PNPERD (PPP$ M)	PNPERD (% of GDP)	PNPERD per capita (PPP$)
Botswana	31.93	0.10	14.40
Burkina Faso	2.90	0.01	0.16
Eswatini	8.08	0.09	6.12
Ethiopia	1.81	0.001	0.02
Mali	57.44	0.19	3.29
Mozambique	21.48	0.07	0.76
Namibia	6.79	0.03	2.79
Niger	0.94	0.006	0.05
Rwanda	8.89	0.05	0.76
Senegal	11.93	0.03	0.80
South Africa	109.17	0.016	1.97
Uganda	3.02	0.01	0.08

2.3.3 What is the share of Public Expenditure on R&D

Globally, governments invest financial resources in R&D activities performed by different sectors of the national economy to create societal benefits. Each investment as part of the Public Expenditure on R&D (PUBERD: calculated as proxy of GOVERD+HERD financed by Government) should directly or indirectly result in societal benefits. Therefore, it is important to know the levels of the public funding on R&D regardless of the source of funds compared to the portion that is financed by government. Based on Agenda 2063 and STISA (2024), governments in consultation with other actors in the R&D systems and national systems of innovation should clearly define the results that they expect from R&D activities performed by public and higher education institutions as well as the pathways for achieving the results.

Public sector spending on R&D is typically 0.64% of GDP in the OECD area. This could be compared to Africa (between 0.20% and 0.78%), and Latin America (Argentina 0.40%, Mexico 0.23% and Chile 0.21%). In other words, public spending on R&D in Africa has a very similar pattern or intensity, as in most other developing countries (see Table 2.8a).

As shown in Table 2.8b, the Public R&D Expenditure intensity for Ghana, Kenya, Senegal and Tanzania increased for 2014 (AIO-2) while South Africa and Uganda reported reduced levels. Uganda had a significant drop in intensity from 1.07% (AIO-1) to 0.32% (AIO-2) then 0.16% (AIO-3). The progressive sharp decrease was caused by a corresponding decrease in funding for GOVERD and HERD while the GDP increased from $32 709 million in 2007/2008 to $47 531 million in 2010 and $66 650 in 2014. For the period 2013-2016 (AIO-3), Ethiopia, Senegal, Tanzania and Togo increased their Public R&D Expenditure intensity by investing more funds for GOVERD and HERD. In 2013/2014, Ethiopia significantly increased its Public R&D Expenditure intensity to 0.61% by investing in HERD and GOVERD from $88.3 million to $577.4 million and $88 million to $190.8 million, respectively. Although South Africa increased funding for GOVERD and HERD during 2014/2015, its Public R&D Expenditure dropped to 0.36% from 0.38%. This drop in Public R&D Expenditure may have been caused by a 2.3% increase in GDP for South Africa from $524 158 million in 2010 to $683 147 million during the period 2014/2015. The decrease in public R&D Expenditure intensity for Mali (2015) and Angola (2014) was due to reduced funding for GOVERD and HERD, while for Ghana (2015) and Mozambique (2014/2015) the decrease may have been due to moderate increases in GDP.

Table 2. 8a African and International R&D Expenditure Data (2017 or latest)

Country	GERD as % of GDP	PUBERD as % of GDP	PUBERD per capita (PPP$)	BERD as % of GDP
Rep. of Korea	4.55	0.87	339.5	3.62
Sweden	3.40	0.97	497.6	2.42
Japan	3.21	0.43	183.5	2.53
Denmark	3.05	1.07	580.9	1.97
United States	2.79	0.63	378.3	2.04
OECD	**2.37**	**0.64**	**284.5**	**1.67**
China	2.15	0.48	79.9	1.66
United Kingdom	1.66	0.49	218.9	1.12
Russian Federation	1.11	0.44	112.6	0.67
Kenya	0.98	0.78	12.83	0.09
South Africa (2016)	0.82	0.36	48.1	0.34
Egypt	0.80	0.75	75.2	0.05
South Africa (2015)	0.70	0.36	45.0	0.32
Ethiopia	0.62	0.61	7.70	0.01
Botswana	0.54	0.34	49.4	0.10
Argentina	0.54	0.40	84.7	0.14
Senegal	0.54	0.45	17.7	0.01
Mexico	0.49	0.23	58.3	0.15
Namibia	0.40	0.32	29.56	0.05
Ghana	0.38	0.34	14.51	0.01
Mozambique	0.38	0.30	3.24	0.01
Chile	0.36	0.21	50.6	0.12
Eswatini	0.32	0.23	17.14	0.02
Uganda	0.18	0.16	2.71	0.01
Tanzania	n.a.	0.71	11.1	n.a.
Togo	n.a.	0.32	38.3	n.a.
Burkina Faso	n.a.	0.21	3.34	n.a.
Seychelles	n.a.	0.21	57.56	n.a.
Mali	n.a.	0.20	3.23	n.a.
Rwanda	n.a.	0.11	21.1	n.a.

Sources: AIO-1, AIO-2 and AIO-3. OECD: Main Science and Technology Indicators 2019. Vol. 1

Table 2. 9b Trends of GOVERD+HERD for AIO-1, AIO-2 and AIO-3

GOVERD+HERD for AIO-1, AIO-2 and AIO-3																		
	AIO-1						AIO-2						AIO-3					
		GDP	GOVERD	HERD	GOVERD+HERD			GDP	GOVERD	HERD	GOVERD+HERD			GDP	GOVERD	HERD	GOVERD+HERD	
Country	Year	*Amount in Million PPP$*	*Amount in Million PPP$*	*Amount in Million PPP$*	*Amount in Million PPP$*	*(Amount in Million PPP$.)/ GDP as %*	Year	*Amount in Million PPP$*	*Amount in Million PPP$*	*Amount in Million PPP$*	*Amount in Million PPP$*	*(Amount in Million PPP$.)/ GDP as %*	Year	*Amount in Million PPP$*	*Amount in Million PPP$*	*Amount in Million PPP$*	*Amount in Million PPP$*	*(Amount in Million PPP$.)/ GDP as %*
Angola	–	–	–	–	–	–	2011	113000	61.3	24.3	85.6	0.08	2014	175 540	20.1	22.7	42.8	0.02
Botswana	–	–	–	–	–	–	–	–	–	–	–	–	2013/14	31 689	22.5	86.8	109.3	0.34
Burkina Faso	–	–	–	–	–	–	2009/10	21763	†	†	†	†	2013/14	27 738	22.5	37.9	60.4	0.22
DRC	–	–	–	–	–	–	–	–	–	–	–	–	2015	61 579	10.2	–	†	†
Egypt	–	–	–	–	–	–	2011	843842	†	†	†	†	2015	996 551	2480.0	4569.3	7049.3	0.71
Eswatini	–	–	–	–	–	–	–	–	–	–	–	–	2015/16	9 011	11.7	11.4	23.1	0.26
Ethiopia	–	–	–	–	–	–	2010	83952	88.0	88.3	176.3	0.21	2013/14	126 748	190.8	577.4	768.3	0.61
Ghana	2007/08	31605	111.4	2.8	114.2	0.36	2010	40368	144.2	5.7	149.9	0.37	2015	116 640	91.4	308.8	400.1	0.34
Kenya	2007/08	57875	193.3	41.9	235.2	0.41	2010	66615	265.0	254.6	519.6	0.78	2013/14	125 770	–	–	–	–
Lesotho	–	–	–	–	–	–	2011	5160	–	0.5	†	†	2015	5 959	0.4	3.0	3.4	0.06
Mali	2007	22998	–	36.3	†	†	2010	17030	92.8	19.6	112.4	0.66	2015	28 924	55.7	1.0	56.7	0.20
Mozambique	2007/08	18821	36.5	–	†	†	2010	21429	54.4	35.7	90.1	0.42	2014/15	29 757	48.5	42.2	90.6	0.30
Namibia	–	–	–	–	–	–	2010	18015	†	18.6	†	†	2013/14	22 245	40.8	31.1	71.8	0.32
Niger	–	–	–	–	–	–	–	–	–	–	–	–	2013	16 341	4.6	8.6	13.2	0.08
Rwanda	–	–	–	–	–	–	–	–	–	–	–	–	2013/14	18 704	6.4	14.7	21.1	0.11
Senegal	2008	20625	33.2	40.3	73.5	0.36	2010	24200	67.9	41.0	108.9	0.45	2015	35 893	81.7	171.0	252.7	0.70
Seychelles	–	–	–	–	–	–	–	–	–	–	–	–	2015	2 435	4.7	0.5	5.2	0.21
South Africa	2007	473962	1079.9	965.5	2045.4	0.43	2010	524158	914.8	1077.0	1991.8	0.38	2014/15	683 147	1123.5	1365.2	2488.7	0.36
Tanzania	2007/08	48875	98.8	126.9	225.7	0.46	2010	62000	44.3	278.1	322.4	0.52	2013/14	84 884	231.7	367.8	599.4	0.71
Togo	–	–	–	–	–	–	2010	6120	8.9	6.4	15.3	0.25	2015	10 958	4.9	23.5	28.4	0.26
Uganda	2007/08	32709	165.5	179.5	345	1.05	2010	47531	91.7	60.4	152.1	0.32	2014	66 650	55.0	53.7	108.7	0.16

–Sector was not surveyed or surveys were not conducted

† R&D Expenditure data for the sector was either not submitted or was incomplete

2.3.4 What are the Sources of Funding?

Data on sources of funding of GERD for the seven countries are presented in Table 2.9. The government financed from as low as 35% of GERD for Eswatini to as high as 94% for Egypt and 97% for Ethiopia. While in Uganda, Eswatini and Mozambique, almost equal proportions of less than 50% of GERD were spent by the government and higher education sectors, respectively.

The business sectors of all the seven countries, except for South Africa (41%), invested less than 20% of GERD for R&D activities. This contrasts with observations from developed countries such as South Korea, Japan, United States, Germany, and Sweden where the business sector funds more than 50% of GERD for R&D activities performed.

The low investment levels from the business sector might be an indication, among other reasons, of the small size of the business sectors (except South Africa) which may not have surplus financial resources to invest in R&D activities or the firms are not in R&D intensive sectors. According to the First Ten Year Implementation Plan 2014-2023[6] for Agenda 2063, it is imperative that African countries aggressively pursue policies and strategies to grow the business sector and consequently encourage R&D within the sector.

Table 2. 9 GERD by Sources of Funding (Percentage)

Country	BUSINESS (%)	Government (%)	Higher Education (%)	Private Non-Profit (%)	Rest of the world (%)
Botswana	18.0	60.0	1.0	0.0	21
Eswatini	13.0	35.0	19.0	2.0	31
Ethiopia	1.0	97.0	0.0	0.0	2
Mozambique	0.5	43.5	13.3	0.0	42.7
Namibia	11.0	63.0	6.0	4.0	16
South Africa	41.0	43.0	1.0	2.0	13
Uganda	4.0	38.0	2.0	3.0	53

Out of the seven countries, Uganda, Mozambique and Eswatini report levels of GERD funded by the Rest of the World to be above 25%, ranging from 31% for Eswatini to 42.7% for Mozambique and the highest being Uganda at 53%.The rest of the countries have less than 25% of their R&D funds being contributed from the rest of the world. The external sources of funding for R&D may indicate knowledge links, collaborations and interactions with the international research community but there is need to increase domestic investment in R&D in Africa especially in those countries where the funds come in form of development aid.

Evidence from elsewhere suggests that most countries can exceed the “1% of GERD to GDP” target when they have an active business enterprise sector. For instance, aggregated data at the European Union level reveals that since 2000 to date, BERD has been at around 1.05% of GDP[7]. In this case, businesses are expected to perform more R&D activities to bring new and improved goods and services to the market and new processes, marketing methods and business models into use, while the researchers are needed to perform R&D activities.

[6]https://www.nepad.org/agenda-2063/publication/agenda-2063-first-ten-year-implementation-plan-2014-2023-0
[7]https://ec.europa.eu/research/innovation-union/pdf/competitiveness-report/2011/chapters/part_i_chapter_5.pdf

2.3.5 R&D Expenditure by Type of Research

R&D expenditure by type of research for the 7 countries which covered all 4 sectors is presented in Table 2.10. The concentration is more in Applied Research except for Ethiopia (24.4%). Eswatini, Mozambique, South Africa and Uganda have more than 20% of GERD spent in Basic Research. Ethiopia has close to three quarters (74.0%) of its GERD invested on experimental development research.

Table 2. 10 GERD by Type of R&D (Percentage)

Countries	GERD	Basic Research	Applied Research	Experimental Development	Not Elsewhere Classified
Eswatini	100.0	20.4	66.1	13.5	-
Ethiopia	100.0	1.3	24.4	74.0	0.2
Mali	100.0	11.9	58.4	28.7	1.05
Mozambique	100.0	27.1	51.0	21.9	-
Namibia	100.0	17.1	44.8	30.4	7.8
South Africa	100.0	23.8	47.3	28.9	-
Uganda	100.0	29.2	47.1	23.6	-

2.3.6 GERD by Type of Costs

R&D Expenditure by type of cost data is presented in Table 2.11. Labour costs accounted for between 34-59% of the total R&D expenditure except for Ethiopia where labour costs constituted only 6% of GERD. In Mozambique, South Africa and Eswatini, labour costs were 52%, 57% and 59% of GERD, respectively. The higher labour costs may be due to several factors, among them, an indication of long-established R&D system that already has in place the basic R&D infrastructure. A case in point is South Africa which spent 57% of GERD on personnel, 34% on other current costs, 7% on instruments and software, and only 2% on land, buildings and vehicles.

Among the 7 countries which provided the full dataset for 4 sectors, only Ethiopia spent 87% of its GERD in capital costs. The rest spent more to cover their current costs, particularly South Africa (91%) with the highest percentage followed by Mozambique (85%) and Eswatini (84%) then Namibia (77%) and Uganda (59%).

The share of HERD by type of costs is predominantly by current costs of more than 62% for 14 countries. This is exceptional in that the HERD was wholly attributed to current costs, which are most likely labour costs for R&D personnel. However, Botswana and Ethiopia, respectively reported 70% and 95% of HERD allocated towards capital costs for R&D. Ethiopia allocated 95% of HERD to capital costs which may suggest that during this period more resources went into R&D infrastructure development. In Botswana 70% of HERD expenditures were capital costs.

Table 2. 11 GERD by Type of costs (Current Cost & Capital Expenditures) (million, PPP international dollar)

Country	BUSINESS			GOVERNMENT			HIGHER EDUCATION			PRIVATE NON-PROFIT			GERD
	BERD	Current cost	Capital Expend.	GOVERD	Current cost	Capital Expend.	HERD	Current cost	Capital Expend.	PNP	Current cost	Capital Expend.	
Angola	n/a	n/a	n/a	20,14	16,77	3,37	22,66	20,00	2,66	-	-	-	-
Botswana	30,33	5,01	25,33	22,53	15,81	6,72	86,75	26,25	60,50	31,93	29,79	2,15	171,54
Burkina Faso	-	-	-	22,51	22,29	0,22	37,91	34,13	3,78	2,90	2,43	0,47	-
D.R. Congo	-	-	-	10,51	8,70	1,81	-	-	-	-	-	-	-
Egypt 2014	518,18	n/a	n/a	2328,70	n/a	n/a	3603,90	n/a	n/a	n/a	n/a	n/a	6450,79
Eswatini	0,21	0,21	0,00	11,71	8,37	3,35	9,04	8,94	0,10	8,08	6,89	1,19	29,05
Ethiopia	10,02	5,47	4,55	190,84	67,61	123,23	577,42	30,95	546,48	1,81	0,56	1,25	780,10
Ghana*	-	-	-	91,35	-	-	308,77	-	-	-	-	-	-
Lesotho	-	-	-	0,44	0,44	0,00	2,96	2,96	0,00	-	-	-	-
Mali	-	-	-	55,66	42,95	12,71	0,99	0,72	0,27	57,44	53,77	3,67	114,09
Mozambique	0,53	0,42	0,11	48,46	41,27	7,19	42,17	35,85	6,33	21,48	18,26	3,22	112,64
Niger	n/a	n/a	n/a	4,62	1,83	2,80	8,57	5,56	3,01	0,94	0,93	0,02	-
Namibia	10,14	7,30	2,84	40,76	25,09	15,67	31,07	29,90	1,18	6,79	6,10	0,69	88,76
Rwanda	-	-	-	6,36	5,53	0,83	14,72	11,95	2,77	8,89	6,38	2,51	-
Senegal	-	-	-	81,69	52,69	29,00	170,97	170,53	0,44	11,93	10,97	0,96	-
Seychelles	-	-	-	4,69	4,49	0,20	0,49	0,49	0,00	-	-	-	5,18
South Africa	2205,73	1993,64	212,09	1123,55	1028,27	95,28	1365,22	1233,06	132,16	109,14	101,65	7,49	4803,63
Tanzania	n/a	n/a	n/a	231,67	220,02	11,65	367,77	227,18	140,59	-	-	-	-
Uganda	5,06	2,24	2,82	54,98	25,29	29,69	53,70	39,57	14,12	3,02	1,66	1,35	116,76

(*) Incomplete coverage with less than 4 R&D performing sectors or missing data
(-) Sector not covered or missing breakdown

2.4 R&D Personnel

The characteristics and number of R&D personnel are important in determining the depth, diversity, quality and quantity of research activities related to creating and disseminating knowledge. Indicators for R&D personnel characteristics require an exhaustive representation and coverage of sectors. In other words, a clear distribution of researchers, technicians and support staff performing R&D activities in sectors such as business enterprise, government, higher education and private non-profit.

R&D personnel includes all persons engaged directly in R&D, whether employed by the statistical unit or external contributors fully integrated into the statistical unit's R&D activities, as well as those providing indirect services for the R&D activities (such as R&D managers, administrators, technicians and clerical staff) (OECD, 2015: 151, para 5.6).

This section answers the following questions:

i. How many people are devoted to R&D projects and activities?
ii. How are R&D personnel distributed according to their functions?
iii. How are researchers distributed among the sectors?
iv. How many equivalent researchers are working on a full-time basis (FTE units)?
v. What is the age distribution of human resources contributing to R&D activities?
vi. How many women are participating in R&D activities?
vii. What are the formal qualifications (doctoral, master, bachelor levels and other qualifications), held by the personnel involved in R&D projects and activities?
viii. What is the distribution of researchers by field of R&D?

2.4.1 How many People are devoted to R&D Projects and Activities?

Regarding the distribution within sectors, the trend where all four sectors were covered reveals a very high concentration of R&D personnel in Higher Education and Government sectors with the exception of Seychelles (see Table 2.12). The same applies to those countries where only three sectors were surveyed. There is a weak representation of R&D personnel in the business sector. Among the nine countries which covered all four sectors, only Seychelles and South Africa have more than 25% of R&D personnel in the business sector. Even though its business sector was not covered, Senegal has the highest concentration of R&D personnel in higher education with 95% of personnel in the three sectors (business sector not surveyed).

Table 2. 12 Distribution of R&D Personnel by Sector of Employment (%) (Headcount)

Surveyed sector	Country	R&D Personnel	Business (%)	Government (%)	Higher education (%)	Private non-profit (%)
BUS|GOV|HE|PNP	Botswana	1716	2%	37%	40%	21%
	Burundi	977	2%	48%	43%	7%
	Ethiopia	18435	1%	50%	48%	2%
	Gabon	972	7%	9%	67%	17%
	Mozambique	4256	0,4%	37%	61%	2%
	Namibia	1132	7%	30%	54%	8%
	Seychelles	442	38%	46%	5%	10%
	South Africa	68838	26%	13%	60%	1%
	Uganda	2881	9%	41%	41%	9%
BUS|GOV|HE	Egypt	231329	5%	18%	77%	*
GOV|HE|PNP	Burkina Faso	3396	*	39%	54%	7%
	Eswatini	673	3%	43%	24%	30%
	Mali	1723	*	76%	18%	6%
	Niger	1586	*	42%	52%	6%
	Rwanda	721	*	18%	45%	37%
	Senegal	16599	*	4%	95%	1%
GOV|HE	Angola	2153	*	36%	64%	*
	Cabo Verde	198	*	37%	63%	*
	Ghana	7230	*	19%	81%	*
	Lesotho	170	*	24%	76%	*
	Tanzania	6502	*	31%	69%	*
	Togo	1365	*	29%	71%	*
GOV	DRC	1967	*	100%	*	*

2.4.2 How are R&D personnel distributed according to their functions?

Table 2.13 presents R&D personnel by functions. Data from this table shows that countries which covered all four sectors had more researchers than technicians and support staff. It is observed that more than a third of R&D personnel is represented by researchers. The same applies to those which only covered three sectors. Namibia, South Africa and Uganda have almost two-thirds of researchers out of total R&D personnel.

Table 2. 13 R&D Personnel by Function (percentage) (Headcount)

Coverage	Country	R&D Personnel	Researcher (%)	Technician (%)	Support Staff (%)
BUS|GOV|HE|PNP	Botswana	1716	44	19	37
	Burundi	977	47	20	33
	Eswatini	673	44	11	45
	Ethiopia	18435	45	25	30
	Gabon	972	41	35	24
	Mozambique	4256	57	24	18
	Namibia	1132	66	23	11
	Seychelles	442	34	32	34
	South Africa	68838	67	16	18
	Uganda	2881	67	21	12
BUS|GOV|HE	Egypt	231329	55	28	17
GOV|HE|PNP	Burkina Faso	3396	46	16	39
	Mali	1723	42	25	33
	Niger	1586	52	21	27
	Rwanda	721	67	17	16
	Senegal	16599	86	5	9
GOV|HE	Lesotho	170	69	18	13
	Angola	1975	71	13	16
	Cabo Verde	198	77	16	7
	Ghana	7230	77	17	6
	Tanzania*	6502	52	21	27
	Togo*	1365	52	13	34
GOV	DRC	1967	34	28	39

The indicator researchers (HC) per million inhabitants varies between 51 and 1568 with Seychelles having the highest density among countries where the four sectors were covered (Table 2.14). For countries where coverage was limited to three sectors, Egypt and Senegal are the only two considerably higher compared to Burkina Faso, Mali, Niger and Rwanda. A different picture appears elsewhere, especially in Malaysia with almost 2 200 researchers per million inhabitants, while top R&D performers such as Finland, United States, Israel, Japan and South Korea have more than 4 000 researchers per million inhabitants.

Table 2. 14 R&D Personnel and Researchers (Headcount)

Coverage	Country	Population in million*	R&D personnel	Researchers	Researchers as % of R&D personnel	R&D personnel per million inhabitants	Researchers per million inhabitants
BUS|GOV|HE|PNP	Botswana	2,1	1716	760	44	825	366
	Burundi	8,8	977	461	47	111	53
	Eswatini	1,1	673	297	44	601	265
	Ethiopia	88,9	18435	8218	45	207	92
	Gabon	1,6	972	401	41	613	253
	Mozambique	26,5	4256	2434	57	161	92
	Namibia	2,2	1132	749	66	521	345
	Seychelles	0,1	442	149	34	4653	1568
	South Africa	53,7	68838	45935	67	1282	855
	Uganda	38,0	2881	1942	67	76	51
BUS|GOV|HE	Egypt	85,4	228357	124976	55	2675	1464
GOV|HE|PNP	Burkina Faso	16,9	3396	1555	46	201	92
	Mali	17,9	1723	719	42	96	40
	Niger	16,6	1237	822	56	75	50
	Rwanda	10,8	721	482	67	67	45
	Senegal	15,0	16599	14335	86	1109	958
GOV|HE	Angola	73,6	2153	1400	65	29	19
	Cabo Verde	0,5	198	153	77	391	302
	Ghana	26,9	7230	5579	77	269	208
	Lesotho	1,9	170	118	69	89	62
	Tanzania	46,3	6502	3400	52	141	73
	Togo	7,2	1365	712	52	190	99
GOV	DRC	81,7	1967	658	33	24	8

(*) World Economic Outlook 2014, International Monetary Fund, World Economic Outlook Database, October 2014 (http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/weoselgr.aspx)

2.4.3 How many Equivalent Researchers are working on a full-time basis (FTE units) compared to the total R&D Personnel?

One FTE unit is equivalent to one employee working 100% of the time in R&D during a period of one year. Table 2.15 shows that when R&D Personnel are expressed in FTE units, researchers represent more than 50% of the total of R&D Personnel except in some countries where they range between 30% and 50%. Namibia, South Africa and Uganda which covered all four sectors have more than 60% as the equivalence of researchers fully involved in R&D the whole year. It is also observed that 88% FTE units (researchers) as percentage of total of R&D personnel in FTE performed their duties in Senegal even though only three sectors were covered. Botswana, Eswatini and Ethiopia had the lowest researchers FTE despite their full sectoral coverage on personnel only.

Table 2. 15 R&D Personnel and Researchers (FTE)

Coverage	Country	Population in million	R&D personnel	Researchers	Researchers (% of R&D personnel)	R&D personnel per million inhabitants	Researchers per million inhabitants
BUS|GOV|HE|PNP	Botswana	2,079	1217	384	432%	585	185
	Eswatini	1,119	376,9	137,7	37%	337	123
	Ethiopia	88,85	10502,4	4042,1	38%	118	45
	Mozambique	26,491	2320	1161,9	50%	88	44
	Namibia	2,174	570,4	351,3	62%	262	162
	Seychelles	0,095	442	149	34%	4653	1568
	South Africa	53,699	37956,48	23346,01	62%	707	435
	Uganda	38,04	1612,6	1027,8	64%	42	27
BUS|GOV|HE	Egypt	85,374	111601,8	61058,6	55%	1307	715
GOV|HE|PNP	Mali	17,92	1283,03	537,9	42%	72	30
	Niger	16,601	908	489,7	54%	55	29
	Rwanda	10,8	288,9	168,1	58%	27	16
	Senegal	14,966	9405,4	8304	88%	628	555
GOV|HE	Angola	73,587	827,4	542,7	66%	11	7
	Cabo Verde	0,506	90	64	71%	178	126
	Ghana	26,886	3422,4	2481,6	73%	127	92
	Lesotho	1,916	170	118	69%	89	62
	Tanzania	46,277	2915,7	2067,3	71%	63	45
	Togo	7,182	605	264,6	44%	84	37
GOV	DRC	81,68	1482	551	37%	18	7

2.4.4 What is the Age Distribution of Human Resources contributing to R&D Activities?

The demographic picture of R&D personnel for countries with a full coverage gives us a concentration in two age groups (25-34 and 35-44) in Table 2.16. However, it is also observed that Eswatini and Seychelles have more than 50% of its R&D personnel represented by the youth (less than 35 years).

Table 2. 16 R&D Personnel by Age

Coverage	Country	R&D Personnel	Under 25 years (%)	25-34 Years (%)	35-44 Years (%)	45-54 Years (%)	55-64 Years (%)	65 Years & more (%)
BUS|GOV|HE|PNP	Eswatini	627	13	46	21	14	6	0
	Ethiopia	18435	5	42	34	15	4	0
	Gabon	972	0	27	33	26	12	2
	Namibia	1132	3	27	34	25	6	5
	Seychelles	442	10	41	27	16	5	1
	Uganda	2881	2	22	37	22	13	5
GOV|HE|PNP	Burkina Faso	3396	0	6	32	31	25	5
	Rwanda	721	0	26	40	21	8	5
	Senegal	16599	8	59	17	10	6	0
GOV|HE	Angola	2153	1	21	29	26	12	12
	Lesotho	170	5	17	29	35	13	1
GOV	DRC	1967	1	19	31	25	16	8

2.4.5 How many Women are participating in R&D Activities - Researchers by Gender

Representation of female R&D personnel and researchers and share of total headcount is presented in Table 2.17. The female share of R&D personnel shows that women are less represented in the sector. This result is also observed among researchers. This trend is also observed where less than four sectors were covered. The female share of total researchers was the lowest in Namibia (9%) and highest in Eswatini (47%).

Table 2. 17 Female R&D Personnel and Researchers and Shares of Total (HC)

Coverage	Country	Female R&D personnel	Female researchers	Female share of total R&D personnel (%)	Female share of total researchers (%)
BUS|GOV|HE|PNP	Botswana	617	225	36	30
	Burundi	191	65	20	14
	Eswatini	303	140	45	47
	Ethiopia	4242	1093	23	13
	Gabon	360	113	37	28
	Mozambique	1269	704	30	29
	Namibia	129	67	11	9
	Seychelles	195	52	44	35
	South Africa	30230	20231	44	44
	Uganda	918	578	32	30
BUS|GOV|HE	Egypt	53707	52759	24	42
GOV|HE|PNP	Burkina Faso	777	237	23	15
	Mali	306	75	18	10
	Niger	227	122	18	18
	Rwanda	109	203	15	42
	Senegal	4880	4201	29	29
GOV|HE	Lesotho	59	43	35	36
	Angola	754	402	35	29
	Cabo Verde	92	70	46	46
	Ghana	1929	1454	27	26
	Tanzania	865	429	13	13
	Togo	243	66	18	9
GOV	DRC	270	68	14	10

2.4.6 What are the Formal Qualifications (doctoral, master, bachelor levels and other qualifications), held by Researchers

The distribution of qualification among researchers is not the same for countries with a full coverage of sectors. However, it is observed in Table 2.18 that more than half of researchers hold doctoral degrees in South Africa (59.46%) with the highest concentration of master's degree holders in Eswatini (43.1%), Mozambique (40.9%) and Namibia (43.5%). The highest concentration of researchers with bachelor's degrees was found in Mozambique. Seychelles (40.27%) had more researchers having other tertiary level degrees less than bachelors.

Table 2. 18 Researchers by Level of Education (Total HC and Percentage)

Coverage	Country	Researchers HC	ISCED 8 (%)	ISCED 7 (%)	ISCED 6 (%)	Short ISCED 5 (%)	≤ISCED 4 (%)
BUS|GOV|HEP|PNP	Eswatini	297	27,26	43,1	422,9	6,4	0,34
	Mozambique	2434	14,01	40,87	44,91	0,21	-
	Namibia	749	26,17	43,53	26,7	1,6	2
	Seychelles	149	9,4	25,5	22,15	40,27	2,68
	South Africa	45935	59,46	32,59	7,95	-	-
	Uganda	1942	32,75	42,38	19,62	2,11	3,14
BUS|GOV|HE	Egypt	124976	56,56	19,95	23,49	-	-
GOV|HE|PNP	Burkina Faso	1555	85,08	14,92	-	-	-
	Rwanda	482	31,54	51,45	15,14	1,04	0,83
	Senegal	14335	41,35	58,65	-	-	-
GOV|HE	Lesotho	118	30,56	52,78	16,66	-	-
	Angola	1400	21,78	40,29	37,93	-	-
	Ghana	5579	31,67	53,08	10,23	2,96	2,06
	Tanzania	3400	24,91	39,38	29,24	4,91	1,56
	Togo	712	77,11	22,89	-	-	-
GOV	DRC	658	13,51	18,81	65,71	1,06	0,91

2.4.7 What is the Distribution of Researchers by Field of R&D (FoRD)?

The distribution of researcher based on field of R&D in Table 2.19 among countries with full coverage of sectors shows a higher concentration of researchers in natural sciences for Botswana and Gabon, in engineering and technology for Seychelles, in medical and health sciences for Egypt, in Agricultural sciences for Ethiopia, and in social sciences in Mozambique and Namibia.

Table 2. 19 Researchers (Headcount) by Field or R&D (FoRD)

Coverage	Country	Researcher	NS (%)	ET (%)	MHS (%)	AGR (%)	SS (%)	Humanities (%)	NEC (%)
BUS|GOV|HE|PNP	Botswana	760	40	119	13	22	5	1	0
	Burundi	977	14	12	9	17	7	11	31
	Egypt	127770	13	10	35	15	16	12	0
	Ethiopia	8218	15	9	18	31	17	7	2
	Gabon	401	49	17	14	16	4	0	0
	Mozambique	1161,9	20	8	13	22	36	0	0
	Namibia	749	25	6	3	12	44	4	6
	Seychelles	149	28	38	11	5	17	1	0
	Uganda	1942	11	12	18	17	29	13	0
GOV|HE|PNP	Burkina Faso	1555	25	6	21	22	18	8	0
	Eswatini	297	7	5	33	21	28	3	3
	Mali	719	9	7	10	53	16	6	0
	Niger	822	39	11	11	12	17	10	1
	Rwanda	482	14	9	18	12	37	9	1
	Senegal	14335	21	7	15	1	39	17	0
GOV|HE	Angola	1400	26	7	12	12	38	5	0
	Cabo Verde	153	12	22	5	16	29	16	0
	Ghana	5579	14	17	8	21	23	11	6
	Lesotho	118	49	25	3	19	4	0	0
	Tanzania	3400	14	7	20	28	17	12	2
	Togo	712	19	7	18	12	29	14	1
GOV	DRC	659	42	3	9	34	8	2	2

Note:

NS: Natural sciences | ET: Engineering & Technologies | MHS: Medical and Health Science | AGR: Agricultural sciences | SS: Social Sciences

2.5 Summary

Given the major role that the government plays in funding R&D performance and facilitating a conducive policy environment for R&D, this sector sets targets for GOVERD intensity aligned with the national research and development agenda. The same applies with the business sector, there is need to increase investments in R&D by the sector. Currently only few African countries are registering substantive investments by the business sector. A case in point is in Europe where the business enterprise sector alone is expected to spend 2% of its GDP in R&D out of 3% target that member countries have agreed upon. Using this as a model, most the AU Member States are revising their S&T policies to be aligned with national development plans, regional and continental STI frameworks. It is therefore, important to have a breakdown of the R&D target to be achieved by each sector.

Currently, the 1% of GDP to be dedicated to R&D investment has not been disaggregated as to how much each of the four or key sectors should contribute to R&D intensity (GERD/GDP). The GERD/GDP ratio encourages governments to set and re-adjust national, regional or continental targets as it is also the case in Europe with the Lisbon target of 3%, from which 2% shall be spent by business enterprises (Gault, 2010:30).

In Africa, the growing experience of ASTII in this report shows that seven countries managed to have a coverage of all four sectors. The ASTII programme advises national STI survey teams to always involve officials from several economic sectors and even more critical ministries responsible for industries and economies should be part of the teams. It has also been demonstrated in other countries that simple incentives like tax rebates have assisted in increasing participation of institutions in STI survey. We recommend Member States to explore incentives that would work best in their setting. This could be determined through national dialogues and sharing experiences at regional and continental levels.

More shall be expected from national statistics offices, agencies or institutes to support the ongoing ASTII national data collection processes. ECOWAS and SADC are the first two regional economic communities (RECs) that have demonstrated a strong commitment among their member countries to track their respective R&D targets which are well-defined in their regional STI policies. Information can easily be collected in the higher education sector through a census. The private non-profit is still very limited but can play a significant role as more engagements on research are carried out to support communities in the current knowledge economies.

Since the inception of the ASTII programme GERD in African countries that covered all four sectors is still below 1% despite the pledge made since 1980 in the Lagos Plan of Action. It has been observed in most of the new policies informed by data or evidences produced by the ASTII programme that some AU Member States have decided to adjust their respective national targets between 1.4% and 2% (Botswana, Kenya, Namibia, etc.). AUDA-NEPAD is exploring with Science granting councils and other STI national funding institutions or agencies regarding the possibility of configuring a new approach of tracking R&D investment after the first decade of ASTII.

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CHAPTER ANNEX

ANGOLA 2014

Tab. 2A-1. 1 Angola - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	2153	-	781	1372	-
Researchers	1400	-	327	1073	-
Technicians	436	-	258	178	-
Other personnel	317	-	196	121	-
Female	754	-	344	410	-
Researchers	402	-	124	278	-
Technicians	228	-	145	83	-
Other personnel	124	-	75	49	-

Tab. 2A-1. 2 Angola - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	827,4	-	508,4	319	-
Researchers	542,7	-	266,5	276,2	-
Technicians	150	-	116,5	33,5	-
Other personnel	134,7	-	125,4	9,3	-
Female	277,8	-	190	87,8	-
Researchers	156,9	-	87,4	69,5	-
Technicians	83	-	67,2	15,8	-
Other personnel	37,9	-	35,4	2,5	-

Tab. 2A-1. 3 Angola - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	2153	-	781	1372	-
ISCED 8	311	-	59	252	-
ISCED 7	600	-	106	494	-
ISCED 6	666	-	256	410	-
ISCED 5	397	-	266	131	-
ISCED 4 & Below	179	-	94	85	-
Female	754	-	344	410	-
ISCED 8	58	-	15	43	-
ISCED 7	187		43	144	
ISCED 6	234		114	120	
ISCED 5	174		118	56	
ISCED 4 & Below	101		54	47	

Tab. 2A-1. 4 Angola - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	1400	0	327	1073	-
Natural sciences	361	-	76	285	-
Engineering and technology	98	-	25	73	-
Medical sciences	167	-	88	79	-
Agricultural sciences	168	-	129	39	-
Social sciences	536	-	7	529	-
Humanities	70	-	2	68	
Not elsewhere classified	0	-	0	0	
Female	402	0	124	278	-
Natural sciences	117	-	37	80	-
Engineering and technology	19	-	10	9	-
Medical sciences	85	-	39	46	-
Agricultural sciences	42	-	35	7	-
Social sciences	119	-	1	118	-
Humanities	20	-	2	18	
Not elsewhere classified	1400	0	327	1073	

Tab. 2A-1. 5 Angola - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	542,7	-	266,5	276,2	-
Natural sciences	155,5	-	66	89,5	-
Engineering and technology	38,6	-	17,6	21	-
Medical sciences	47	-	33,2	13,8	-
Agricultural sciences	154,9	-	143,8	11,1	-
Social sciences	119,3	-	4,2	115,1	-
Humanities	27,4	-	1,7	25,7	
Not elsewhere classified	0	-	0	0	
Female	156,9	-	87,4	69,5	-
Natural sciences	62,8	-	31,1	31,7	-
Engineering and technology	7,5	-	6	1,5	-
Medical sciences	21,5	-	14	7,5	-
Agricultural sciences	36,6	-	34,2	2,4	-
Social sciences	23,5	-	0,4	23,1	-
Humanities	5	-	1,7	3,3	
Not elsewhere classified	0	-	0	0	

Tab. 2A-1. 6 Angola - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	2153	-	781	1372	-
Under 25 years	16	-	8	8	-
25-34 Years	456	-	161	295	-
35-44 Years	614	-	247	367	-
45-54 Years	558	-	230	328	-
55-64 Years	260	-	92	168	-
65 Years and more	249	-	43	206	-
Female	754	-	344	410	-
Under 25 years	6	-	3	3	-
25-34 Years	151	-	66	85	-
35-44 Years	248	-	127	121	-
45-54 Years	199	-	102	97	-
55-64 Years	78	-	32	46	-
65 Years and more	72	-	14	58	-

BOTSWANA 2013/2014

Tab. 2A-2. 1 Botswana - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1716	30	640	686	360
Researchers	760	27	198	481	54
Technicians	328	2	118	165	43
Other personnel	628	1	324	40	263
Female	617	16	178	198	225
Researchers	225	16	62	125	22
Technicians	110	0	34	49	27
Other personnel	282	0	82	24	176

Tab. 2A-2. 2 Botswana - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1210		602	282	326
Researchers	384	5	174	165	40
Technicians	259	2	108	112	37
Other personnel	575	1	320	5	249
Female	456	3	170	81	202
Researchers	118	3	57	44	14
Technicians	89	0	33	34	22
Other personnel	249	0	80	3	166

Tab. 2A-2. 3 Botswana - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED 1997)	Total	Business	Government	Higher education	Private non- profit
Total	1716	30	640	686	360
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	265	1	17	243	4
1st Stage Tertiary Education: Theoretical (ISCED 5A)	690	28	194	339	129
1st Stage Tertiary Education: Practical (ISCED 5B)	200	1	67	71	61
Other Qualifications (ISCED 4 & below)	561	0	362	33	166
Female	617	16	178	198	225
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	59	0	6	51	2
1st Stage Tertiary Education: Theoretical (ISCED 5A)	252	16	62	105	69
1st Stage Tertiary Education: Practical (ISCED 5B)	103	0	24	32	47
Other Qualifications (ISCED 4 & below)	203	0	86	10	107

Tab. 2A-2. 4 Botswana - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	760	27	198	481	54
Natural sciences	304	25	79	150	50
Engineering and technology	147	0	19	128	0
Medical sciences	100	0	7	92	1
Agricultural sciences	168	2	86	80	0
Social sciences	37	0	4	30	3
Humanities	4	0	3	1	0
Not elsewhere classified	0	0	0	0	0
Female	225	16	62	125	22
Natural sciences	90	16	25	30	19
Engineering and technology	21	0	5	16	0
Medical sciences	48	0	2	45	1
Agricultural sciences	50	0	29	21	0
Social sciences	15	0	0	13	2
Humanities	1	0	1	0	0
Not elsewhere classified	0	0	0	0	0

Tab. 2A-2. 5 Botswana: Gross Domestic Expenditures on R&D by Source of Funds in Pula (2013)

Gross Domestic Expenditures on R&D (GERD) in Million LCU	Total	Business	Government	Higher education	Private non- profit
Business Enterprises	118,9	118,9	0	0	0
Government	401,52	0	67,41	325,41	8,7
Higher Education	6,36	0	0	6,36	0
Private Non-Profit	0	0	0	0	0
Rest of the world	145,67	0	20,9	8,29	116,48
GERD by Sector and Source of Funds	672,45	118,9	88,31	340,06	125,18

Tab. 2A-2. 5 Botswana: Gross Domestic Expenditures on R&D by Source of Funds in Pula (2013)

Gross Expenditures on R&D (GERD)	Total	Business	Government	Higher education	Private non- profit
GERD by type of costs	672,45	118,9	88,31	340,06	125,18
Labour cost	227,54	1,54	54,31	90,27	81,42
Other Current Cost	73,73	18,08	7,67	12,63	35,35
Total Current Cost	301,27	19,62	61,98	102,9	116,77
Vehicles, Lands, Buildings	-	-	-		-
Instruments, Equipment, Software	-	-	-		-
Total Capital Expenditures	371,18	99,28	26,33	237,16	8,41

BURKINA FASO 2012

Tab. 2A-3. 1 Burkina Faso - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	3396	-	1334	1835	227
Researchers	1555	-	559	925	71
Technicians	528	-	435	36	57
Other personnel	1313	-	340	874	99
Female	777	-	284	434	59
Researchers	237	-	112	111	14
Technicians	80	-	66	3	11
Other personnel	460	-	106	320	34

Tab. 2A-3. 2 Burkina Faso - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	3396	-	1334	1835	227
ISCED 8	1323	-	358	909	56
ISCED 7	232	-	201	16	15
ISCED 6	307	-	128	149	30
ISCED 5	462	-	241	184	37
ISCED 4 & Below	1072	-	406	577	89
Female	777	-	284	434	59
ISCED 8	191	-	66	111	14
ISCED 7	46	-	46	0	0
ISCED 6	79	-	33	34	12
ISCED 5	186	-	68	97	21
ISCED 4 & Below	275	-	71	192	12

Tab. 2A-3. 3 Burkina Faso - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	1555	-	559	925	71
Natural sciences	381	-	127	254	0
Engineering and technology	97	-	21	73	3
Medical sciences	325	-	90	228	7
Agricultural sciences	339	-	200	90	49
Social sciences	286	-	81	193	12
Humanities	127	-	40	87	0
Not elsewhere classified	0	-	0	0	0
Female	237	-	112	111	14
Natural sciences	57	-	30	27	0
Engineering and technology	11	-	8	3	0
Medical sciences	65	-	22	41	2
Agricultural sciences	28	-	17	4	7
Social sciences	60	-	27	28	5
Humanities	16	-	8	8	0
Not elsewhere classified	0	-	0	0	0

Tab. 2A-3. 4 Burkina Faso - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	3396	-	1334	1835	227
Under 25 years	2	-	0	2	0
25-34 Years	219	-	83	131	5
35-44 Years	1101	-	472	578	51
45-54 Years	1047	-	388	569	90
55-64 Years	843	-	345	420	78
65 Years and more	184	-	46	135	3
Female	718	-	284	434	59
Under 25 years	1	-	0	1	0
25-34 Years	44	-	22	22	2
35-44 Years	294	-	127	167	12
45-54 Years	210	-	68	142	30
55-64 Years	157	-	64	93	15
65 Years and more	12	-	3	9	0

BURUNDI 2011/2012

Tab. 2A-4. 1 Burundi - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	977	19	465	423	70
Researchers	461	9	52	385	15
Technicians	197	7	146	21	23
Other personnel	319	3	267	17	32
Female	191	1	112	62	16
Researchers	65	0	17	48	0
Technicians	53	0	33	10	10
Other personnel	73	1	62	4	6

Tab. 2A-4. 2 Burundi - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	634,4	19	408,9	156,5	50
Researchers	193,5	9	44,3	125,2	15,0
Technicians	162,8	7,0	123,2	17,6	15,0
Other personnel	278,1	3,0	241,4	13,7	20,0
Female	134	1	94	29	10
Researchers	30	0,0	15,0	15,0	0,0
Technicians	40	0,0	25,0	10,0	5,0
Other personnel	64	1,0	54,0	4,0	5,0

Tab. 2A-4. 3 Burundi - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	977	20	476	430	51
ISCED 8	238	1	4	227	6
ISCED 7	263	9	57	186	11
ISCED 6	92	3	84	0	5
ISCED 5	152	2	104	17	29
ISCED 4 & Below	232	5	227	0	0
Female	191	1	112	62	16
ISCED 8	29	0	2	27	0
ISCED 7	49	0	16	31	2
ISCED 6	31	0	30	0	1
ISCED 5	73	0	57	4	12
ISCED 4 & Below	9	1	7	0	1

Tab. 2A-4. 4 Burundi - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	977	19	465	423	70
Natural sciences	136	7,0	26,0	103,0	0,0
Engineering and technology	114	0,0	55,0	58,0	1,0
Medical sciences	85	0,0	8,0	77,0	0,0
Agricultural sciences	169	0,0	117,0	37,0	15,0
Social sciences	67	0	11	44,0	12,0
Humanities	104	0	0	104,0	0,0
Not elsewhere classified	302	12	248	0	42
Female	191,0	1,0	84	93	13
Natural sciences	16	0,0	5,0	11,0	0,0
Engineering and technology	20	0,0	11,0	9,0	0,0
Medical sciences	13	0,0	4,0	9,0	0,0
Agricultural sciences	26	0,0	19,0	7,0	0,0
Social sciences	15	0	7,0	6,0	2,0
Humanities	13	0	0,0	13,0	0,0
Not elsewhere classified	88	1	38	38	11

Tab. 2A-4. 5 Burundi - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	542,7	-	266,5	276,2	-
Natural sciences	191,4	9	41,8	126,6	14
Engineering and technology	39	0	8,6	30,4	0
Medical sciences	26,2	0	4,8	21,4	0
Agricultural sciences	30	9	2,4	18,6	0
Social sciences	45,1	0	26	11,1	8
Humanities	19,9	0	0	13,9	6
Not elsewhere classified	31,2	0	0	31,2	0
Female	0	0	0	0	0
Natural sciences	31,1	0	15,9	15,2	0
Engineering and technology	9,3	0	4,8	4,5	0
Medical sciences	3,2	0	0,6	2,6	0
Agricultural sciences	2,4	0	1,5	0,9	0
Social sciences	11,1	0	9	2,1	0
Humanities	1,2	0	0	1,2	0
Not elsewhere classified	3,9	0	0	3,9	0

CABO VERDE 2014

Tab. 2A-5. 1 Cabo Verde - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	198	-	73	125	-
Researchers	153	-	47	106	-
Technicians	32	-	23	9	-
Other personnel	13	-	3	10	-
Female	92	-	35	57	-
Researchers	70	-	22	48	-
Technicians	14	-	10	4	-
Other personnel	8	-	3	5	-

Tab. 2A-5. 2 Cabo Verde - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	90	-	58	32	-
Researchers	64	-	38	26	-
Technicians	21	-	18	3	-
Other personnel	5	-	2	3	-
Female	43	-	27	16	-
Researchers	30	-	17	13	-
Technicians	9	-	8	1	-
Other personnel	4	-	2	2	-

Tab. 2A-5. 3 Cabo Verde - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED 1997)	Total	Business	Government	Higher education	Private non- profit
Total	198	-	73	125	-
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	41	-	4	37	-
1st Stage Tertiary Education: Theoretical (ISCED 5A)	135	-	47	88	-
1st Stage Tertiary Education: Practical (ISCED 5B)	22	-	22	0	-
Other Qualifications (ISCED 4 & below)	0	-	0	0	-
Female	92	-	35	57	-
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	24	-	3	21	-
1st Stage Tertiary Education: Theoretical (ISCED 5A)	56	-	20	36	-
1st Stage Tertiary Education: Practical (ISCED 5B)	12	-	12	0	-
Other Qualifications (ISCED 4 & below)	0	-	0	0	-

Tab. 2A-5. 4 Cabo Verde - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	153	-	47	106	-
Natural sciences	19	-	8	11	-
Engineering and technology	34	-	6	28	-
Medical sciences	7	-	0	7	-
Agricultural sciences	24	-	21	3	-
Social sciences	45	-	6	39	-
Humanities	24	-	6	18	-
Not elsewhere classified	0	-	0	0	-
Female	70	-	22	48	-
Natural sciences	10	-	1	4	-
Engineering and technology	7	-	6	6	-
Medical sciences	5	-	1	5	-
Agricultural sciences	9	-	0	1	-
Social sciences	24	-	8	20	-
Humanities	15	-	4	12	-
Not elsewhere classified	0	-	3	0	-

Tab. 2A-5. 5 Cabo Verde - Researcher in FTEs by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	64	-	38	26	-
Natural sciences	8	-	6	2	-
Engineering and technology	7	-	5	2	-
Medical sciences	6	-	0	6	-
Agricultural sciences	19	-	17	2	-
Social sciences	15	-	5	10	-
Humanities	9	-	5	4	-
Not elsewhere classified	0	-	0	0	-
Female	30	-	17	13	-
Natural sciences	6	-	5	1	-
Engineering and technology	2	-	1	1	-
Medical sciences	1	-	0	1	-
Agricultural sciences	7	-	6	1	-
Social sciences	10	-	3	7	-
Humanities	4	-	2	2	-
Not elsewhere classified	0	-	0	0	-

DEMOCRATIC REPUBLIC OF CONGO 2015

Tab. 2A-6. 1 D.R. Congo - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1967	-	1967	-	-
Researchers	659	-	659	-	-
Technicians	542	-	542	-	-
Other personnel	766	-	766	-	-
Female	271	-	271	-	-
Researchers	68	-	68	-	-
Technicians	65	-	65	-	-
Other personnel	138	-	138	-	-

Tab. 2A-6. 2 D.R. Congo - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1482,3	-	1482,3	-	-
Researchers	550,8	-	550,8	-	-
Technicians	426,3	-	426,3	-	-
Other personnel	505,2	-	505,2	-	-
Female	221,4	-	221,4	-	-
Researchers	64,2	-	64,2	-	-
Technicians	66,3	-	66,3	-	-
Other personnel	90,9	-	90,9	-	-

Tab. 2A-6. 3 D.R. Congo - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	1967	-	1967	-	-
ISCED 8	108	-	108	-	-
ISCED 7	137	-	137	-	-
ISCED 6	569	-	569	-	-
ISCED 5	313	-	313	-	-
ISCED 4 & Below	840	-	840	-	-
Female	271	-	271	-	-
ISCED 8	1,5	-	1,5	-	-
ISCED 7	14,5	-	14,5	-	-
ISCED 6	76	-	76	-	-
ISCED 5	65	-	65	-	-
ISCED 4 & Below	114	-	114	-	-

Tab. 2A-6. 4 D.R. Congo - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	659	-	659	-	-
Natural sciences	276	-	276	-	-
Engineering and technology	20	-	20	-	-
Medical sciences	58	-	58	-	-
Agricultural sciences	227	-	227	-	-
Social sciences	54	-	54	-	-
Humanities	11	-	11	-	-
Not elsewhere classified	13	-	13	-	-
Female	68	-	68	-	-
Natural sciences	22	-	22	-	-
Engineering and technology	3	-	3	-	-
Medical sciences	13	-	13	-	-
Agricultural sciences	20	-	20	-	-
Social sciences	3	-	3	-	-
Humanities	1	-	1	-	-
Not elsewhere classified	6	-	6	-	-

Tab. 2A-6. 5 D.R. Congo - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	550,8	-	550,8	-	-
Natural sciences	233,8	-	233,8	-	-
Engineering and technology	16,3	-	16,3	-	-
Medical sciences	41,2	-	41,2	-	-
Agricultural sciences	193,5	-	193,5	-	-
Social sciences	43	-	43	-	-
Humanities	12,1	-	12,1	-	-
Not elsewhere classified	10,9	-	10,9	-	-
Female	64,2	-	64,2	-	-
Natural sciences	20,6	-	20,6	-	-
Engineering and technology	3,9	-	3,9	-	-
Medical sciences	10,6	-	10,6	-	-
Agricultural sciences	20,1	-	20,1	-	-
Social sciences	3,9	-	3,9	-	-
Humanities	2,2	-	2,2	-	-
Not elsewhere classified	2,9	-	2,9	-	-

Tab. 2A-6. 6 D.R. Congo - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	1967	-	1967	-	-
Under 25 years	16	-	16	-	-
25-34 Years	381	-	381	-	-
35-44 Years	600	-	600	-	-
45-54 Years	491	-	491	-	-
55-64 Years	315	-	315	-	-
65 Years and more	164	-	164	-	-
Female	271	-	271	-	-
Under 25 years	6	-	6	-	-
25-34 Years	104	-	104	-	-
35-44 Years	88	-	88	-	-
45-54 Years	47	-	47	-	-
55-64 Years	16	-	16	-	-
65 Years and more	10	-	10	-	-

EGYPT 2014

Tab. 2A-7 1 Egypt - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	231329	11777	40898	178255	399
Researchers	127770	4653	22505	100391	221
Technicians	64998	4721	11496	48665	116
Other personnel	38561	2403	6897	29199	62
Female	99819	1429	17530	80648	212
Researchers	55467	481	9254	45610	122
Technicians	27504	382	5173	21899	50
Other personnel	16848	566	3103	13139	40

Tab. 2A-7 2 Egypt - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	112877,8	7767,1	39621,8	65168	320,9
Researchers	62208,4	3381,1	21914,5	36717,9	194,9
Technicians	31884,4	2947	11067,1	17781,3	89
Other personnel	18785	1439	6640,2	10668,8	37
Female	47909,3	996,4	16960,8	29784,3	167,8
Researchers	26476,5	392,4	8992,5	16981,8	109,8
Technicians	13338,7	324	4980,2	8001,5	33
Other personnel	8094,1	280	2988,1	4801	25

Tab. 2A-7 3 Egypt - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	127770	4653	22505	100391	221
ISCED 8	70600	91	16369	54085	55
ISCED 7	26154	179	4015	21891	69
ISCED 6	31016	4383	2121	24415	97
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0
Female	55467	481	9254	45610	122
ISCED 8	27697	13	6834	20823	27
ISCED 7	12894	24	1572	11258	40
ISCED 6	14876	444	848	13529	55
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0

Tab. 2A-7 4 Egypt - R&D Personnel in FTEs by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	62208,4	3381,1	21914,5	36717,9	194,9
ISCED 8	34234,3	66,5	15926	18195,5	46,3
ISCED 7	12838,6	130,6	3889,5	8756,4	62,1
ISCED 6	15135,5	3184	2099	9766	86,5
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0
Female	26476,5	392,4	8992,5	16981,8	109,8
ISCED 8	13749,4	10,6	6647,5	7067	24,3
ISCED 7	6072,8	19,6	1514	4503,2	36
ISCED 6	6654,3	362,2	831	5411,6	49,5
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0

Tab. 2A-7 5 Egypt - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	127770	4653	22505	100391	221
Natural sciences	16127	1302	4919	9898	8
Engineering and technology	12632	194	1814	10624	0
Medical sciences	44266	1842	3431	38790	203
Agricultural sciences	19379	688	11879	6812	0
Social sciences	20140	496	410	19226	8
Humanities	15226	131	52	15041	2
Not elsewhere classified	0	0	0	0	0
Female	55467	481	9254	45610	122
Natural sciences	6519	163	2136	4213	7
Engineering and technology	3105	66	638	2401	0
Medical sciences	20968	126	1995	18732	115
Agricultural sciences	6627	42	4248	2337	0
Social sciences	10488	84	200	10204	0
Humanities	7760	0	37	7723	0
Not elsewhere classified	0	0	0	0	0

Tab. 2A-7 6 Egypt - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	62037,4	3381,1	21743,5	36717,9	194,9
Natural sciences	9418,4	949	4856	3606,2	7,2
Engineering and technology	5898,6	145,5	1814	3939,1	0
Medical sciences	18326,9	1332,1	2756	14056,1	182,7
Agricultural sciences	14799,1	497,1	11855,5	2446,5	0
Social sciences	7841,6	363,6	410	7064	4
Humanities	5752,8	93,8	52	5606	1
Not elsewhere classified	0	0	0	0	0
Female	26419,5	392,4	8935,5	16981,8	109,8
Natural sciences	3803,5	133	2089,5	1574,7	6,3
Engineering and technology	1605,8	53,8	638	914	0
Medical sciences	8837,8	102,8	1733,5	6898	103,5
Agricultural sciences	5135,1	34,3	4237,5	863,3	0
Social sciences	4077,4	68,5	200	3808,9	0
Humanities	2959,9	0	37	2922,9	0
Not elsewhere classified	0	0	0	0	0

ESWATINI 2015/2016

Tab. 2A-8. 1 Eswatini - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	673	21	288	160	204
Researchers	297	5	90	130	72
Technicians	75	10	22	13	30
Other personnel	301	6	176	17	102
Female	300		103	72	125
Researchers	140	1	39	58	42
Technicians	35	1	11	2	21
Other personnel	128	1	53	12	62

Tab. 2A-8. 2 Eswatini - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	376,9		174,8	57,8	144,3
Researchers	137,7	1,5	44,4	48,3	43,5
Technicians	34,4	0,8	12,5	6,1	15
Other personnel	209,3	2,2	117,9	3,4	85,8
Female	177,2		58,7	26,3	92,2
Researchers	67,9	0,1	17,9	23,5	26,4
Technicians	18,8	0,1	7,5	0,2	11
Other personnel	91,2	0,5	33,3	2,6	54,8

Tab. 2A-8. 3 Eswatini - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	652	21	267	160	204
ISCED 8	82	0	9	62	11
ISCED 7	140	1	52	67	20
ISCED 6	144	4	57	11	72
ISCED 5	89	11	41	6	31
ISCED 4 & Below	197	5	108	14	70
Female	300	3	103	71	123
ISCED 8	35	0	6	25	4
ISCED 7	60	0	17	32	11
ISCED 6	76	0	28	3	45
ISCED 5	41	0	15	4	22
ISCED 4 & Below	88	3	37	7	41

Tab. 2A-8. 4 Eswatini - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	297	5	90	130	72
Natural sciences	22	0	13	7	2
Engineering and technology	15	2	0	13	0
Medical sciences	99	0	10	44	45
Agricultural sciences	61	1	16	37	7
Social sciences	82	0	50	22	10
Humanities	8	0	0	2	6
Not elsewhere classified	10	2	1	5	2
Female	140	1	39	58	42
Natural sciences	2	0	2	0	0
Engineering and technology	6	0	0	6	0
Medical sciences	62	0	6	29	27
Agricultural sciences	19	0	6	9	4
Social sciences	39	0	25	9	5
Humanities	6	0	0	1	5
Not elsewhere classified	6	1	0	4	1

Tab. 2A-8. 5 Eswatini - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	136,3		44,4	48,4	43,5
Natural sciences	6,4	0	3,7	2,5	0,2
Engineering and technology	2,8	0,3	0	2,5	0
Medical sciences	53	0	2,1	25,5	25,4
Agricultural sciences	25,8	1	12,8	9,4	2,6
Social sciences	39,4	0	24,8	6,6	8
Humanities	7,1	0	0	1,1	6
Not elsewhere classified	3,3	0,2	1	0,8	1,3
Female	67,8		17,9	23,5	26,4
Natural sciences	0,9	0	0,9	0	0
Engineering and technology	1,1	0	0	1,1	0
Medical sciences	34,1	0	1,6	16,5	16
Agricultural sciences	7,8	0	4,8	1,8	1,2
Social sciences	17,9	0	10,6	3,3	4
Humanities	5,2	0	0	0,2	5
Not elsewhere classified	0,9	0,1	0	0,6	0,2

Tab. 2A-8. 6 Eswatini - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	627	21	288	114	204
Under 25 years	80	5	54	4	17
25-34 Years	288	12	103	23	150
35-44 Years	130	3	79	19	29
45-54 Years	89	1	46	35	7
55-64 Years	38	0	5	32	1
65 Years and more	2	0	1	1	0
Female	273	3	103	42	125
Under 25 years	37	0	24	2	11
25-34 Years	153	2	44	11	96
35-44 Years	44	1	23	6	14
45-54 Years	23	0	10	9	4
55-64 Years	14	0	1	13	0
65 Years and more	2	0	1	1	0

Tab. 2A-8. 7 Eswatini - Gross Domestic Expenditures on R&D by source of funds in Swazi Lilangeni (2015)

Gross Domestic Expenditures on R&D (GERD) in Million LCU	Total	Business	Government	Higher education	Private non- profit
Business Enterprises	7,8	1,0	1,2	0,0	5,7
Government	40,4	0,0	40,4	0,0	0,0
Higher Education	28,5	0,0	0,0	28,3	0,2
Private Non-Profit	3,2	0,0	0,4	2,8	0,0
Rest of the world	45,7	0,0	13,1	0,5	32,1
GERD by Sector and Source of Funds	125,7	1,0	55,1	31,6	38,0

Tab. 2A-8. 8 Eswatini: Gross Domestic Expenditures on R&D by Type of Costs in Swazi Lilangeni (2015)

Gross Expenditures on R&D (GERD)	Total	Business	Government	Higher education	Private non- profit
GERD by type of costs	125,69	1,48	54,86	31,11	38,24
Labour cost	77,93	1,06	29,36	30,04	17,47
Other Current Cost	27,34	0,42	10,54	1,00	15,38
Total Current Cost	105,28	1,48	39,90	31,04	32,85
Vehicles, Lands, Buildings	10,68	-	10,00	-	0,68
Instruments, Equipment, Software	9,74	-	4,96	0,08	4,71
Total Capital Expenditures	20,42	-	14,96	0,08	5,39

Tab. 2A-8. 9 Eswatini - Gross Domestic Expenditures on R&D by Type of Research in Swazi Lilangeni (2015)

Gross Expenditures on R&D (GERD)		TOTAL	BE	GOV	HE	PNP
GERD by type of R&D	Current Costs & Capital Expenditures	125,70	1,48	54,86	31,12	38,23
	Current Costs	105,28	1,48	39,90	31,04	32,85
	Capital Expenditures	20,42	0,00	14,96	0,08	5,38
Basic Research	Current Costs & Capital Expenditures	18,96	0,07	2,48	13,93	2,48
	Current Costs	17,08	0,07	1,54	13,86	1,61
	Capital Expenditures	1,88	0,00	0,94	0,07	0,87
Applied Research	Current Costs & Capital Expenditures	79,43	0,59	48,96	13,52	16,36
	Current Costs	62,75	0,59	35,45	13,51	13,20
	Capital Expenditures	16,68	0,00	13,51	0,01	3,16
Experimental Development	Current Costs & Capital Expenditures	27,29	0,81	3,43	3,66	19,39
	Current Costs	25,42	0,81	2,91	3,66	18,04
	Capital Expenditures	1,87	0,00	0,52	0,00	1,35
Not elsewhere classified	Current Costs & Capital Expenditures	0	0	0	0	0
	Current Costs	0	0	0	0	0
	Capital Expenditures	0	0	0	0	0

ETHIOPIA 2013/2014

Tab. 2A-9. 1 Ethiopia - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	18435	114	9141	8804	376
Researchers	8218	39	2555	5472	152
Technicians	4672	52	2650	1953	17
Other personnel	5545	23	3936	1379	207
Female	4242	28	2192	1906	116
Researchers	1093	6	306	749	32
Technicians	1106	17	701	382	6
Other personnel	2043	5	1185	775	78

Tab. 2A-9. 2 Ethiopia - R&D Personnel in FTEs by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	112877,8	7767,1	39621,8	65168	320,9
Researchers	62208,4	3381,1	21914,5	36717,9	194,9
Technicians	31884,4	2947	11067,1	17781,3	89
Other personnel	18785	1439	6640,2	10668,8	37
Female	47909,3	996,4	16960,8	29784,3	167,8
Researchers	26476,5	392,4	8992,5	16981,8	109,8
Technicians	13338,7	324	4980,2	8001,5	33
Other personnel	8094,1	280	2988,1	4801	25

Tab. 2A-9. 3 Ethiopia - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	18435	114	9140	8805	376
ISCED 8	830	5	410	398	17
ISCED 6 & 7	7756	48	3855	3695	158
ISCED 5	6319	39	3128	3023	129
ISCED 4 & Below	2735	17	1356	1306	56
Female	4242	28	2192	1906	116
ISCED 8	155	6	26	123	0
ISCED 6 & 7	1600	13	536	1013	38
ISCED 5	1037	5	641	355	36
ISCED 4 & Below	1450	4	989	415	42

Tab. 2A-9. 4 Ethiopia - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	8218	39	2555	5472	152
Natural sciences	1244	7	207	1020	10
Engineering and technology	767	14	106	647	0
Medical sciences	1514	2	131	1381	0
Agricultural sciences	2545	0	1761	680	104
Social sciences	1380	12	210	1120	38
Humanities	581	0	124	457	0
Not elsewhere classified	187	4	16	167	0
Female	1093	6	307	748	32
Natural sciences	170	1	25	140	4
Engineering and technology	104	1	14	89	0
Medical sciences	204	1	16	187	0
Agricultural sciences	324	0	211	93	20
Social sciences	186	2	23	153	8
Humanities	77	0	14	63	0
Not elsewhere classified	28	1	4	23	0

Tab. 2A-9. 5 Ethiopia - Researcher in FTEs by Field of R&D and Gender

R&D Personnel by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	4011,3	34,1	2090,2	1761,4	125,6
Natural sciences	460,2	7	172,2	276	5
Engineering and technology	267,1	11,9	82,2	173	0
Medical sciences	754,4	1,4	129,7	623,3	0
Agricultural sciences	1826,5	0	1442,4	281	103,1
Social sciences	428,9	12	130,4	269	17,5
Humanities	259,1	0	124	135,1	0
Not elsewhere classified	15,1	1,8	9,3	4	0
Female	552,5	5,4	290,5	232	24,6
Natural sciences	58	1	20,6	35,4	1
Engineering and technology	28,2	1	8,8	18,4	0
Medical sciences	91,5	0,4	14,7	76,4	0
Agricultural sciences	263,2	0	211	32,2	20
Social sciences	74,8	2	17,7	51,5	3,6
Humanities	31,2	0	14	17,2	0
Not elsewhere classified	5,6	1	3,7	0,9	0

Tab. 2A-9. 6 Ethiopia - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	18435	114	9140	8805	376
Under 25 years	830	5	410	398	17
25-34 Years	7756	48	3855	3695	158
35-44 Years	6319	39	3128	3023	129
45-54 Years	2735	17	1356	1306	56
55-64 Years	779	5	383	375	16
65 Years and more	16	0	8	8	0
Female	4242	28	2192	1906	116
Under 25 years	190	1	98	86	5
25-34 Years	1789	12	924	804	49
35-44 Years	1452	10	750	652	40
45-54 Years	629	4	326	282	17
55-64 Years	178	1	92	80	5
65 Years and more	4	0	2	2	0

Tab. 2A-9. 7 Ethiopia - Gross Domestic Expenditures on R&D by Source of Funds in Birr (2013)

Gross Domestic Expenditures on R&D (GERD) in Million LCU	Total	Business	Government	Higher education	Private non- profit
Business Enterprises	56,9	41,4	2,6	1,1	11,8
Government	5078,8	26,0	1187,8	3865,0	0,0
Higher Education	0	0,0	0,0	0,0	0,0
Private Non-Profit	0	0,0	0,0	0,0	0,0
Rest of the world	112,8	0,0	93,6	18,8	0,4
GERD by Sector and Source of Funds	5248,5	67,4	1284,0	3884,9	12,2

Tab. 2A-9. 8 Ethiopia - Gross Domestic Expenditures on R&D by type of Costs in Birr (2013)

Gross Expenditures on R&D (GERD)	Total	Business	Government	Higher education	Private non- profit
GERD by type of costs	5248,45	67,35	1284	3884,9	12,2
Labour cost	323,61	11,91	149,4	160,5	1,8
Other Current Cost	380,04	24,84	305,5	47,7	2
Total Current Cost	703,65	36,75	454,9	208,2	3,8
Vehicles, Lands, Buildings	4078,99	1,99	437	3635,7	4,3
Instruments, Equipment, Software	465,81	28,61	392,1	41	4,1
Total Capital Expenditures	4544,8	30,6	829,1	3676,7	8,4

Tab. 2A-9. 9 Ethiopia - Gross Domestic Expenditures on R&D by type of research in Birr (2013)

Gross Expenditures on R&D (GERD)		TOTAL	BE	GOV	HE	PNP
GERD by type of R&D	Current Costs & Capital Expenditures	5248,1	67,4	1284	3884,5	12,2
	Current Costs	703,7	36,8	455	208,1	3,8
	Capital Expenditures	4544,4	30,6	829	3676,4	8,4
Basic Research	Current Costs & Capital Expenditures	590,9	8,8	77	505,1	0
	Current Costs	59,2	4,8	27,3	27,1	0
	Capital Expenditures	531,7	4	49,7	478	0
Applied Research	Current Costs & Capital Expenditures	2390	24,9	925	1437	3,1
	Current Costs	419,7	13,6	328,1	77	1
	Capital Expenditures	1970,3	11,3	596,9	1360	2,1
Experimental Development	Current Costs & Capital Expenditures	2217,2	33,7	232	1942,4	9,1
	Current Costs	208	18,4	82,8	104	2,8
	Capital Expenditures	2009,2	15,3	149,2	1838,4	6,3
Not elsewhere classified	Current Costs & Capital Expenditures	50	0	50	0	0
	Current Costs	16,8	0	16,8	0	0
	Capital Expenditures	33,2	0	33,2	0	0

GABON 2014

Tab. 2A-10. 1 Gabon - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	972	65	90	650	167
Researchers	401	5	17	338	41
Technicians	341	26	51	184	80
Other personnel	230	34	22	128	46
Female	360	16	19	229	96
Researchers	113	1	3	93	16
Technicians	113	5	3	55	50
Other personnel	134	10	13	81	30

Tab. 2A-10. 2 Gabon - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED 1997)	Total	Business	Government	Higher education	Private non- profit
Total	972	65	90	650	167
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	109	2	0	90	17
1st Stage Tertiary Education: Theoretical (ISCED 5A)	226	3	17	147	59
1st Stage Tertiary Education: Practical (ISCED 5B)	126	0	21	101	4
Other Qualifications (ISCED 4 & below)	511	60	52	312	87
Female	360	16	19	229	96
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	31	0	0	16	15
1st Stage Tertiary Education: Theoretical (ISCED 5A)	85	0	3	46	36
1st Stage Tertiary Education: Practical (ISCED 5B)	37	0	3	31	3
Other Qualifications (ISCED 4 & below)	207	16	13	136	42

Tab. 2A-10. 3 Gabon - Researcher Headcount by Field of R&D and Gender

R&D Personnel by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	401	5	17	338	41
Natural sciences	197	5	4	184	4
Engineering and technology	67	0	13	54	0
Medical sciences	55	0	0	18	37
Agricultural sciences	64	0	0	64	0
Social sciences	18	0	0	18	0
Humanities	0	0	0	0	0
Not elsewhere classified	0	0	0	0	0
Female	113	1	3	93	16
Natural sciences	58	1	0	55	2
Engineering and technology	7	0	3	4	0
Medical sciences	28	0	0	14	14
Agricultural sciences	14	0	0	14	0
Social sciences	6	0	0	6	0
Humanities	0	0	0	0	0
Not elsewhere classified	0	0	0	0	0

Tab. 2A-10. 4 Gabon - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	972	65	90	650	167
Under 25 years	2	0	0	2	0
25-34 Years	258	16	17	172	53
35-44 Years	321	29	26	214	52
45-54 Years	256	15	34	174	33
55-64 Years	120	4	12	78	26
65 Years and more	15	1	1	10	3
Female	360	16	19	229	96
Under 25 years	0	0	0	0	0
25-34 Years	99	4	3	78	14
35-44 Years	142	10	4	90	38
45-54 Years	79	2	10	47	20
55-64 Years	40	0	2	14	24
65 Years and more	0	0	0	0	0

GHANA 2015

Tab. 2A-11. 1 Ghana - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	7230	-	1403	5827	-
Researchers	5579	-	870	4709	-
Technicians	1227	-	175	1052	-
Other personnel	424	-	358	66	-
Female	1929	-	390	1539	-
Researchers	1454	-	208	1246	-
Technicians	330	-	73	257	-
Other personnel	145	-	109	36	-

Tab. 2A-11. 2 Ghana - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	3422,4	-	994,6	2427,8	-
Researchers	2481,7	-	633,6	1848,1	-
Technicians	798	-	261,2	536,8	-
Other personnel	142,7	-	99,8	42,9	-
Female	694,5	-	310,4	384,1	-
Researchers	524,2	-	188,6	335,6	-
Technicians	60,3	-	24,7	35,6	-
Other personnel	110	-	97,1	12,9	-

Tab. 2A-11. 3 Ghana - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	7230	-	1403	5827	-
ISCED 8	2087	-	413	1674	-
ISCED 7	3646	-	611	3035	-
ISCED 6	907	-	165	742	-
ISCED 5	514	-	190	324	-
ISCED 4 & Below	76	-	24	52	-
Female	1929	-	390	1539	-
ISCED 8	327	-	78	249	-
ISCED 7	1218	-	227	991	-
ISCED 6	210	-	26	184	-
ISCED 5	101	-	38	63	-
ISCED 4 & Below	73	-	21	52	-

Tab. 2A-11. 4 Ghana - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	5579		870	4709	-
Natural sciences	808		81	727	-
Engineering and technology	943		86	857	-
Medical sciences	463		13	450	-
Agricultural sciences	1169		130	1039	-
Social sciences	1274		311	963	-
Humanities	587		175	412	
Not elsewhere classified	335		74	261	
Female	1454		208	1246	-
Natural sciences	75		8	67	-
Engineering and technology	64		3	61	-
Medical sciences	52		0	52	-
Agricultural sciences	289		46	243	-
Social sciences	442		58	384	-
Humanities	318		49	269	-
Not elsewhere classified	214		44	170	-

LESOTHO 2015

Tab. 2A-12. 1 Lesotho - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	170	-	41	129	-
Researchers	118	-	24	94	-
Technicians	30	-	11	19	-
Other personnel	22	-	6	16	-
Female	59	-	22	37	-
Researchers	43	-	14	29	-
Technicians	8	-	5	3	-
Other personnel	8	-	3	5	-

Tab. 2A-12. 2 Lesotho - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	170	-	41	129	-
Researchers	118	-	24	94	-
Technicians	30	-	11	19	-
Other personnel	22	-	6	16	-
Female	59	-	22	37	-
Researchers	43	-	14	29	-
Technicians	8	-	5	3	-
Other personnel	8	-	3	5	-

Tab. 2A-12. 3 Lesotho - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	170	-	41	129	-
ISCED 8	33	-	2	31	-
ISCED 7	63	-	6	57	-
ISCED 6	46	-	21	25	-
ISCED 5	27	-	12	15	-
ISCED 4 & Below	1	-	0	1	-
Female	59	-	22	37	-
ISCED 8	8	-	1	7	-
ISCED 7	23	-	3	20	-
ISCED 6	19	-	12	7	-
ISCED 5	9	-	6	3	-
ISCED 4 & Below	0	-	0	0	-

Tab. 2A-12. 4 Lesotho - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	118	-	24	94	-
Natural sciences	58	-	0	58	-
Engineering and technology	29	-	1	28	-
Medical sciences	3	-	0	3	-
Agricultural sciences	23	-	23	0	-
Social sciences	5	-	0	5	-
Humanities	0	-	0	0	-
Not elsewhere classified	0	-	0	0	-
Female	43	-	14	29	-
Natural sciences	23	-	0	23	-
Engineering and technology	3	-	0	3	-
Medical sciences	1	-	0	1	-
Agricultural sciences	14	-	14	0	-
Social sciences	2	-	0	2	-
Humanities	0	-	0	0	-
Not elsewhere classified	0	-	0	0	-

Tab. 2A-12. 5 Lesotho - Researcher in FTEs by Field of R&D and Gender

R&D Personnel by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	118	-	24	94	-
Natural sciences	58	-	0	58	-
Engineering and technology	29	-	1	28	-
Medical sciences	3	-	0	3	-
Agricultural sciences	23	-	23	0	-
Social sciences	5	-	0	5	-
Humanities	0	-	0	0	-
Not elsewhere classified	0	-	0	0	-
Female	43	-	14	29	-
Natural sciences	23	-	0	23	-
Engineering and technology	3	-	0	3	-
Medical sciences	1	-	0	1	-
Agricultural sciences	14	-	14	0	-
Social sciences	2	-	0	2	-
Humanities	0	-	0	0	-
Not elsewhere classified	0	-	0	0	-

Tab. 2A-12. 6 Lesotho - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	170	-	41	129	-
Under 25 years	8	-	0	8	-
25-34 Years	29	-	5	24	-
35-44 Years	50	-	15	35	-
45-54 Years	60	-	16	44	-
55-64 Years	22	-	5	17	-
65 Years and more	1	-	0	1	-
Female	59	-	22	37	-
Under 25 years	3	-	0	3	-
25-34 Years	10	-	3	7	-
35-44 Years	17	-	8	9	-
45-54 Years	23	-	9	14	-
55-64 Years	6	-	2	4	-
65 Years and more	0	-	0	0	-

MALI 2015

Tab. 2A-13. 1 Mali - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1723		1316	302	105
Researchers	719		407	266	46
Technicians	434		372	30	32
Other personnel	570		537	6	27
Female	306		258	27	21
Researchers	75		55	17	3
Technicians	95		76	8	11
Other personnel	136		127	2	7

Tab. 2A-13. 2 Mali - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1283,2		972,1	225,6	85,5
Researchers	537,9		289,3	213,6	35
Technicians	319,9		284,9	9	26
Other personnel	425,4		397,9	3	24,5
Female	228,8		196,6	13,2	19
Researchers	55,1		41,9	10,2	3
Technicians	71,7		60,7	2	9
Other personnel	102		94	1	7

Tab. 2A-13. 3 Mali - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED 1997)	Total	Business	Government	Higher education	Private non- profit
Total	1723	-	1316	302	105
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	440	-	159	239	42
1st Stage Tertiary Education: Theoretical (ISCED 5A)	438	-	345	46	47
1st Stage Tertiary Education: Practical (ISCED 5B)	74	-	58	16	0
Other Qualifications (ISCED 4 & below)	771	-	754	1	16
Female	306	-	258	27	21
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	28	-	16	9	3
1st Stage Tertiary Education: Theoretical (ISCED 5A)	79	-	59	7	13
1st Stage Tertiary Education: Practical (ISCED 5B)	36	-	25	11	0
Other Qualifications (ISCED 4 & below)	163	-	158	0	5

Tab. 2A-13. 4 Mali - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	719	-	407	266	46
Natural sciences	65	-	34	29	2
Engineering and technology	48	-	23	25	0
Medical sciences	70	-	50	14	6
Agricultural sciences	380	-	231	113	36
Social sciences	114	-	59	53	2
Humanities	42	-	10	32	0
Not elsewhere classified	0	-	0	0	0
Female	75	-	55	17	3
Natural sciences	3	-	2	0	1
Engineering and technology	12	-	4	8	0
Medical sciences	22	-	22	0	0
Agricultural sciences	27	-	18	7	2
Social sciences	11	-	9	2	0
Humanities	0	-	0	0	0
Not elsewhere classified	0	-	0	0	0

Tab. 2A-13. 5 Mali - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	537,9	-	289,3	213,6	35
Natural sciences	48,9	-	18,9	28	2
Engineering and technology	41,2	-	21,9	19,3	0
Medical sciences	66,5	-	46,5	14	6
Agricultural sciences	267,2	-	167	75,2	25
Social sciences	80,3	-	26,7	51,6	2
Humanities	33,8	-	8,3	25,5	0
Not elsewhere classified	0	-	0	0	0
Female	55,1	-	41,9	10,2	3
Natural sciences	2,4	-	1,4	0	1
Engineering and technology	10,3	-	3,3	7	0
Medical sciences	19,8	-	19,8	0	0
Agricultural sciences	17,1	-	12,2	2,9	2
Social sciences	5,5	-	5,2	0,3	0
Humanities	0	-	0	0	0
Not elsewhere classified	0	-	0	0	0

MOZAMBIQUE 2014/2015

Tab. 2A-14. 1 Mozambique - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	4256	17	1557	2596	86
Researchers	2434	8	537	1881	8
Technicians	1042	8	618	357	59
Other personnel	780	1	402	358	19
Female	1269	10	494	738	27
Researchers	704	4	220	477	3
Technicians	311	5	169	120	17
Other personnel	254	1	105	141	7

Tab. 2A-14. 2 Mozambique - R&D Personnel in FTEs by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	2320,1	9,8	909,6	1345,8	54,9
Researchers	1162	3,5	256,8	898,2	3,5
Technicians	723,5	6,2	428,8	248	40,5
Other personnel	434,6	0,1	224	199,6	10,9
Female	697,4	2,8	277	400,8	16,8
Researchers	337	1	74,5	260,5	1
Technicians	216,9	1,7	128,6	74,4	12,2
Other personnel	143,5	0,1	73,9	65,9	3,6

Tab. 2A-14. 3 Mozambique - Researcher Headcount by Field of R&D and Gender

R&D Personnel by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	2434	8	537	1881	8
Natural sciences	538	3	89	446	0
Engineering and technology	201	0	11	190	0
Medical sciences	284	1	164	111	8
Agricultural sciences	540	2	234	304	0
Social sciences	871	2	39	830	0
Humanities	0	0	0	0	0
Not elsewhere classified	0	0	0	0	0
Female	704	4	220	477	3
Natural sciences	145	0	25	120	0
Engineering and technology	49	0	2	47	0
Medical sciences	152	1	98	50	3
Agricultural sciences	138	1	82	55	0
Social sciences	220	2	13	205	0
Humanities	0	0	0	0	0
Not elsewhere classified	0	0	0	0	0

Tab. 2A-14. 4 Mozambique - Researcher in FTEs by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	1161,9	3,3	256,9	898,2	3,5
Natural sciences	236,9	1,3	42,6	193	0
Engineering and technology	96	0	5,3	90,7	0
Medical sciences	155	0,1	78,4	73	3,5
Agricultural sciences	258,1	1	111,9	145,2	0
Social sciences	415,9	0,9	18,7	396,3	0
Humanities	0	0	0	0	0
Not elsewhere classified	0	0	0	0	0
Female	335,9	1,1	73,3	260,5	1
Natural sciences	62,6	0	17,6	45	0
Engineering and technology	27,5	0	2	25,5	0
Medical sciences	59,2	0,1	18,1	40	1
Agricultural sciences	75	0,1	29,9	45	0
Social sciences	111,6	0,9	5,7	105	0
Humanities	0	0	0	0	0
Not elsewhere classified	0	0	0	0	0

Tab. 2A-14. 5 Mozambique - Gross Domestic Expenditures on R&D by Source of Funds in Metical (2014)

Gross Domestic Expenditures on R&D (GERD) in Million LCU	Total	Business	Government	Higher education	Private non- profit
Business Enterprises	9,42	9,4	0,0	0,0	0,0
Government	868,48	0,0	673,2	187,6	7,6
Higher Education	266	0,0	0,0	266,0	0,0
Private Non-Profit	0.0	0,0	0,0	0,0	0,0
Rest of the world	853,08	0,0	185,9	294,0	373,1
GERD by Sector and Source of Funds	1996,98	9,4	859,2	747,7	380,8

Tab. 2A-14. 6 Mozambique - Gross Domestic Expenditures on R&D by type of Costs in Metical (2014)

Gross Expenditures on R&D (GERD)	Total	Business	Government	Higher education	Private non- profit
GERD by type of costs	1996,96	9,42	859,14	747,65	380,75
Labour cost	1035,98	4,58	446,32	387,66	197,42
Other Current Cost	662,34	2,93	285,35	247,84	126,22
Total Current Cost	1698,32	7,51	731,67	635,5	323,64
Vehicles, Lands, Buildings	0	0	0	0	0
Instruments, Equipment, Software	298,64	1,91	127,47	112,15	57,11
Total Capital Expenditures	298,64	1,91	127,47	112,15	57,11

Tab. 2A-14. 7 Mozambique - Gross Domestic Expenditures on R&D by type of research in Metical (2014)

Gross Expenditures on R&D (GERD)		TOTAL	BE	GOV	HE	PNP
GERD by type of R&D	Current Costs & Capital Expenditures	1996,96	9,42	859,14	747,65	380,75
	Current Costs	1698,33	7,51	731,68	635,5	323,64
	Capital Expenditures	298,63	1,91	127,46	112,15	57,11
Basic Research	Current Costs & Capital Expenditures	541,91	6,2	116,01	381,65	38,05
	Current Costs	460,48	4,94	98,8	324,4	32,34
	Capital Expenditures	81,43	1,26	17,21	57,25	5,71
Applied Research	Current Costs & Capital Expenditures	1017,77	3,22	552,03	234,04	228,48
	Current Costs	865,84	2,57	470,13	198,93	194,21
	Capital Expenditures	151,93	0,65	81,9	35,11	34,27
Experimental Development	Current Costs & Capital Expenditures	437,28	0	191,1	131,96	114,22
	Current Costs	372,01	0	162,75	112,17	97,09
	Capital Expenditures	65,27	0	28,35	19,79	17,13
Not elsewhere classified	Current Costs & Capital Expenditures	0	0	0	0	0
	Current Costs	0	0	0	0	0
	Capital Expenditures	0	0	0	0	0

NAMIBIA 2013/2014

Tab. 2A-15. 1 Namibia - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1132	82	343	615	92
Researchers	749	44	174	500	31
Technicians	255	26	143	63	23
Other personnel	128	12	26	52	38
Female	464	30	129	258	47
Researchers	290	17	67	193	13
Technicians	95	7	50	24	14
Other personnel	79	6	12	41	20

Tab. 2A-15. 2 Namibia - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	570,4	42	253,1	211,8	63,5
Researchers	351,3	24,5	134,6	167,4	24,8
Technicians	150,4	11	98,1	23,3	18
Other personnel	68,7	6,5	20,4	21,1	20,7
Female	226,2	17,9	90,1	87,9	30,3
Researchers	135,9	11,4	52,5	63,1	8,9
Technicians	51,6	3,6	29,1	8,4	10,5
Other personnel	38,7	2,9	8,5	16,4	10,9

Tab. 2A-15. 3 Namibia - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	1132	82	343	615	92
ISCED 8	212	14	24	163	11
ISCED 7	345	14	71	243	17
ISCED 6	311	28	115	141	27
ISCED 5	134	4	78	38	14
ISCED 4 & Below	130	22	55	30	23
Female	464	30	129	258	47
ISCED 8	56	6	2	43	5
ISCED 7	149	6	30	107	6
ISCED 6	143	10	45	72	16
ISCED 5	61	3	28	20	10
ISCED 4 & Below	55	5	24	16	10

Tab. 2A-15. 4 Namibia - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	749	44	174	500	31
Natural sciences	184	10	73	91	10
Engineering and technology	44	2	0	41	1
Medical sciences	21	8	3	10	0
Agricultural sciences	93	7	48	35	3
Social sciences	328	6	29	277	16
Humanities	32	0	12	20	0
Not elsewhere classified	47	11	9	26	1
Female	290	17	67	193	13
Natural sciences	51	1	19	27	4
Engineering and technology	10	1	0	9	0
Medical sciences	11	5	2	4	0
Agricultural sciences	36	2	22	12	0
Social sciences	154	4	16	125	9
Humanities	14	0	6	8	0
Not elsewhere classified	14	4	2	8	0

Tab. 2A-15. 5 Namibia - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	351,6	24,6	134,7	167,4	24,9
Natural sciences	101,7	3,3	58,1	32,2	8,1
Engineering and technology	12	2,1	0	9,6	0,3
Medical sciences	10,8	6	0,8	4	0
Agricultural sciences	64,7	2,3	45,5	14,7	2,2
Social sciences	136,2	5	24	93,3	13,9
Humanities	6,5	0	0,4	6,1	0
Not elsewhere classified	19,7	5,9	5,9	7,5	0,4
Female	135,9	11,4	52,5	63,1	8,9
Natural sciences	30	0,7	14,3	11	4
Engineering and technology	2,9	1	0	1,9	0
Medical sciences	5,5	3,3	0,5	1,7	0
Agricultural sciences	26,5	0,6	21,1	4,8	0
Social sciences	64,5	4	14,5	41,1	4,9
Humanities	0,6	0	0,1	0,5	0
Not elsewhere classified	5,9	1,8	2	2,1	0

Tab. 2A-15. 6 Namibia - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	1132	82	343	615	92
Under 25 years	39	5	13	8	13
25-34 Years	306	43	97	124	42
35-44 Years	380	15	154	188	23
45-54 Years	279	4	68	197	10
55-64 Years	71	12	8	49	2
65 Years and more	57	3	3	49	2
Female	464	30	129	258	47
Under 25 years	25	4	8	6	7
25-34 Years	151	18	52	57	24
35-44 Years	149	5	51	84	9
45-54 Years	93	1	13	74	5
55-64 Years	29	1	5	21	2
65 Years and more	17	1	0	16	0

Tab. 2A-15. 7 Namibia - Gross Domestic Expenditures on R&D by Source of Funds in Namibian Dollar (2013)

Gross Domestic Expenditures on R&D (GERD) in Million LCU	Total	Business	Government	Higher education	Private non- profit
Business Enterprises	268,54	50,21	216,19	0,69	1,45
Government	82,028	2,61	0	74,27	5,148
Higher Education	28,32	0	0	28,32	0
Private Non-Profit	18,26	1,06	0	2,82	14,38
Rest of the world	74,48	0	0,42	59,06	15
GERD by Sector and Source of Funds	471,628	53,88	216,61	165,16	35,978

Tab. 2A-15. 8 Namibia - Gross Domestic Expenditures on R&D by Type of Costs in Namibian Dollar (2013)

Gross Expenditures on R&D (GERD)	Total	Business	Government	Higher education	Private non- profit
GERD by type of costs	471,74	53,89	216,62	165,15	36,08
Labour cost	221,27	13,78	87,27	100,1	20,12
Other Current Cost	142,18	25,02	46,07	58,8	12,29
Total Current Cost	363,45	38,8	133,34	158,9	32,41
Vehicles, Lands, Buildings	26,93	1,92	23,4	0,17	1,44
Instruments, Equipment, Software	81,36	13,17	59,88	6,08	2,23
Total Capital Expenditures	108,29	15,09	83,28	6,25	3,67

Tab. 2A-15. 9 Namibia - Gross Domestic Expenditures on R&D by Type of Research in Namibian Dollar (2013)

Gross Expenditures on R&D (GERD)		TOTAL	BE	GOV	HE	PNP
GERD by type of R&D	Current Costs & Capital Expenditures	471,74	53,89	216,61	165,15	36,09
	Current Costs	363,46	38,81	133,33	158,91	32,41
	Capital Expenditures	108,28	15,08	83,28	6,24	3,68
Basic Research	Current Costs & Capital Expenditures	80,57	9,16	27,03	43,25	1,13
	Current Costs	63,24	3,88	16,64	41,71	1,01
	Capital Expenditures	17,33	5,28	10,39	1,54	0,12
Applied Research	Current Costs & Capital Expenditures	211,33	34,15	84,47	92,1	0,61
	Current Costs	168,37	26,39	51,99	89,44	0,55
	Capital Expenditures	42,96	7,76	32,48	2,66	0,06
Experimental Development	Current Costs & Capital Expenditures	143,28	10,58	82,29	29,8	20,61
	Current Costs	105,46	8,54	50,65	27,76	18,51
	Capital Expenditures	37,82	2,04	31,64	2,04	2,1
Not elsewhere classified	Current Costs & Capital Expenditures	36,56	0	22,82	0	13,74
	Current Costs	26,39	0	14,05	0	12,34
	Capital Expenditures	10,17	0	8,77	0	1,4

NIGER 2013

Tab. 2A-16. 1 Niger - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1586		662	302	99
Researchers	822		363	266	79
Technicians	330		98	30	9
Other personnel	434		201	6	11
Female	278		146	27	16
Researchers	140		97	17	10
Technicians	69		34	8	4
Other personnel	69		15	2	2

Tab. 2A-16. 2 Niger - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	908		662	206,4	39,6
Researchers	489,7		363	95,1	31,6
Technicians	157,4		98	55,8	3,6
Other personnel	260,9		201	55,5	4,4
Female	181,5		146	29,1	6,4
Researchers	109,3		97	8,3	4
Technicians	43,4		34	7,8	1,6
Other personnel	28,8		15	13	0,8

Tab. 2A-16. 3 Niger - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED 1997)	Total	Business	Government	Higher education	Private non- profit
Total	1586		662	825	99
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	552		96	419	37
1st Stage Tertiary Education: Theoretical (ISCED 5A)	415		190	198	27
1st Stage Tertiary Education: Practical (ISCED 5B)	0		0	0	0
Other Qualifications (ISCED 4 & below)	619		376	208	35
Female	278		146	116	16
2nd Stage Tertiary Education: Doctorate Level (ISCED 6)	98		21	73	4
1st Stage Tertiary Education: Theoretical (ISCED 5A)	77		54	20	3
1st Stage Tertiary Education: Practical (ISCED 5B)	0		0	0	0
Other Qualifications (ISCED 4 & below)	103		71	23	9

Tab. 2A-16. 4 Niger - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	822		363	380	79
Natural sciences	319		136	177	6
Engineering and technology	92		14	27	51
Medical sciences	90		51	39	0
Agricultural sciences	98		85	13	0
Social sciences	138		51	70	17
Humanities	80		26	54	0
Not elsewhere classified	5		0	0	5
Female	140		97	33	10
Natural sciences	36		23	10	3
Engineering and technology	6		1	2	3
Medical sciences	19		15	4	0
Agricultural sciences	4		4	0	0
Social sciences	54		41	10	3
Humanities	20		13	7	0
Not elsewhere classified	1		0	0	1

Tab. 2A-16. 5 Niger - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	482,8	-	356	95,2	31,6
Natural sciences	176,3	-	136	36,3	4
Engineering and technology	41,6	-	14	14,8	12,8
Medical sciences	61,5	-	51	10,5	0
Agricultural sciences	80,5	-	78	2,5	0
Social sciences	79	-	51	16,8	11,2
Humanities	40,3	-	26	14,3	0
Not elsewhere classified	3,6	-	0	0	3,6
Female	12,4	-	0	8,4	4
Natural sciences	3,5	-	0	2,3	1,2
Engineering and technology	2	-	0	0,8	1,2
Medical sciences	1	-	0	1	0
Agricultural sciences	0	-	0	0	0
Social sciences	3	-	0	1,8	1,2
Humanities	2,5	-	0	2,5	0
Not elsewhere classified	1733,4	-	1733	0	0,4

RWANDA 2013/2014

Tab. 2A-17. 1 Rwanda - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	721		132	325	264
Researchers	482		78	301	103
Technicians	123		35	18	70
Other personnel	116		19	6	91
Female	203		43	58	102
Researchers	109		24	51	34
Technicians	46		12	5	29
Other personnel	48		7	2	39

Tab. 2A-17. 2 Rwanda - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	288,9		48,5	89,9	150,5
Researchers	168,1		31,4	83,6	53,1
Technicians	57,8		11,6	4,3	41,9
Other personnel	63		5,5	2	55,5
Female	101,2		18,8	16	66,4
Researchers	41,6		11,4	13,6	16,6
Technicians	28,6		5,9	1,5	21,2
Other personnel	31		1,5	0,9	28,6

Tab. 2A-17. 3 Rwanda - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	721		132	325	264
ISCED 8	157		13	124	20
ISCED 7	284		47	166	71
ISCED 6	183		51	26	106
ISCED 5	37		10	5	22
ISCED 4 & Below	60		11	4	45
Female	203		43	58	102
ISCED 8	29		2	21	6
ISCED 7	67		17	30	20
ISCED 6	69		16	7	46
ISCED 5	17		4	0	13
ISCED 4 & Below	21		4	0	17

Tab. 2A-17. 4 Rwanda - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	482		78	301	103
Natural sciences	66		11	50	5
Engineering and technology	44		5	33	6
Medical sciences	89		34	32	23
Agricultural sciences	57		7	46	4
Social sciences	177		11	102	64
Humanities	44		10	33	1
Not elsewhere classified	5		0	5	0
Female	109		24	51	34
Natural sciences	8		2	5	1
Engineering and technology	5		0	2	3
Medical sciences	37		16	11	10
Agricultural sciences	8		0	8	0
Social sciences	45		6	20	19
Humanities	1		0	0	1
Not elsewhere classified	5		0	5	0

Tab. 2A-17. 5 Rwanda - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	168,1		31,4	83,6	53,1
Natural sciences	18,6		3,2	12,4	3
Engineering and technology	13,8		2,8	9,2	1,8
Medical sciences	33,1		14,4	6,2	12,5
Agricultural sciences	17		0,4	14	2,6
Social sciences	68,6		5,8	30,6	32,2
Humanities	15,8		4,8	10	1
Not elsewhere classified	1,2		0	1,2	0
Female	41,6		11,4	13,6	16,6
Natural sciences	2,6		0,3	1,9	0,4
Engineering and technology	1		0	0,3	0,7
Medical sciences	13,3		7,5	1,6	4,2
Agricultural sciences	2,6		0	2,6	0
Social sciences	19,9		3,6	6	10,3
Humanities	1		0	0	1
Not elsewhere classified	1,2		0	1,2	0

Tab. 2A-17. 6 Rwanda - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	721		132	325	264
Under 25 years	1		0	1	0
25-34 Years	187		55	65	67
35-44 Years	289		49	127	113
45-54 Years	149		22	80	47
55-64 Years	61		5	33	23
65 Years and more	34		1	19	14
Female	203		43	58	102
Under 25 years	0		0	0	0
25-34 Years	65		19	17	29
35-44 Years	77		20	23	34
45-54 Years	37		4	14	19
55-64 Years	15		0	2	13
65 Years and more	9		0	2	7

SENEGAL 2015

Tab. 2A-18. 1 Senegal - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	16599		635	15768	196
Researchers	14335		164	14123	48
Technicians	822		174	628	20
Other personnel	1442		297	1017	128
Female	4880		161	4656	63
Researchers	4201		43	4141	17
Technicians	258		35	220	3
Other personnel	421		83	295	43

Tab. 2A-18. 2 Senegal - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	9405,4		432,6	8862,4	110,4
Researchers	8304		183	8078,8	42,2
Technicians	538		147,2	376,8	14
Other personnel	563,4		102,4	406,8	54,2
Female	2826,6		114,6	2692	20
Researchers	2511,2		54	2442	15,2
Technicians	165,8		32	132	1,8
Other personnel	149,6		28,6	118	3

Tab. 2A-18. 3 Senegal - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	16599	-	635	15768	196
ISCED 8	6058	-	93	5927	38
ISCED 7	9097	-	96	8931	70
ISCED 6	604	-	168	385	51
ISCED 5	536	-	170	335	31
ISCED 4 & Below	304	-	108	190	6
Female	4880	-	161	4656	63
ISCED 8	1516	-	18	1484	14
ISCED 7	2975	-	33	2912	30
ISCED 6	225	-	67	140	18
ISCED 5	118	-	38	80	0
ISCED 4 & Below	46	-	5	40	1

Tab. 2A-18. 4 Senegal - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	14335	-	164	14123	48
Natural sciences	3024	-	42	2951	31
Engineering and technology	1014	-	27	985	2
Medical sciences	2127	-	18	2099	10
Agricultural sciences	188	-	57	128	3
Social sciences	5616	-	20	5594	2
Humanities	2366	-	0	2366	0
Not elsewhere classified	0	-	0	0	0
Female	4201	-	43	4141	17
Natural sciences	700	--	8	682	10
Engineering and technology	202	-	10	192	0
Medical sciences	781	-	2	775	4
Agricultural sciences	55	-	11	43	1
Social sciences	1841	-	12	1827	2
Humanities	622	-	0	622	0
Not elsewhere classified	0	-	0	0	0

Tab. 2A-18. 5 Senegal - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	8268	-	147	8078,8	42,2
Natural sciences	1831,2	-	42	1766	23,2
Engineering and technology	817,9	-	23	793,2	1,7
Medical sciences	1151	-	5	1137	9
Agricultural sciences	155,3	-	57	92	6,3
Social sciences	2530,1	-	20	2508,1	2
Humanities	1782,5	-	0	1782,5	0
Not elsewhere classified	0	-	0	0	0
Female	2499,2	-	43	2441	15,2
Natural sciences	338,2	-	8	321	9,2
Engineering and technology	100	-	10	90	0
Medical sciences	437	-	2	432	3
Agricultural sciences	55	-	11	43	1
Social sciences	1172	-	12	1158	2
Humanities	397	-	0	397	0
Not elsewhere classified	0	-	0	0	0

Tab. 2A-18. 6 Senegal - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	16599		635	15768	196
Under 25 years	1252		4	1224	24
25-34 Years	9837		118	9646	73
35-44 Years	2878		220	2605	53
45-54 Years	1625		178	1424	23
55-64 Years	968		115	830	23
65 Years and more	39		0	39	0
Female	4880		161	4656	63
Under 25 years	693		2	682	9
25-34 Years	2920		39	2856	25
35-44 Years	793		54	721	18
45-54 Years	322		30	283	9
55-64 Years	146		36	108	2
65 Years and more	6		0	6	0

SEYCHELLES 2015

Tab. 2A-19. 1 Seychelles - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	442	169	204	23	46
Researchers	149	55	53	18	23
Technicians	141	48	75	3	15
Other personnel	152	66	76	2	8
Female	195	41	120	13	21
Researchers	52	0	31	11	10
Technicians	57	4	46	0	7
Other personnel	86	37	43	2	4

Tab. 2A-19. 2 Seychelles - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	442	169	204	23	46
Researchers	149	55	53	18	23
Technicians	141	48	75	3	15
Other personnel	152	66	76	2	8
Female	195	41	120	13	21
Researchers	52	0	31	11	10
Technicians	57	4	46	0	7
Other personnel	86	37	43	2	4

Tab. 2A-19. 3 Seychelles - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	442	169	204	23	46
ISCED 8	19	0	3	3	13
ISCED 7	50	6	25	8	11
ISCED 6	50	16	24	6	4
ISCED 5	158	88	59	4	7
ISCED 4 & Below	165	59	93	2	11
Female	195	41	120	13	21
ISCED 8	9	0	2	1	6
ISCED 7	28	1	14	6	7
ISCED 6	16	0	13	3	0
ISCED 5	55	10	40	1	4
ISCED 4 & Below	87	30	51	2	4

Tab. 2A-19. 4 Seychelles - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	149	55	53	18	23
Natural sciences	41	0	16	6	19
Engineering and technology	56	55	0	0	1
Medical sciences	17	0	17	0	0
Agricultural sciences	7	0	4	1	2
Social sciences	26	0	16	9	1
Humanities	2	0	0	2	0
Not elsewhere classified	0	0	0	0	0
Female	52	0	31	11	10
Natural sciences	19	0	8	4	7
Engineering and technology	0	0	0	0	0
Medical sciences	13	0	13	0	0
Agricultural sciences	4	0	1	1	2
Social sciences	15	0	9	5	1
Humanities	1	0	0	1	0
Not elsewhere classified	0	0	0	0	0

Tab. 2A-19. 5 Seychelles - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	149	55	53	18	23
Natural sciences	41	0	16	6	19
Engineering and technology	56	55	0	0	1
Medical sciences	17	0	17	0	0
Agricultural sciences	7	0	4	1	2
Social sciences	26	0	16	9	1
Humanities	2	0	0	2	0
Not elsewhere classified	0	0	0	0	0
Female	52	0	31	11	10
Natural sciences	19	0	8	4	7
Engineering and technology	0	0	0	0	0
Medical sciences	13	0	13	0	0
Agricultural sciences	4	0	1	1	2
Social sciences	15	0	9	5	1
Humanities	1	0	0	1	0
Not elsewhere classified	0	0	0	0	0

Tab. 2A-19. 6 Seychelles - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	442	169	204	23	46
Under 25 years	43	12	25	2	4
25-34 Years	181	96	69	7	9
35-44 Years	121	39	58	13	11
45-54 Years	71	18	41	1	11
55-64 Years	20	2	10	0	8
65 Years and more	6	2	1	0	3
Female	195	41	120	13	21
Under 25 years	26	8	14	2	2
25-34 Years	73	22	41	4	6
35-44 Years	51	5	35	6	5
45-54 Years	30	4	22	1	3
55-64 Years	11	1	7	0	3
65 Years and more	4	1	1	0	2

SOUTH AFRICA 2014/2015

Tab. 2A-20. 1 South Africa - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	68838	17599	8758	41464	1017
Researchers	45935	6182	3185	36133	435
Technicians	10800	6397	1914	2284	205
Other personnel	12103	5020	3659	3047	377
Female	30230	6407	3922	19241	660
Researchers	20231	2287	1498	16213	233
Technicians	3900	1979	820	970	131
Other personnel	6099	2141	1604	2058	296

Tab. 2A-20. 2 South Africa - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	37956,7	11877,5	7410	17777,7	891,5
Researchers	23346,2	4530,2	2705	15772,5	338,5
Technicians	6905,5	4253,1	1613,6	843,7	195,1
Other personnel	7705	3094,2	3091,4	1161,5	357,9
Female	16487,8	4434,7	3343,6	8119,5	590
Researchers	10165,3	1780,8	1254,4	6947,2	182,9
Technicians	2565,2	1376,8	682,7	378,6	127,1
Other personnel	3757,3	1277,1	1406,5	793,7	280

Tab. 2A-20. 3 South Africa - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	68839	17600	8758	41464	1017
ISCED 8	27909	848	1182	25767	112
ISCED 7	22859	8325	3977	10009	548
ISCED 6	18071	8427	3599	5688	357
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0
Female	30230	6407	3922	19241	660
ISCED 8	11572	266	456	10806	44
ISCED 7	10867	3236	2000	5271	360
ISCED 6	7791	2905	1466	3164	256
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0

Tab. 2A-20. 4 South Africa - Researcher Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	45935	6182	3185	36133	435
ISCED 8	27314	775	1056	25377	106
ISCED 7	14972	4373	2059	8238	302
ISCED 6	3649	1034	70	2518	27
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0
Female	20231	2287	1498	16213	233
ISCED 8	11361	244	420	10657	40
ISCED 7	7057	1642	1046	4197	172
ISCED 6	1813	401	32	1359	21
ISCED 5	0	0	0	0	0
ISCED 4 & Below	0	0	0	0	0

Tab. 2A-20. 5 South Africa - Gross Domestic Expenditures on R&D by Source of Funds in Rand (2014)

Gross Domestic Expenditures on R&D (GERD) in Million LCU	Total	Business	Government	Higher education	Private non- profit
Business Enterprises	10615.95	9552.7	421.2	588.6	53.4
Government	11007.08	685.7	4848.9	5369.3	103.2
Higher Education	181.87	0.8	9.5	169.0	2.6
Private Non-Profit	540.49	316.7	9.0	123.3	91.5
Rest of the world	3315.24	1227.0	713.1	1042.6	332.6
GERD by Sector and Source of Funds	25660.63	11782.9	6001.7	7292.9	583.2

Tab. 2A-20. 6 South Africa - Gross Domestic Expenditures on R&D by Type of Costs (2014)

Gross Expenditures on R&D (GERD)	Total	Business	Government	Higher education	Private non- profit
GERD by type of costs	25661	11783	6002	7293	583
Labour cost	14529,5	6768	2984	4473,5	304
Other Current Cost	8743,5	3882	2509	2113,5	239
Total Current Cost	23273	10650	5493	6587	543
Vehicles, Lands, Buildings	529,5	159	95,5	256	19
Instruments, Equipment, Software	1858,5	974	413,5	450	21
Total Capital Expenditures	2388	1133	509	706	40

TANZANIA 2013/2014

Tab. 2A-21. 1 Tanzania - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	6502	-	2013	4489	-
Researchers	3400	-	1318	2082	-
Technicians	1354	-	446	908	-
Other personnel	1748	-	249	1499	-
Female	2964	-	865	2099	-
Researchers	1186	-	429	757	-
Technicians	725	-	246	479	-
Other personnel	1053	-	190	863	-

Tab. 2A-21. 2 Tanzania - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	2915,9	-	668,8	2247,1	-
Researchers	2067,3	-	366,3	1701	-
Technicians	299,2	-	129,4	169,8	-
Other personnel	549,4	-	173,1	376,3	-
Female	708,6	-	178,2	530,4	-
Researchers	404,8	-	80,8	324	-
Technicians	64,1	-	17	47,1	-
Other personnel	239,7	-	80,4	159,3	-

Tab. 2A-21. 3 Tanzania - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	6502	-	2013	4489	-
ISCED 8	1323	-	321	1002	-
ISCED 7	2167	-	448	1719	-
ISCED 6	1880	-	732	1148	-
ISCED 5	1062	-	442	620	-
ISCED 4 & Below	70	-	70	0	-
Female	2964	-	865	2099	-
ISCED 8	579	-	209	370	-
ISCED 7	1082	-	418	664	-
ISCED 6	626	-	131	495	-
ISCED 5	650	-	80	570	-
ISCED 4 & Below	27	-	27	0	-

Tab. 2A-21. 4 Tanzania - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	3400	-	1318	2082	-
Natural sciences	487	-	192	295	-
Engineering and technology	231	-	129	102	-
Medical sciences	682	-	308	374	-
Agricultural sciences	955	-	468	487	-
Social sciences	569	-	176	393	-
Humanities	418	-	45	373	-
Not elsewhere classified	58	-	0	58	-
Female	1186	-	429	757	-
Natural sciences	195	-	87	108	-
Engineering and technology	101	-	25	76	-
Medical sciences	280	-	115	165	-
Agricultural sciences	134	-	51	83	-
Social sciences	306	-	113	193	-
Humanities	160	-	38	122	-
Not elsewhere classified	10	-	0	10	-

Tab. 2A-21. 5 Tanzania - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	2055,4	-	366,3	1689,1	-
Natural sciences	311,9	-	62,8	249,1	-
Engineering and technology	160,4	-	58,4	102	-
Medical sciences	423	-	49	374	-
Agricultural sciences	478,7	-	110,7	368	-
Social sciences	435,8	-	63,6	372,2	-
Humanities	210,6	-	21,8	188,8	-
Not elsewhere classified	35	-	0	35	-
Female	446,3	-	80,8	365,5	-
Natural sciences	65,4	-	18,8	46,6	-
Engineering and technology	86,4	-	10,4	76	-
Medical sciences	64,9	-	10,3	54,6	-
Agricultural sciences	60,3	-	10	50,3	-
Social sciences	98,2	-	20,6	77,6	-
Humanities	61,1	-	10,7	50,4	-
Not elsewhere classified	10	-	0	10	-

Tab. 2A-21. 6 Tanzania - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	6502	-	2013	4489	-
18-35 Years	2117	-	572	1545	-
36-45 Years	2511	-	911	1600	-
46-60 Years	1321	-	413	908	-
61 Years and more	553	-	117	436	-
Female	2964	-	865	2099	-
18-35 Years	1014	-	262	752	-
36-45 Years	1154	-	404	750	-
46-60 Years	586	-	195	391	-
61 Years and more	210	-	4	206	-

TOGO 2015

Tab. 2A-22. 1 Togo - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1365	-	402	963	-
Researchers	712	-	63	649	-
Technicians	184	-	55	129	-
Other personnel	469	-	284	185	-
Female	243	-	50	193	-
Researchers	66	-	3	63	-
Technicians	55	-	12	43	-
Other personnel	122	-	35	87	-

Tab. 2A-22. 2 Togo - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	605,1		321,6	283,5	-
Researchers	264,6		50,4	214,2	-
Technicians	76,3		44	32,3	-
Other personnel	264,2		227,2	37	-
Female	89		40	49	-
Researchers	23,2		2,4	20,8	-
Technicians	20,4		9,6	10,8	-
Other personnel	45,4		28	17,4	-

Tab. 2A-22. 3 Togo - R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	1365		402	963	-
ISCED 8	549		4	545	-
ISCED 7	163		59	104	-
ISCED 6	181		52	129	-
ISCED 5	3		3	0	-
ISCED 4 & Below	469		284	185	-
Female	243		50	193	-
ISCED 8	52		1	51	-
ISCED 7	14		2	12	-
ISCED 6	55		12	43	-
ISCED 5	0		0	0	-
ISCED 4 & Below	122		35	87	-

Tab. 2A-22. 4 Togo - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	712		63	649	-
Natural sciences	135		0	135	-
Engineering and technology	47		3	44	-
Medical sciences	128		0	128	-
Agricultural sciences	87		60	27	-
Social sciences	207		0	207	-
Humanities	103		0	103	
Not elsewhere classified	5		0	5	
Female	66		3	63	-
Natural sciences	10		0	10	-
Engineering and technology	5		0	5	-
Medical sciences	9		0	9	-
Agricultural sciences	3		3	0	-
Social sciences	21		0	21	-
Humanities	16		0	16	
Not elsewhere classified	2		0	2	

UGANDA 2014

Tab. 2A-23. 1 Uganda - R&D Personnel Headcount by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	Eswatini	257	1194	1178	252
Researchers	1942	109	573	1099	161
Technicians	599	90	419	46	44
Other personnel	340	58	202	33	47
Female	918	62	417	344	95
Researchers	578	24	176	320	58
Technicians	205	26	146	14	19
Other personnel	135	12	95	10	18

Tab. 2A-23. 2 Uganda - R&D Personnel in Full-Time Equivalents by Function and Gender

R&D Personnel by function	Total	Business	Government	Higher education	Private non- profit
Total	1612,6	93,5	934,9	490,5	93,7
Researchers	1027,8	40,7	456,6	467,8	62,7
Technicians	398,4	32	333,8	12,6	20
Other personnel	186,4	20,8	144,5	10,1	11
Female	500,8	20,3	314,1	136,7	29,7
Researchers	289,1	8,1	133,4	131	16,6
Technicians	132,3	8,8	111,1	3,4	9
Other personnel	79,4	3,4	69,6	2,3	4,1

Tab. 2A-23. 3 Uganda -R&D Personnel Headcount by Level of Education and Gender

R&D Personnel by level of Education (ISCED)	Total	Business	Government	Higher education	Private non- profit
Total	2881	257	1194	1178	252
ISCED 8	661	14	92	532	23
ISCED 7	929	26	318	535	50
ISCED 6	863	122	569	81	91
ISCED 5	199	39	133	8	19
ISCED 4 & Below	229	56	82	22	69
Female	918	62	417	344	95
ISCED 8	160	2	18	135	5
ISCED 7	294	9	96	169	20
ISCED 6	301	26	209	31	35
ISCED 5	60	5	48	3	4
ISCED 4 & Below	103	20	46	6	31

Tab. 2A-23. 4 Uganda - Researcher Headcount by Field of R&D and Gender

Researcher by Field of R&D	Total	Business	Government	Higher education	Private non- profit
Total	1942	109	573	1099	161
Natural sciences	212	10	39	161	2
Engineering and technology	234	27	41	150	16
Medical sciences	358	13	137	198	10
Agricultural sciences	332	16	176	132	8
Social sciences	558	35	150	282	91
Humanities	248	8	30	176	34
Not elsewhere classified	0	0	0	0	0
Female	578	24	176	320	58
Natural sciences	53	1	12	40	0
Engineering and technology	48	2	14	30	2
Medical sciences	110	5	37	66	2
Agricultural sciences	91	3	51	34	3
Social sciences	201	11	50	98	42
Humanities	75	2	12	52	9
Not elsewhere classified	0	0	0	0	0

Tab. 2A-23. 5 Uganda - Researchers in Full-Time Equivalents by Field of R&D and Gender

Researchers FTEs	Total	Business	Government	Higher education	Private non- profit
Total	1027,8	40,7	456,6	467,8	62,7
Natural sciences	105,2	5,6	33,4	65,4	0,8
Engineering and technology	97,4	7,8	20,7	58,5	10,4
Medical sciences	200,9	5,5	108,3	84,8	2,3
Agricultural sciences	210,9	9,1	155,6	45,1	1,1
Social sciences	291,6	10,4	110	136,6	34,6
Humanities	121,8	2,3	28,6	77,4	13,5
Not elsewhere classified	0	0	0	0	0
Female	289,1	8,1	133,4	131	16,6
Natural sciences	24,5	0,5	10	14	0
Engineering and technology	19,9	0,9	8,1	10,2	0,7
Medical sciences	58,9	2	28	28,8	0,1
Agricultural sciences	48,2	0,8	39,3	7,7	0,4
Social sciences	101,1	3,7	37,4	48,5	11,5
Humanities	36,5	0,2	10,6	21,8	3,9
Not elsewhere classified	0	0	0	0	0

Tab. 2A-23. 6 Uganda - R&D Personnel Headcount by Age and Gender

R&D Personnel by Age	Total	Business	Government	Higher education	Private non- profit
Total	2881	257	1194	1178	252
Under 25 years	50	19	7	1	23
25-34 Years	632	143	218	184	87
35-44 Years	1056	50	388	544	74
45-54 Years	633	31	268	291	43
55-64 Years	367	12	211	127	17
65 Years and more	143	2	102	31	8
Female	918	62	417	344	95
Under 25 years	19	5	2	0	12
25-34 Years	243	47	96	62	38
35-44 Years	334	5	127	168	34
45-54 Years	184	2	87	86	9
55-64 Years	104	2	74	26	2
65 Years and more	34	1	31	2	0

Tab. 2A-23. 7 Uganda - Gross Domestic Expenditures on R&D by Source of Funds in Ugandan Shilling (2014)

Gross Domestic Expenditures on R&D (GERD) in Million LCU	Total	Business	Government	Higher education	Private non- profit
Business Enterprises	4043.5	3636.5	56.0	217.0	134.0
Government	45145	0.0	29815.0	15258.0	72.0
Higher Education	2734	0.0	0.0	2226.0	508.0
Private Non-Profit	3929.3	77.3	992.0	1575.0	1285.0
Rest of the world	62217.2	1406.2	24736.0	35024.0	1051.0
GERD by Sector and Source of Funds	118069	5120.0	55599.0	54300.0	3050.0

Tab. 2A-23. 8 Uganda - Gross Domestic Expenditures on R&D by Type of Costs in Ugandan Shilling (2014)

Gross Expenditures on R&D (GERD)	Total	Business	Government	Higher education	Private non- profit
GERD by type of costs	118070	5120	55600	54300	3050
Labour cost	40370	1100	13678	24706	886
Other Current Cost	29172	1167	11898	15313	794
Total Current Cost	69542	2267	25576	40019	1680
Vehicles, Lands, Buildings	17135	835	7562	7928	810
Instruments, Equipment, Software	31393	2018	22462	6353	560
Total Capital Expenditures	48528	2853	30024	14281	1370

Tab. 2A-23. 9 Uganda - Gross Domestic Expenditures on R&D by Type of Research in Ugandan Shilling (2014)

Gross Expenditures on R&D (GERD)		TOTAL	BE	GOV	HE	PNP
GERD by type of R&D	Current Costs & Capital Expenditures	118070	5120	55600	54300	3050
	Current Costs	69542	2267	25576	40019	1680
	Capital Expenditures	48528	2853	30024	14281	1370
Basic Research	Current Costs & Capital Expenditures	34489	686	15000	17539	1264
	Current Costs	20826	304	6900	12926	696
	Capital Expenditures	13663	382	8100	4613	568
Applied Research	Current Costs & Capital Expenditures	55666	2877	25700	25847	1242
	Current Costs	32830	1274	11822	19049	685
	Capital Expenditures	22836	1603	13878	6798	557
Experimental Development	Current Costs & Capital Expenditures	27915	1557	14900	10914	544
	Current Costs	15886	689	6854	8044	299
	Capital Expenditures	12029	868	8046	2870	245
Not elsewhere classified	Current Costs & Capital Expenditures	0	0	0	0	0
	Current Costs	0	0	0	0	0
	Capital Expenditures	0	0	0	0	0

CHAPTER 3: STATUS OF INNOVATION PERFORMANCE

3.1 Introduction

This chapter presents the status of innovation performance in the business sector, mainly focusing on manufacturing and services firms from 10 African countries during the period 2013-2015. The 10 countries, with a total of 321 million inhabitants, represent nearly a third of Africa's population and a total gross domestic product (GDP) of $630 billion in 2016 prices (OECD/Eurostat, 2005). While 10 countries do not accurately represent a continent of 55 countries, it is a reasonable number from which key lessons can be drawn.

The assessment of innovation at firm level gives a wide range of information that can be used to indirectly gauge the state of key aspects of innovation systems. While the previous chapter focused on the national R&D system, this chapter provides complimentary information on innovation activities such as capital expenditure on machinery and equipment, R&D and software, as well as expenditure on the acquisition and use of knowledge, product design, personnel training, pilot scale production, and market analysis from a firm-level perspective. The survey specifically looks at firms that introduced new products and processes, organisational and marketing innovations and other aspects such as challenges faced by firms and sources of useful information for innovations.

The chapter begins with the introductory section. The second section covers definitions and an overview of the innovation measurement. The third section gives the guidelines on measuring and interpreting the results and an overview of the sample. The remainder of the chapter presents the status of innovation performance in the business sector for 10 African countries, covering a three-year reference period between 2011 and 2016. This is achieved by addressing key policy-relevant questions. The fourth section attempts to answer the following question: To what extent are African firms innovative? The fifth section looks at the question: What are the different types of innovation? The sixth section provides highlights on the question: How do firms innovate? The section addresses this question through the following sub-questions: (1) How do firms implement and invest in innovation? (2) To what extent do innovative firms engage in R&D activity? The seventh section investigates the question: What are the impacts of innovation activities on firms? This is done by looking at the following sub-questions: a) How novel are product innovations by firms? (b) What are the outcomes of innovation? (c) To what extent are firms using intellectual property in their businesses? The eighth section examines the question: What factors promote innovation? This is done by addressing the questions: (i) What motivates firms to undertake innovation activities? (ii) Are the qualifications of employees and revenue favourable for firms to engage in innovative activities? (iii) What sources of information do firms draw on in order to innovate? The ninth section provides highlights on the question: What are the major factors that hamper innovation from the perspective of firms with innovation activities and firms without innovation activities?

3.2 Definition of Innovation and Guidelines on its Measurement

The innovation measurement puts firms at the centre of the innovation system in terms of building the technological and industrial foundation in all sectors of the economy – ranging from communication to finance; agriculture to manufacturing and education to health service firms. Although innovation occurs everywhere, it happens within a context and it means different things to different people: the farmer improving an irrigation system, breeding new varieties of crops and animals, the chef coming up with a new recipe, the hospital designing and using a new diagnosis or treatment procedure, and the engineer improving the landing gear for a plane. Due to the various perspectives on innovation a clear and shared understanding of what innovation entails will help countries, firms and individuals to devise means and ways of fully exploiting innovation for economic, social and environmental benefits.

According to the fourth edition of the ***Oslo Manual***, a business innovation is defined as "a new or improved product, or business process, (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm" (OECD/Eurostat, 2018:33, Para 1.30). However, an innovation in general refers to a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD/Eurostat, 2018:32, Para 25). The explanation of the generic term 'unit' contrary to a firm means that the actor responsible for innovations can be any institutional unit in any sector, including households and their individual members. The definition is appropriate for measuring innovation developed by individuals, a key goal identified at the 2016. Blue Sky Forum (OECD/Eurostat, 2018: 32, Para 26).

With the reduction of complexity allowing to not consider both organisational and marketing innovation in the latest edition based on evidences from cognitive testing work (OECD/Eurostat, 2018: 131, Para 1.32), in the context of this report, the definition used is derived from the third edition of the ***Oslo Manual*** (OECD, 2005) where innovation is still defined as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations." (OECD/Eurostat, 2005: 146-150). The hallmark of an innovation is that it must have been implemented. A new or improved product is implemented when it is introduced on the market or used by the firm (OECD/Eurostat, 2018: 68, Para 9)[8]. New or significantly improved processes by firms, and marketing or organisational methods are implemented when they are brought into actual use in the firm's operations. The act of introduction is defined as implementation and is the point in time when a significantly different product or business process is first made available for use. Firms will often make further adjustments to an innovation after its implementation (OECD/Eurostat, 2018:69).

Given the large number of terms used in describing innovation, it is important to note that innovation can affect business performance by either enhancing existing structures or improving internal operations, termed core innovations (Anthony et al., 2014), and can also generate new growth by reaching new customer segments or new markets, often via new business models, termed new growth innovations (Harrison et al., 2014).

Innovation activities are "all scientific, technological, organisational, financial and commercial steps which actually, or are intended to lead to the implementation of innovations" (OECD/Eurostat, 2005). Some of these activities are undertaken to implement different types of innovation. Some of the innovations may or may not, require R&D activities. For example, the acquisition of equipment and technologies to develop a novel platform for accelerated breeding of plant varieties. Although the platform development processes include aspects of novelty (i.e. the developed platform) and non-novelty (i.e. acquisition), the overall activities are non-R&D but are nevertheless important to realize the innovation.

The innovation survey questionnaire used by the 10 countries was inspired by EU Community Innovation Survey (CIS) Questionnaires for 2012 and 2014. The instrument collects data on general information about the firm such as the main business activity, age of firm, number of employees, total turnover, etc. This is followed by questions on whether the firm introduced a new or significantly improved product or process on to the market. These sections of the instrument also ask the respondent to indicate the novelty, origin as well as destination of their products or processes. Other parts of the instrument address questions about ongoing and abandoned innovation activities for new or significantly improved product or process, innovation activities and associated expenditures, sources of information for innovation, organizational innovation, marketing innovation, intellectual property, and reasons for innovation and barriers to innovation, among others.

The revised standard questionnaire for innovation survey used during ASTII Phase 3 is found on the AUDA-NEPAD website[9].

[8]The definition of innovation in the business sector in the fourth edition of the ***Oslo Manual*** is simpler.
[9]https://www.nepad.org/publication/model-questionnaire-national-innovation-surveys-astii

3.3 Guidelines on Interpreting the Innovation results

Given the wide differences in socio-economic conditions among the countries in the sample, among and between firms of varying sizes in different sectors, industries and markets, the results should be interpreted with caution. Although the different teams that collected the data may have a shared understanding of the importance of good quality data, the realities on the ground (e.g. resources, firm size, national interests and institutional beliefs, legal realities and understanding of questions) will always affect the quality of data collected. While efforts were devoted to collecting data of comparable quality and standard, a conclusion that firms in one country are more innovative than those in another country cannot be drawn.

In addition, measuring innovation is costly, and identifying the best instrument to collect innovation data is difficult from a cost-benefit perspective. Even where large firms have codified the processes and practices that drive their innovation, the culture of a firm and business environment that often drives innovation is difficult to measure. However, it is these aspects that often shape the decisions to invest limited resources (human, finance, time, networks, etc.) into innovation activities. The same aspects also underline the persistence of firms and their executives to nurture promising yet uncertain ideas and untested products. These uncertainties are relatively easier to manage for firms with past experiences in introducing innovations on the market. Such firms learnt valuable lessons navigating the complex legal and regulatory barriers and/or can also tap into existing and emerging networks. The firms can also minimize risks by forging strategic partnerships even with competitors to ensure success.

Most of the countries that participated in the research for the AIO-3 have limited experience in conducting innovation surveys. The most experienced, Egypt and Uganda, are in their third round of surveys while, for others such as Eswatini, it is their first. In this case, both the firms and the national teams conducting the survey have limited experience in completing and analysing responses to innovation survey questionnaires and data respectively. Given the circumstances, differences in survey instruments, sampling methodology and population of inference all undermine international comparisons and benchmarking of innovation indicators, as well as tracking performance across countries over time (Anthony, Duncan and Pontus, 2014). Thus, it is not possible to conclude that: (a) one country is more innovative than the other or (b) that firms in the same economy are becoming more innovative or not since there is limited longitudinal data to enable comparison over-time.

The above issue notwithstanding, significant insights can be drawn from the emerging data to inform policymakers, businesses, and heads of R&D institutions to design appropriate responses and strategies. More importantly, some of the team members that conducted surveys have also participated in targeted regional and national training on the analytical, theoretical and practical simulations of the real-world innovation surveys, methodologies and analysis to impart a minimum level of confidence in the findings. In addition, the national data presented was also discussed at regional level and the feedback helped country teams to validate the data or review and verify their data before submission. In some cases, country teams made requests for technical support from other national teams to collect and analyse the data (e.g. South African team supported Eswatini and Namibian teams). In future, it would be desirable to strengthen the capacity of more country teams who are directly involved in conducting national surveys.

The innovation survey results will among many other factors, present the rate of innovation in the countries that submitted full datasets, sources of relevant ideas and information for innovation, objectives for innovation, reveal the fundamental drivers of innovation at firm level, highlight the importance of support measures on innovation activities, reveal cooperation arrangements or strategic alliances for innovation, and identify key obstacles that discourage innovation in firms, among others. Some of these factors may be more pronounced in one country than the other due to differences in the innovation policy environment. Aspects such as partnerships, cooperation, networking, and innovation support activities may reveal insights that can be addressed at the national as well as regional level.

Such insights may be critical in increasing ***"knowledge about innovation in firms with a view to developing effective innovation policies"*** (OECD, 2010:11-17). To achieve this purpose, the data collected must be sufficiently disaggregated to bring out the reasons firms of different sizes and industry sectors choose to innovate, build relationships and interactions with key players in the innovation system, perform R&D, and offer education and training to their employees. These key tangible and intangible factors have an impact on the process of innovation and the performance of the firm.

3.3.1 Snap Overview of the Sample and Innovation Surveys for AIO-3

The innovation survey results presented from here-upon refer to the implementation of any new or significantly improved goods, services, processes, and organizational or marketing methods by firms in different sectors of the economy. All the countries surveyed firms with a minimum of 10 employees per firm.

About 6 343 sample firms were surveyed for a business sector target population of 74 902, in the 10 countries that submitted data. The highest number of sampled firms was from Egypt (3 000) while the smallest number was from Lesotho (56). For the realised sample firms, Seychelles had the least number of firms (15) and the highest was Egypt (2985) (see Table 3.1). Except for Cabo Verde, Ethiopia, Seychelles and Uganda, the results of the other 6 countries are not extrapolated to the targeted business sector population size.

Table 3. 1 Characteristics of the Innovation Surveys for AIO-3

Country	Reference period	Targeted business sector population size	Random stratified sample used (Yes/No)	Original sample size	Realized sample size	Extrapolation techniques used (Yes/No)	Number of completed returns obtained	Response Rate	Number of innovative firms in completed returns	Number of innovative firms in extrapolated sample	Percentage of innovative firms in extrapolated sample (%)
Angola	2013-2015	610	No	141	131	No	41		35	-	-
Cabo Verde	2012-2014	3067	No	201	201	No	201		120	120	3.9
Egypt	2012-2014	37848	Yes	3000	2985	No	2985		1123	-	-
Eswatini	2014-2016	528	Random Sampling	228	149	No	149		89	-	-
Ethiopia	2012-2014	10740	Yes*	1,402	1200	Yes	1200		794	6381	59.41
Kenya	2012-2014	18517	Yes	2000	700	Yes	376		167	†	†
Lesotho	2013-2015	56	Census	56	56	No	36		27	-	-
Namibia	2013-2015	68	Census	68	68	No	68		36	-	-
Seychelles	2013-2015	60	Yes	60	15	Yes	15		15	11	73
Uganda	2011-2014	6475	Yes	589	533	Yes	533		493	5973	77

† Unavailable Metadata

*1038 for Small and Medium enterprises and Census on 364 large enterprises

Source: ASTII Phase3 Surveys

The survey captured all the four types of innovation; product, process, organisational and marketing innovation. All four types of innovation are important in bringing a single successful innovation to fruition or in supporting a single innovative business operation. For instance, the successes of the Ethiopian Commodity Exchange and Kenyan MPESA are largely attributable more to organizational and marketing innovations than to the novelty of the technology employed. The same can be said of firms such as Amazon, Google and Uber which are defying sectoral boundaries because of their non-technological innovations that are as critical as the technological innovations to their business performance.

3.4 To what extent are African firms innovative

3.4.1 Are firms in Africa Innovative?

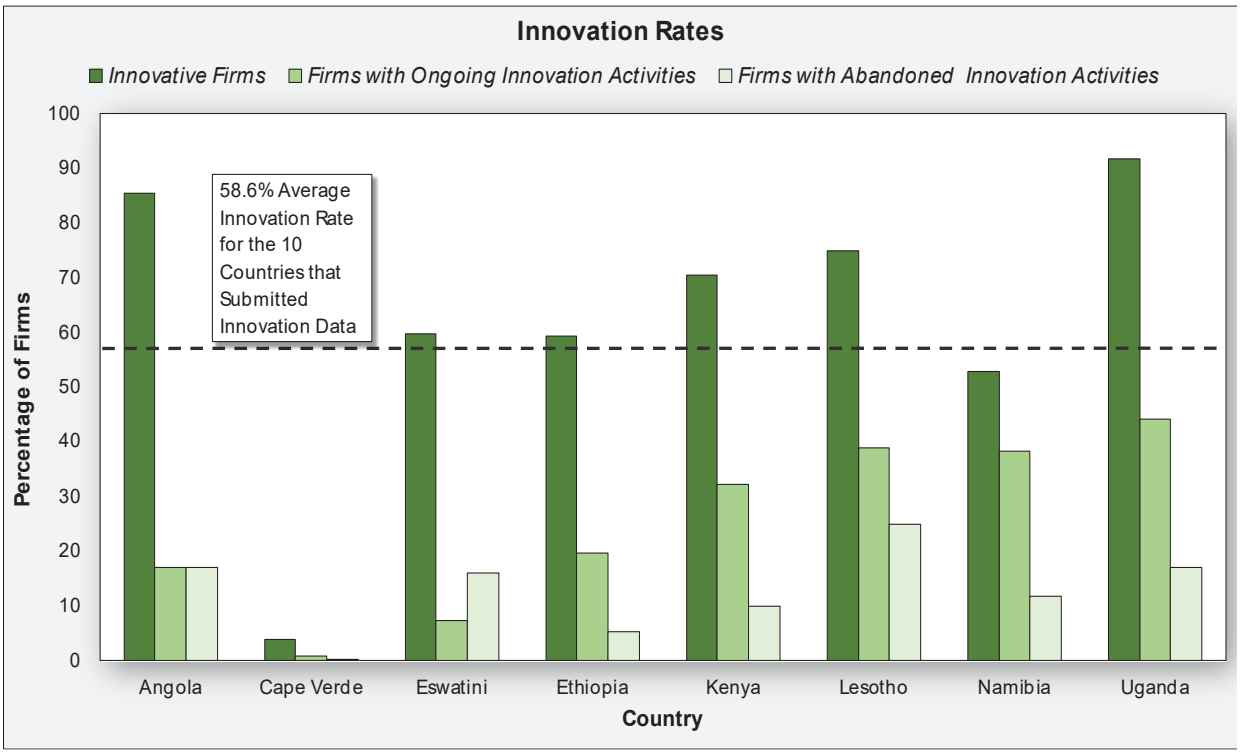
The innovation process varies by organization and within organizations, and also varies by product, sector and segment. Firms and entrepreneurs in general, continuously seek new ways to drive allocative efficiency and productivity growth. Empirical literature mainly based on data from OECD countries, documents a robust positive relationship between firm-level innovation and productivity (EU, 2017; Statistics New Zealand, 2005); innovation and employment; R&D and productivity; and innovation and profitability. In Latin America, linkages between innovation and productivity were previously reported (Crespi and Zuniga, 2012; Zuniga and Crespi, 2013; Crespi, Tacsir and Vargas, 2014) but outside Latin America there is limited evidence of the impact of innovation.

The impact of innovation on productivity was reported from the analysis of a large sample of countries from Sub-Saharan Africa, South Asia, Eastern and Central Europe and the Middle East (Xavier and Silvia, 2016). Of the total 6 343 firms surveyed in the 10 countries, 58.6% were innovative (see Figure 3.1). In brief, the innovation rate is the proportion of innovative firms (OECD/Eurostat, 2005: 47) expressed as a percentage of the total number of firms in the sample[10]. This refers to the total number of firms that introduced new or significantly improved product or a new or significantly improved process, organisation, or marketing method.

It is important to emphasize that innovation surveys treat several projects implemented by a firm (subject approach) and not as individual projects (object approach) (OECD/Eurostat, 2005: 20-21). Ongoing or abandoned refers to innovation activities that are in progress or were terminated for various reasons. As such, firms with ongoing or abandoned innovation activities could also have either product or process innovations or both during the reference period as shown in the case of Ethiopia (see Figure 3.1, Tables 3.2 and 3.3). To be more competitive, it is useful for firms to have an innovation strategy regardless of the number of successful innovation activities.

[10]This is a statistical sample that is suitably weighted to provide population estimates

Fig. 3. 1 Innovation Rates



The average innovation rate varies widely at the national level (see Figure 3.1 and Table 3.1 and Table 3.2 for details). As shown in Figure 3.1, the innovation rates for all the countries range from a low level of 3.9% for Cabo Verde to a high level of 91.7% for Uganda. Firms in Uganda reported more than 50%, except for Cabo Verde and Namibia. The innovation rates ranged from a low to the highest rate for ongoing innovation activities (44.0%), while Cabo Verde reported the lowest rate of 0.9%. In Lesotho, firms reported a 25% rate for abandoned innovation activities and in Cabo Verde the rate was 0.2%. Although the overall innovation rates are higher, the wide variations are not unique to African countries. The OECD (OECD, 2009) and EU[11] have observed similar wide variations among their countries. For instance, about 49% of the firms in EU-2018 were innovative but varied from 67% for Germany down to 12.8% for Romania.

Cabo Verde conducted purposeful sampling, whereby only 201 firms that had previously conducted innovation activities from a target population of 3 067 were surveyed (see Table 3.2). Of the 201 firms, 120 reported introducing new or significantly improved products on the market. 26 and 6 firms had ongoing and abandoned innovation activities respectively, with 49 non-responses. This explains why Cabo Verde had the lowest rate of ongoing and abandoned innovation activities. The rates for abandoned and/or ongoing innovation activities are high compared to those for the developed countries (Statistics New Zealand, 2005).

[11]EU (2017) Innovation statistics – Statistics explained (http://ec.europa.eu/eurostat/statistics-explained/pdfscache/1204.pdf)

Table 3. 2 Innovation Rate, Ongoing and Abandoned Innovation Activities

Country	Targeted business sector population size (a)	Innovative Firms[1]		Firms[2] with Ongoing Innovation Activities		Firms[2] with Abandoned Innovation Activities		Firms[2] with ONLY Ongoing Innovation Activities		Firms[2] with ONLY Abandoned Innovation Activities		Firms[2] with BOTH Ongoing and Abandoned Innovation Activities	
		(b)						(n)	*Percentage with respect to targeted business sector population size (%)*	(n)	*Percentage with respect to targeted business sector population size (%)*	(n)	*Percentage with respect to targeted business sector population size (%)*
Angola	41	35	85.4	7	17.1	7	17.1	†	†	†	†	†	†
Cabo Verde	3067	120	3.9	26	0.8	6	0.2	†	†	†	†	†	†
Egypt	2985	1123	37.6	†	†	†	†	†	†	†	†	1072	35.9
Eswatini	149	89	59.7	11	7.4	24	16.1	†	†	†	†	†	†
Ethiopia	10740	6381	59.4	2114	19.7	561	5.2	1738	16.2	185	1.7	376	3.5
Kenya	376	265	70.5	121	32.2	37	9.8	†	†	†	†	136	36.2
Lesotho	36	27	75.0	14	38.9	9	25.0	†	†	†	†	†	†
Namibia	68	36	52.9	26	38.2	8	11.8	†	†	†	†	†	†
Seychelles	15	11	73.3	11	73.3	4	26.7	†	†	†	†	†	†
Uganda	6475	5973	92.2	2872	44.4	1108	17.1	†	†	†	†	†	†

[1] These are firms that had product and/or process and/or organization and/or marketing innovation(s) for the referenced period
[2] The results presented are for both innovative firms (i.e., firms that had product and/or process and/or organization and/or marketing innovation(s) for the referenced period) and non-innovative firms
[3] These are the Innovation Rates for the ten countries
(n): Number of Firms
† Data was either not available or was not disaggregated

Table 3. 3 Disaggregated Data on Innovation Rate, Ongoing and Abandoned Innovation Activities by Product and Process Innovations for Ethiopia (see Table I in the Annexure for details)

Innovation Rates, Ongoing and Abandoned Innovation Activities	(n)	(%) with respect to targeted business sector size
All Firms	10740	100.00
Firms with Product Innovations	2545	23.70
Firms with Process Innovations	3208	29.87
Firms with ONLY Product Innovations	108	1.01
Firms with ONLY Process Innovations	149	1.39
Firms with BOTH Product and Process Innovations	1824	16.98
Non-Innovative Firms	4359	40.59

In general, innovative firms had higher turnover than non-innovative firms. The share of total turnover for innovative firms ranged from 59.5% for Namibia to 100% for Eswatini. The innovative firms in Uganda, Ethiopia and Kenya had high turnovers of 6.3, 4.3 and 1.7 billion PPPs, respectively. The high turnover was as a result of the size of firms, size of the economies and the industry sectors.

3.4.2 Innovation Rates by Firm Size and Industry Sector

3.4.2.1 Innovation Rates by Firm Size: Eswatini, Ethiopia and Uganda

This section presents the effect of firm size on the innovation rates for Eswatini, Ethiopia and Uganda. The size of the firm often represents the depth of resources available, its ability to compete globally, relationships with public institutions and agility or robustness. The larger the firm in a specific industry sector, the more likely it is to have highly skilled workers, large production networks and deep financial and technical resources. Smaller firms may be more agile, but they usually have limited internal resources. As such, size is often a determinant for economic performance of industries measured as employment growth, R&D intensity, and export diversity (Greve, 2008). Internally, large firms have more complex products and professional structures that may require a great number of resources, for example resources to perform R&D and to innovate. Externally, large firms have strong market power and have much influence on the diffusion of innovations.

Large and small firms differ not only in R&D productivity and investments but also in how they manage innovation. Large firms have been thought of as the main contributors to technological change processes. However, small firms are viewed as agents of change, creating technological diversity which stimulates productivity and innovation[12].

[12]McAdam, Rodney, et al. “Developing a model of innovation implementation for UK SMEs: A path analysis and explanatory case analysis.” International Small Business Journal 28.3 (2010): 195-214
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Table 3. 4 Innovation Rates for Eswatini, Ethiopia and Uganda by Main Firm Size Groups and Sub-Groups

Country	Number of Firms	Innovative Firms		Firms with Ongoing and/or Abandoned Innovation Activities	
Firm Size	N	n	%	n	%
ESWATINI					
Small (10-49)	80	40	50.0	3	3.8
Medium (50-249)	60	43	71.7	6	10.0
Large (≥ 250)	9	6	66.7	2	22.2
UGANDA					
Small (10-49)	5356	4884	91.2	3164	59.1
Medium (50-249)	926	896	96.8	623	67.4
Large (≥ 250)	193	193	100.0	193	100.0

Firm Size	N	n	%	Firms with Ongoing Activities		Abandoned Innovation Activities	
				n	%	n	%
ETHIOPIA							
Small (10-49)	7714	4418	57.3	1336	17.3	397	5.1
Medium (50-249)	2607	1633	62.6	548	21.0	106	4.1
Large (≥ 250)	419	330	78.8	230	54.9	58	13.8

Small firms consisting of 10-49 employees dominate the business sectors in Africa.

Data from the innovation surveys for Eswatini, Ethiopia and Uganda used in this Third Edition of the Outlook had an average of 60% small firms out of the total business sector target population. Specifically, small firms accounted for 54% of firms surveyed in Eswatini, 72% in Ethiopia, and 54% for Uganda.

Innovation Rate by Firm Size for Eswatini

The innovation rate for Eswatini by firm size is presented in Table 3.4. A total of 149 firms reported results on innovation for Eswatini of which 59.7% were innovative, and 7.4% reported ongoing and abandoned innovation activities (see Table 3.2).

The distribution of firms by size was 54% small-size, 40% medium-sized, and 6% large-size. The medium size firms reported the highest innovation rate of about 72%, followed by large firms at 67% and small firms at 50%. Similar to the case of Ethiopia an increase in firm size resulted in an increase in the share of ongoing and abandoned innovation activities. Specifically, only 4% of small firms and 10% of medium sized firms reported abandoned innovation activities compared to 22% for large firms. The ratio of successful innovations to abandoned and ongoing innovation activities is highest for large firms (67% to 22%), followed by medium-sized firms (72% to 10%) and small firms (50% to 4%). This observation may point to small firms having more efficient innovation processes than their larger counterparts or are strategic in selecting quick to market and less risky innovations.

Innovation Rate by Firm Size for Ethiopia

In Ethiopia the findings show that innovation rate improved with an increase in the size of the firm: 57% for small firms, 63% for medium and 79% for large ones. The innovation rate for large and medium firms was higher than the overall rate of 59%. Similar patterns were observed for the rate of ongoing innovation activities. Over half of the large firms had ongoing innovation activities at the

time of the survey. About a fifth of the medium-sized firms and less for the small firms pursued ongoing innovation activities. There is a 40% gap between firms that were innovative and those with ongoing innovation activities, mainly for small and medium-sized firms. In contrast, for large firms, the gap is only 24%. This observation may indicate differences in approach to the innovation process by firms of different sizes. Once again, it is observed that size plays an important role in determining the success of innovations.

Large firms may have a long-term strategy for investments in the innovation process (explaining the high levels of overlaps) while the smaller firms may opt for a short-term strategy due to limited resources, or age. This may also explain why, compared to 145 for large firms, small and medium-sized firms reported lower levels of abandoned innovation activities (4-5%). The smaller firms may be pursuing innovations that take a shorter run to the market and are less risky than large firms. More research is needed to get a full understanding of the observed differences.

Innovation Rate by Firm Size for Uganda

Uganda's innovation rate of 92% was the highest among the 10 countries that submitted data. Out of the 6 475 firms surveyed, 5 973 introduced a new or significantly improved product on the market or processed a new business or marketing model into use. The rates for ongoing and abandoned innovation activities were 44% (or 2 872 firms) and 17% (or 1 108 firms) respectively. However, 3 980 had ongoing and/or abandoned innovation activities representing a rate of 62%.

The rates for innovative firms and firms with ongoing and/or abandoned innovation activities were further disaggregated by firm size into small (10-49 employees), medium (50-249 employees), and large (≥ 250 employees). Specifically, there were 5 356 small firms, 926 medium-sized firms, and 193 large firms representing a share of 83% small, 14% medium and 3% large. The innovation rate increased with an increase in the size of firms ranging from 91% for small, 97% for medium and 100% for large firms. A similar pattern was evident for ongoing and/or abandoned innovation activities that ranged from small (59%), medium (67%) to large (100%) firms.

The share of abandoned and/or ongoing innovation activities is very high in large firms in Uganda probably because of a wider product range and associated processes for larger firms than in smaller firms. Given that large firms are likely to have more resources than smaller firms, they may be involved in risky and more complex innovation activities than smaller firms.

3.4.2.2 Innovation Rates by Industry Sector: Eswatini, Ethiopia and Uganda

This section discusses the patterns of innovation rates by industry sectors in Eswatini, Ethiopia and Uganda. It is also possible that differences in the diversity of industry sectors (and firms per sector), levels of competition, government regulations, customer demands and resources, may influence the rate of innovation reported. Sectors that are dominated by fewer firms (e.g. monopolies in energy, health and water sectors), rigid regulatory systems (e.g. transport), high competition (e.g. ICT and pharmaceuticals) and government subsidies (e.g. agriculture, education and health), among others, are likely to adopt different approaches to how they invest their limited resources in innovation activities.

The main aim here is to show the potential of industry sector innovations to African economies in order to deepen understanding of the nature, determinants and dynamics of sectoral performance. Such analysis would provide a clear picture of economic measures impacted on by sectoral innovations.

Despite the limitations in innovation measurement instruments and systems in place to capture high coverage data for detailed characterization of firms, the current data could provide useful insights into innovation rates for the main industry sectors[13] of the three countries.

Although the firm distribution by economic sector varied widely, the service sector constitutes the biggest share (47%) of the total business sector target population reported by the three countries. For instance, the service sector is about 68% of the firms surveyed in Eswatini, 31% in Ethiopia and 73% in Uganda. The manufacturing sector had the second largest share of 39% but also varied widely among the three countries. About 15% of the firms surveyed in Eswatini were in the manufacturing sector, 51% Ethiopia and 39% for Uganda.

The service sector in AU Member State economies is dominated by service industries which can potentially play a central and integral role in strengthening the innovation systems elsewhere (other economic sectors). Services are becoming an integral part of any manufacturing, agricultural and other industrial processes from production to distribution of products. This section deals with innovation rates of the main industry sectors and at the division level (manufacturing and services) for Eswatini, Ethiopia and Uganda.

Innovation Rate by Industry Sector for Eswatini

The main industry sectors for Eswatini were agriculture, representing 8% (11 firms) of the total targeted business sector population size, manufacturing, representing 15% (23 firms), construction representing 9% (13 firms), and the service sector representing 68% (102 firms) (see Table 3.5). The contribution to the total innovation rate for Eswatini (59.7%) by the type of industry sector was examined for innovative firms, as well as firms with ongoing and abandoned innovation activities (Table 3.5). The innovation rates for firms in agriculture (48%) and construction (38%) sectors were below the overall innovation rate of 59.7% for Eswatini. As observed earlier for Ethiopia, the highest contributor to the overall innovation rate for Eswatini was the manufacturing sector with an innovation rate of 78%. The innovation rate of 60% for the service sector was above the overall innovation rate for the country but was a greater influence on the national innovation rate given the large size of the sector.

In all four sectors, the rates for firms with ongoing and abandoned innovation activities were less than half the innovation rates. All 13 firms in the construction sector had no ongoing and abandoned innovation activities. Further analyses of the division level innovation rates for firms in the manufacturing and the service sector are presented since the two sectors together constitute 84% of the total targeted business sector. The divisions in the two sectors were classified using ISIC Revision 4.

The manufacturing sector is the second largest sector (i.e. 23 firms representing a share of 15%) out of the four sectors covered. The contribution of each of the ten divisions within the broad manufacturing sector of Eswatini to the total innovation rate of 78% of the sector were examined (Table 3.5 and the end of the chapter). Out of the ten divisions that made up the manufacturing sector for Eswatini, seven divisions reported 100% innovation rates for the sector.

[13]The analysis is at the division level within each sector of the firms (Division Level Classification in either ISIC Rev 3 or Rev 4) and not at principal activity level of the firms (Class Level Classification in either ISIC Rev 3 or Rev 4).

Table 3. 5 Innovation Rate for Firms in the Mining, Agriculture, Manufacturing and Construction Sectors for Eswatini, Ethiopia and Uganda (see Tables II-IV in the Annexure for details)

Industry Sector	Number of Firms	Innovative Firms		Innovative Firms		Innovative Firms		Innovative Firms	
	n	n	%	n	%	n	%	n	%
ESWATINI									
Agriculture	11	5	45.5					2	18.2
Manufacturing	23	18	78.3					7	30.4
Construction	13	5	38.5					0	0.0
Service	102	61	59.8					2	2.0
ETHIOPIA									
Mining	118	61	51.7	27	22.9	9	7.6		
Manufacturing	5438	3680	67.7	1444	26.6	520	9.6		
Construction	1866	955	51.2	250	13.4	16	0.9		
Service	3318	1685	50.8	393	11.8	16	0.5		
UGANDA									
Mining	53	53	100.0					18	34.0
Manufacturing	1285	1218	94.8					997	77.6
Construction	411	411	100.0					260	63.3
Service	4726	4291	90.8					2705	57.2

Although the number of firms in each division is small (in most cases 1 firm), it is important to note that most of the divisions that had 100% innovation rates also reported 100% rates for ongoing and abandoned innovation activities. These divisions are the manufacture of textiles, manufacture of paper and paper products, manufacture of coke and refined petroleum products, and manufacture of other non-metallic mineral products. Firms involved in the manufacture of beverages, rubber and plastics products, repair and installation of machinery and equipment and other activities in the manufacturing sector such as the manufacture of jewelry, sport goods, etc., did not report having ongoing and abandoned innovation activities.

The service sector constitutes 68% of the total targeted business sector population size for Eswatini. This is not unexpected given that the service sector accounts for about 50% of the GDP of Eswatini. The service sector reported 31 division levels out which 11 had innovation rates of 100%. The financial service sector reported the least innovation rate of 13%.

Only firms in the activities of membership organizations and firms in the travel and related activities sectors reported having ongoing and abandoned innovation activities with rates of 100% and 33%, respectively.

Innovation Rate by Industry Sector for Ethiopia

The 2012-2014 innovation survey for Ethiopia covered four main sectors, namely (1) Mining, consisting of 118 firms and representing 1% of the business sector; (2) Manufacturing, consisting of 5438 firms and representing 51% of the business sector; (3) Construction consisting of 1866 firms and representing 17% of the sector; and (4) Service consisting of 3318 firms and representing 31% of the

sector (see Table 3.5). The individual innovation rates for the sectors - mining (52%), construction (51%) and service (51%) were below the overall innovation rate of 59.4% for Ethiopia while that for the manufacturing sector (68%) was above the national average. The manufacturing sector was the main driver of the higher innovation rate of Ethiopia while the construction sector contributed the least.

In all the four sectors, the percentage of firms with ongoing and abandoned innovation activities was less than half the innovation rates. The mining sector reported 23% and 8% share of ongoing and abandoned innovation activities while the manufacturing sector reported 27% and 10%, respectively. The construction sector reported a share of 13% and 1% for ongoing and abandoned innovation activities. The service sector had the lowest share of 0.5% for abandoned innovation activities. Further analyses of division level innovation rates for firms in the manufacturing and the service sectors are presented since the two sectors together constitute 82% of the total targeted business population size. The divisions in the two sectors were classified using ISIC Revision 3.1 instead of the current ISIC Revision 4.

The manufacturing sector accounted for the highest number of firms in the survey, that is 5 438 firms, representing a share of 51%, and the highest innovation rate of all the sectors. To get a clear picture, the contribution of each of the seventeen divisions within the manufacturing sector in Ethiopia was analysed and is shown in Table 3.5. Out of the 17 divisions making up the manufacturing sector in Ethiopia, nine reported an innovation rate that was more than the manufacturing sector's average of 68%. The more technologically complex manufacturers reported higher innovation rates. For instance, the two firms in the manufacture of motor vehicles and trailers and the 10 firms in the manufacture of paper and paper products reported innovation rates of 100%, while 991 manufacturers of wood and wood products had an innovation rate of 90%.

The largest division in the manufacturing sector was the manufacture of furniture which reported an innovation rate of 61% (or 864 out of 1429 firms were innovative). The firms in the manufacture of coke, refined petroleum products, and the recycling industry, were non-innovative. Although the six firms in the recycling industry had no ongoing innovation activities, it is important to understand why all the six firms abandoned their innovation activities. Some highlights of probable reasons are provided in Section 3.9. The firm in the manufacture of coke and refined petroleum products had no ongoing or abandoned innovation activities.

The innovation rates for firms (including firms with ongoing and abandoned innovation activities) in the tanning and dressing of leather and manufacture of luggage industry were the second highest. The share of ongoing and abandoned innovation activities for firms in this division were 60% and 21%, respectively. Generally, the proportion of firms with abandoned innovation activities in the manufacturing sector was low. The main contributors to the overall 10% share of firms with abandoned innovation activities are; (a) firms in the manufacture of motor vehicles and trailers (100%), (b) firms in the manufacture of wearing apparel, dressing and dyeing of fur (29%), (c) firms in the manufacture of basic metals (27%), (d) firms in the tanning and dressing of leather and manufacture of luggage industry (21%) and (e) firms in the manufacture of chemicals and chemical products (14%). Section 3.9 highlights some of the likely reasons why firms in these sectors abandoned their innovation activities.

Firms in the manufacture of coke and refined petroleum products had 0% rates for innovation, ongoing and abandoned innovation activities. All 6 firms engaged in the recycling had abandoned activities.

The service sector is a major contributor to the GDP of countries worldwide. In the 2012-2014 innovation survey for Ethiopia, 3 318 out of 10 740 firms were in the service sector (Table 3.5). The largest number of firms are in (a) Hotels and restaurants (983 firms); (b) Retail trade and repair of personal and household goods (605); and (c) Sale, maintenance and repair of motor vehicles (416 firms) collectively accounting for 60% of firms in this sector.

The average innovation rate of firms in the service sector was reported at 50.8%. A detailed analysis revealed low innovation rates in (i) Firms in the supporting and auxiliary transport activities (0% for the 114 firms) and (ii) Activities of auxiliary to financial intermediation (3% or one out of the 34 firms). All firms in the computer and related activities (149); wholesale trade and commission trade (209); and undifferentiated service-producing activities (344); reported introducing a new or significantly improved product or used a new process during the referenced period. Firms in undifferentiated service-producing activities provide private households services such as cooking, teaching, and caring for household members and other services. The reported new or significantly improved products, processes or methods could include ways of managing internal operations to marketing and processes for managing external clients. Ethiopia is one of the African countries experiencing high economic growth and an in-depth understanding of the financial services is critical. Firms in the financial services and intermediation reported 94% innovation rate (30 out of the 34 firms surveyed were innovative).

The service sector had relatively low rates for firms with ongoing and abandoned innovation activities. Firms in the computer and related activities, and public administration and defence reported 100% rates for ongoing innovation activities. Firms in the financial service and intermediation sector reported a rate of 63% for ongoing innovation activities. Only four divisions, namely hotels and restaurants, post and telecommunications, financial intermediation and other business activities, reported having abandoned innovation activities.

Innovation Rate by Industry Sector for Uganda

The main industry sectors for Uganda surveyed are mining, consisting of 53 firms representing 1% of the total targeted business sector; manufacturing consisting of 1 285 firms and representing 20% of the sector; construction consisting of 411 firms and representing 6% of the sector; and the service sector consisting of 4 726 firms representing 73% of the sector. For details see Table 3.5. The contribution of the different industrial sectors to the overall innovation rate of Uganda (92.2%) was examined and the results are presented in Table 3.5. All the firms in the mining and construction sectors reported innovation rates of 100%. The innovation rates for the manufacturing and service sectors were 95% and 91% respectively. Compared to innovation rates in other developing countries, an innovation rate of 91% for 4 726 firms in the service sector is relatively high but lower than the national average.

The rates for ongoing and/or abandoned innovation activities are relatively higher for Uganda than Ethiopia and Eswatini. Apart from the mining sector which had a rate of 34% for ongoing and/or abandoned innovation activities, all the other 3 sectors had rates greater than half their innovation rates. Further analyses of division level innovation rates for firms in the manufacturing and the service sectors are presented since the two sectors together constitute 93% out of the total targeted business sector.

The manufacturing sector is the second biggest sector with 1 285 firms representing 20% of surveyed firms from the four sectors covered. The contribution of each of the sixteen divisions within the broad manufacturing sector in Uganda to the total innovation rate of 95% of the sector were examined (Table 3.5). Apart from firms in the manufacture of wood and wood products, manufacture of food products and manufacture of wearing apparel sectors, all other 13 divisions in the manufacturing sector had an innovation rate of 100%. All 144 firms in the manufacture of fabricated metal products and in the manufacture of furniture sectors reported introducing an innovation during the referenced period.

All firms in the manufacture of pharmaceuticals, paper and paper products, and in the printing and reproduction of recorded media sectors, reported having ongoing and/or abandoned innovation activities. On the other hand, firms in the repair and installation of machinery, the manufacture of transport equipment and machinery and equipment reported to having no ongoing and/or abandoned innovation activities. It is interesting that firms in the manufacture of wearing apparel had higher rate of 53% for ongoing and/or abandoned innovation activities than the industry's overall innovation rate of 47%.

The service sector constitutes 73% of the total targeted business sector for Uganda. The sector had 19 division levels out of which 11 had 100% innovation rates (Table 3.5). The division level innovation rates for the service sector are higher (with the least innovation rate of 80% for firms in computer programming, consultancy and related activities) than that of manufacturing, although the cumulative rate for the manufacturing sector is higher than the service sector. One of the key characteristics of firms in the service sector is the pervasiveness of ongoing and/or abandoned innovation activities. All firms reported having ongoing and/or abandoned innovation activities, except for firms in the electricity, gas, steam and air conditioning supply sector.

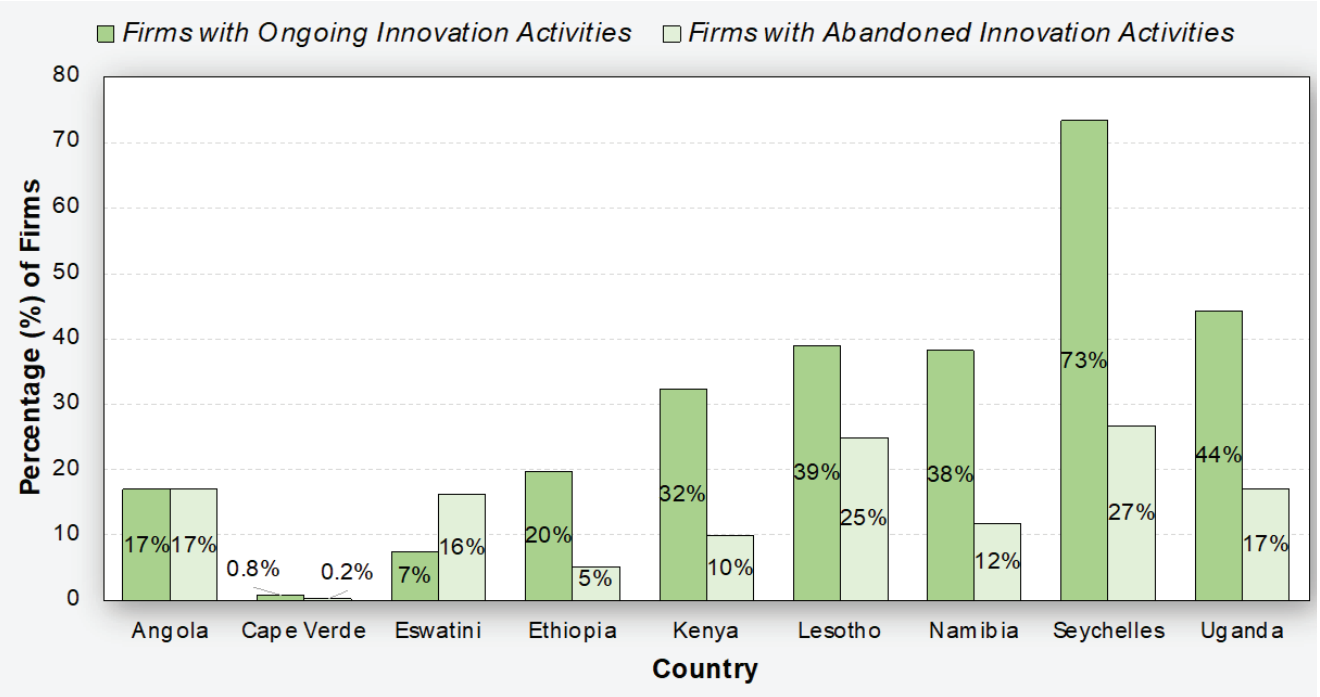
3.4.3 The innovation pipeline

Firms have an obligation to innovate and to remain competitive, and as a result healthy innovation outlook should have several firms whose process pipeline is characterized by a continuum of profitable projects and learning from some discontinued projects. A healthy innovation portfolio should therefore, have both ongoing and abandoned innovations to meet the ever-changing business environment (strategy, costs, regulatory hurdles, and competition).

The results show that most firms had more ongoing than abandoned innovation activities. The sample average had 17.9% of firms with ongoing innovations while 5.0% had abandoned innovations. At the national level, Seychelles recorded the highest share of firms with ongoing innovations (73.3%), followed by Uganda (44.1%), Lesotho (38.9%) and Namibia (38.2%), while Cabo Verde and Eswatini had the lowest of 0.8% and 7%, respectively (see Figure 3.2). The innovation pipeline results presented are for both innovative and non-innovative firms. Given that our results are not presented as innovation rate by the size of firm and industry sector for all the ten countries, a discussion of the specifics for each country cannot be presented. However, the disaggregated data and discussions on firm size and industry sector for Ethiopia, Eswatini and Uganda have been presented in Section 3.4. In highly regulated sectors such as mining, information technology, food and drinks, and the pharmaceuticals, innovations that are technically ready may take long to be deployed into the market.

It is important to note from figure 3.2 that 26.7% of firms in Seychelles have not been successful in securing effective innovation activities throughout the reference period followed by Lesotho with 25%, Ethiopia (5%) and Cabo Verde (0.2%) based on their target sample. Abandoned innovation activities may not fit in with the business strategy or be too radical to apply or too expensive to implement. However, those unsuccessful innovation activities may at a later point in time find suitable niches to thrive, or even be sold to other firms. Ultimately, finding the right context in which to apply and manage innovations towards the best outcomes is pivotal for business survival (Burnett, 2011).

Fig. 3. 2 **Innovation pipeline for Firms.**
NOTE: Egypt combined ongoing and abandoned innovations



3.5 What are the different types of innovation?

Africa has a stated ambition to become the next hub for manufacturing and value-addition in the world as their commitment to fulfilling Agenda 2063. The innovation survey results are presented as rate of the types of innovation undertaken by firms from the 10 countries. In order to provide a clear picture, we also present the innovation rate by type of innovation and size of firm for the countries that submitted full datasets. On average, more firms introduced product and process innovations than organizational and marketing innovations. However, out of all target firms involved in the innovation survey, Egypt reported more process innovations while Ethiopia recorded more marketing innovation activities. Overall, most countries largely reported on product innovations (Table 3.6 and 3.7).

Table 3. 6 Number of surveyed firms with and without innovation activity in ten countries

	Angola	Cabo Verde	Egypt	Eswatini	Ethiopia	Kenya	Lesotho	Namibia	Seychelles	Uganda
All Firms	**41**	**3 067**	**2 985**	**149**	**10 740**	**376**	**36**	**68**	**15**	**6 033**
Innovation-active Firms: [Innovative firms or Innovators + Ongoing and/or Abandoned]	**35**	**120**	**1 123**	**89**	**6 567**	**265**	**27**	**36**	**11**	**5 973**
Non-Innovative Firms	**6**	**2 947**	**1 862**	**60**	**4 173**	**111**	**9**	**32**	**4**	**60**

Table 3. 7 Types of Innovation reported by ten countries

	Angola	Cabo Verde	Egypt	Eswatini	Ethiopia	Kenya	Lesotho	Namibia	Seychelles	Uganda
Firms which Introduced new Goods/Services [Product Innovators or Innovative firms]	21	78	764	53	2 545	212	27	28	15	3 851
New Goods	16	-	739	23	1 990	160	16	19	4	2 511
New Services	15	-	25	30	551	142	11	21	10	3 385
Process Innovators or Innovative Firms	25	67	1027	55	3208	209	16	31	10	3948
Organisational Innovators:										
Business practices	17	53	-	45	2 466	161	12	0	7	3 417
Work responsibilities	21	39	-	65	2 975	239	20	30	8	4 112
External relations	13	17	-	34	1 963	143	15	21	5	2 835
Marketing Innovators:										
Significant changes to the design	13	32	-	44	3 511	156	12	22	6	2 370
New media or techniques	16	-	-	46	2 890	178	10	16	6	2 635
New methods for product placement	16	41	-	36	1 011	0	11	16	5	2 502
New methods of pricing goods	16	58	-	36	2 698	0	14	16	-	3 261

3.5.1 Product and process innovations

A closer look at product (goods and services) and process innovations suggests that process innovations were higher at 33.4% followed by product innovations separately presented as goods (21.6%) and as services (17.0%). However, wider differences were observed among countries (Tables 3.8 and 3.9). For instance, in Seychelles firms reported 66.7% of process innovations and 66.7% of service innovations and goods innovations were at 26.7%. On the other hand, Egypt and Ethiopia reported much lower innovation rates for services as compared to goods and processes. Similarly, firms in Lesotho pursued more innovations in goods (44.4%) and processes (44.4%) than in services (30.6%).

3.5.2 Organizational Innovation

In today's business world, firms secure their survival in a fiercely competitive environment by changing the way they do business at the right point in time. Like other institutions, firms continuously seek new or better ways of conducting their business activities (e.g. internal and external practices, interactions and relationships) to enhance their competitiveness. Most, if not all innovation activities in a firm are linked to the behaviour of employees and their employers. These new or improved ways of doing business enable the development of knowledge and continuous learning which positively impact on the firm's competitive advantage. The effects may include improved workflows, new ways of managing and implementing activities, improved transparency, improved customer service, and new offerings, among many others.

The results suggest that most of the organizational innovations were targeted at improving workplace responsibilities (e.g. new methods that enable workers to take on new work responsibilities, control functions) followed by new and improved business practices. Organizational innovations include workplace improvements. In today's business environment workplace improvements are critical to good performance and survival of business operations. Therefore, organizational innovations at firms encourage employees and their employers to see, think, learn and act in new ways, regardless of the challenges or opportunities they face. As shown in Table 3.8, Kenya and Uganda recorded the highest proportion of firms that undertook innovations related to workplace responsibilities (64%), while Uganda recorded the highest in terms of external relations (44%). Except for Cabo Verde, firms in all eight countries focused on introducing new work responsibilities.

Table 3. 8 Types of organisational Innovation reported in number of firms and percentage

Countries	Business practices		Work responsibilities		External relations	
	n	%	n	%	n	%
Angola	17	41,46	21	51,22	13	31,71
Cabo Verde	53	1,73	39	1,27	17	0,55
Ethiopia	2 466	22,96	2 975	27,70	1 963	18,28
Kenya	161	42,82	239	63,56	143	38,03
Lesotho	12	33,33	20	55,56	15	41,67
Namibia	0	0,00	30	44,12	21	30,88
Seychelles	7	46,67	8	53,33	5	33,33
Eswatini	45	30,20	65	43,62	34	22,82
Uganda	3 417	52,45	4 112	63,12	2 835	43,51

3.5.3 Marketing innovations

According to Peter Drucker[14] "because the purpose of business is to create a customer, the business enterprise has two-and only two-basic functions: marketing and innovation". Therefore, marketing innovations are intended to come up with smarter ways of solving problems for customers, meeting market needs, and making profit for the business. Marketing is key to ensuring that new methods of commercialisation are implemented to either meet the needs of customers or generate a new market. Thus innovations, depending on the industry type, may include new and significantly improved packaging, presentation, promotion, pricing and channels to reach or attract new customers. The availability of self-service tools such as social media for designing novel and captivating marketing campaigns can reduce both the required technical skills and costs. In this section, the extent to which firms invested resources to come up with new or improved marketing methods is presented.

Focusing on new or significantly improved designs, product placements, and techniques and methods for pricing goods, it was observed that firms in the surveyed countries paid special attention to different marketing approaches. This may reflect the wide differences in the nature of businesses and sectors of the countries surveyed. In general, new methods of product placement were lower than design methods and pricing.

At the national level, Kenya reported the highest proportion of firms using new techniques and media for marketing (47.3%), while Namibia scored the highest firms that introduced design changes (42.4%) (Table 3.9). Similarly, 50.4% of Ugandan firms introduced new innovations for pricing and Angola had the highest firms (39.0%) that implemented innovations for product placement.

Table 3. 9 Types of marketing Innovation reported in number of firms and percentage

Countries	Significant changes to the design		New media or Techniques		New methods for product placement		New methods of pricing goods	
	n	%	n	%	n	%	n	%
Angola	13	*31,71*	13	*39,02*	13	*39,02*	13	*39,02*
Cabo Verde	32	*1,04*	0	-	41	*1,34*	58	*1,89*
Eswatini	44	*29,53*	46	*30,87*	36	*24,16*	36	*24,16*
Ethiopia	3 511	*32,69*	2 890	*26,91*	1 011	*9,41*	2 698	*25,12*
Kenya	156	*41,49*	178	*47,34*	0	-	0	-
Lesotho	12	*33,33*	10	*27,78*	11	*30,56*	14	*38,89*
Namibia	22	*32,35*	16	*23,53*	16	*23,53*	16	*23,53*
Seychelles	6	*40,00*	6	*40,00*	5	*33,33*	0	-
Uganda	2 370	*36,38*	2 635	*40,45*	2 502	*38,40*	3 261	*50,05*

[14]https://www.readytalk.com/blog/dan-king/growth-through-marketing-and-innovation-how-peter-drucker-shaped-readytalk

3.6 How do firms innovate?

3.6.1 How do firms implement and invest in innovation?

In order to bring new ideas and concepts to market, firms may have to invest in a variety of areas. One of the key innovation-supporting activities is R&D that is aimed at generating new knowledge and insights to competitively bring an innovation to market. To successfully bring new products and processes to market may entail investment in equipment and facilities, training of workers, new marketing campaigns, staff and licensing of intellectual property owned by others. Most firms surveyed in the countries spent money on the acquisition of equipment and machinery to support innovation (Table 3.10).

Namibia was the only country where more than 50% of the firms engaged in R&D activities in support of innovation. It is interesting to note that at least there were firms in all countries, except Cabo Verde, that engaged in R&D activities to support innovation. All these supporting activities are important to introduce an innovation on a market. For instance, there is a plethora of mobile applications for money transfer, hailing a taxi and making calls and yet newcomers such a MPESA, Uber and WhatsApp, respectively, have succeeded and overshadowed some technologically advanced incumbents to become the standard bearers.

Table 3. 10 : Expenditures on Innovation Activities in percentage

	Egypt	Eswatini	Ethiopia	Kenya	Lesotho	Namibia	Uganda
Intramural R&D	8,04	14,77	18,50	26,21	14,02	26,11	8,66
Extramural R&D	1,51	6,66	3,68	15,43	0,25	26,84	19,33
Acquisition of equipment, machinery	58,00	41,85	66,69	39,89	80,30	37,49	64,25
Acquisition of software	0,00	10,11	0,00	0,00	0,00	0,00	0,00
Acquisition of other external knowledge	7,18	1,69	11,13	18,47	5,42	9,55	2,11
Training	14,48	24,92	0,00	0,00	0,00	0,00	0,00
Market Introduction	10,80	0,00	0,00	0,00	0,00	0,00	0,00
Design	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Other activities	0,00	0,00	0,00	0,00	0,00	0,00	5,64
Total	100,00	100,00	100,00	100,00	100,00	100,00	100,00

An improved understanding of where the firms are allocating most of their resources in bringing innovation to the market could be helpful for investors, policy makers and decision makers. In general, acquisition of machinery is the most cited expense in the process of innovation, followed by R&D expenditures and acquisition of external knowledge from others. Governments wishing to encourage firms to undertake innovation activities may opt to support the acquisition of capital goods and knowledge assets by funding R&D or providing incentives (e.g. R&D tax rebates).

3.6.2 To what extent do innovative firms engage in R&D activity?

In this section we present the results on the share of innovative firms that were engaged in R&D activities to support innovation. On average, an estimated 80% of the innovative firms in Cabo Verde, Ethiopia and Kenya did not engage in any R&D activities (for details see Table 3.11). Most innovative firms in Namibia (52%) and Seychelles (55%) engaged in R&D activities to support innovation. Overall, the firms in the eight countries presented in this section were innovative without engaging in R&D activities to support the innovation.

Table 3. 11 Proportions of Innovative Firms that Engaged in R&D Activities

Countries	Intramural (in-house) R&D		Innovative Firms WITH R&D Activities		Innovative Firms WITHOUT R&D Activities	
	n	*%*	*n*	*%*	*n*	*%*
Cabo Verde	7	*5.8*	7	*5.8*	113	*94.2*
Ethiopia	586	*8.9*	586	*8.9*	5795	*91.1*
Eswatini	23	*25.8*	23	*25.8*	66	*74.2*
Kenya	59	*22.3*	59	*22.3*	206	*77.7*
Lesotho	7	*26*	13	*48.2*	14	*51.9*
Namibia	19	*52.8*	19	*52.8*	17	*47.2*
Seychelles	6	*54.6*	6	*54.6*	5	*45.5*
Uganda	2364	*39.6*	2364	*39.6*	3609	*60.4*

3.7 What are the impacts of innovation activities on firms?

3.7.1 How novel are the product innovations by firms?

The new ***Oslo Manual*** (OECD, 2018) defines novelty as follows:

"The novelty of an idea, model, method or prototype is linked to its potential uses, as determined by the characteristics of a product or process compared to alternatives, and by the previous experiences of its provider and intended users" (OECD/ Eurostat, 2018:46, Para 17).

The more novel a type of innovation is, the more it will run counter to systems and processes designed to strengthen and support the current business performance (Table 3.12). Firms need to have processes in place that link their different types of innovation to their short and long-term goals. Therefore, some of the key questions that need to be addressed are: 'How novel or unique are the innovations that were reported by firms and how the innovations were distributed by size of firm and industry type?'

Novelty is hard to determine, let alone compare among firms. For the purposes of this report, novelty is understood in terms of whether the innovation is new to the firm or new to the market. The newness of the innovation to the world is not considered in this report. The results of novelty on product innovations in parts of Table 3.12 showed that most firms from Kenya (64%), Lesotho (56%) and Ethiopia (30%) introduced products that were new to the firms. However, a substantial proportion of the firms from Kenya (35%), Lesotho (33%) and Ethiopia (11%) also had new or significantly improved products introduced to their markets. Ethiopia reported a high percentage of 59% of firms with unchanged products, while Kenya and Lesotho registered 1% and 11% respectively.

Table 3. 12 Innovation Novelty Assessment of Firms that Introduced New Goods/Services

Countries	New to Firm	New to Market	Unchanged or Only Marginally Modified	Total Firms that Introduced New Goods or Service
Ethiopia	768	282	1 495	2 545
Kenya	169	93	3	265
Lesotho	15	9	3	27

3.7.2 What are the outcomes of innovation?

Did the innovations that the firms brought to market meet the expected outcomes and impact on firm performance and standing in the marketplace? As noted earlier, firms pursued innovations for a range of objectives and motivations. This section will reveal the major impacts reported by firms. In addition, what were the major challenges that firms faced in bringing new innovations to market? These factors may be discouraging firms to innovate.

In terms of product innovation, the main impact of innovation is an increased range of goods and services and improved quality (Table 3.13). Some national differences were observed. For instance, more firms in Eswatini reported that product innovation helped them to expand their market share than those who reported improved quality. Innovative firms in Lesotho generally reported a higher impact of product innovation than innovative firms in the other countries.

Table 3. 13 Effects of product innovation implemented by Innovative firms

Countries		Increased range of goods	Entered new market*	Increased market share	improved quality goods or services†
Angola	n	17	7	11	18
	(%)	*(48,57)*	*(20,00)*	*(31,43)*	*(51,43)*
Cabo Verde	n	4	2		5
	(%)	*(3,33)*	*(1,67)*	-	*(4,17)*
Egypt	n	770	515		696
	(%)	*(68,57)*	*(45,86)*	-	*(61,98)*
Eswatini	n	32	29	36	22
	(%)	*(35,96)*	*(32,58)*	*(40,45)*	*(24,72)*
Ethiopia	n	1 876	1 705	1 580	2 276
	(%)	*(28,57)*	*(25,96)*	*(24,06)*	*(34,66)*
Kenya	n	139	72	93	163
	(%)	*(52,45)*	*(27,17)*	*(35,09)*	*(61,51)*
Lesotho	n	23	19	18	18
	(%)	*(85,19)*	*(70,37)*	*(66,67)*	*(66,67)*
Namibia	n	14	5	7	18
	(%)	*(38,89)*	*(13,89)*	*(19,44)*	*(50,00)*
Seychelles	n	6	3	3	8
	(%)	*(54,55)*	*(27,27)*	*(27,27)*	*(72,73)*
Uganda	n	2 228	1 557	1 674	2 500
	(%)	*(37,30)*	*(26,07)*	*(28,03)*	*(41,86)*

(*) including market share for Egypt
(†) including Flexibility of product provision for Egypt

Process innovations however, had a greater impact on improving production capacity and flexibility in almost all the countries. Although there are national differences in terms of the proportion of innovative firms in the countries that reported innovation having an impact, more firms reported a high impact of product innovation on firm performance as measured here than process innovation. Eswatini stands out in this case as more of its firms reported a high impact of process innovation of firm performance as measured than that of product innovation.

3.7.3 To what extent are firms using intellectual property in their business?

The process of innovation may include the use of intellectual assets owned by others but is also likely to generate new knowledge, processes and products that can be protected using a variety of intellectual property rights. Firms will generally guard such intellectual assets, against free use by others, to enable them to recoup their investment in innovation support activities such as R&D, new business models and applications. In this section, intellectual property is seen as one of the outcomes, impacts or by-product of the process of innovation (Table 3.14).

The trademarks were the most sought-after form of intellectual property rights for the firms in all the countries whether they were innovative or not, followed by industrial designs and copy rights. Patents were sought after mostly by firms in Lesotho (19.4%); Angola (14.6%); Kenya (12.0%); and Eswatini (11.4%) and least in Cabo Verde (0.2%). Lesotho stands out in terms of copy rights claimed (30.6%) – which is about three times higher than the second country (Eswatini at 10.1%). In general, innovative firms sought after most of the intellectual property rights reported than non-innovative firms (e.g. Kenya).

Table 3. 14 **Firms with Intellectual Properties.**

NOTE: Egypt and Uganda were not included here because they did not submit data on Intellectual Properties

Firms with Intellectual Properties													
Country	Total Number of Firms (*n*)	Secured patent in own country		Applied for patent outside of own country		Registered an industrial design		Registered a trademark		Claimed copyright		Granted a licence on any IP resulting from Innovation*	
		n	%	*N*	%	*n*	%	*n*	%	*n*	%	*n*	%
Angola	41	6	14.6	1	2.4	1	2.4	8	19.5	1	2.4	1	2.4
Cabo Verde	3067	6	0.2	2	0.1	4	0.1	12	0.4	0	0.0	7	0.2
Eswatini	149	17	11.4	11	7.4	7	4.7	14	9.4	15	10.1	7	4.7
Ethiopia	10740	983	9.2	82	0.8	374	3.5	2258	21.0	350	3.3	287	2.7
Kenya	376	45	12.0	15	4.0	34	9.0	69	18.4	27	7.2	24	6.4
Lesotho	36	7	19.4	2	5.6	6	16.7	13	36.1	11	30.6	5	13.9
Namibia	68	6	8.8	3	4.4	6	8.8	14	20.6	5	7.4	5	7.4
Seychelles	15	1	6.7	0	0.0	0	0.0	2	13.3	0	0.0	1	6.7

* Trade secret for Cabo Verde

3.8 What factors promote innovation?

3.8.1 What motivates firms to undertake innovation activities?

There are several reasons why firms invest their limited resources in innovation. Simply defined as creating value from ideas, profit is perhaps the most obvious but not the only reason. Such value may be in meeting legal and regulatory requirements (e.g. improved packaging that limits use of chemicals in preserving food), enhanced safety (e.g. of workers in a factory), environmental credential (e.g. car emissions and fuel efficiency), compassion (e.g. wheelchairs, automatic cars and touch screens) and health issues (e.g. cheaper sanitary pads and mosquito nets for the poor), among many others reasons. It is therefore important to understand what drives African firms to invest their resources in innovation.

Table 3. 15 Objectives motivating Innovations in Firms: number of firms and their percentage

Objectives		Ethiopia	Kenya	Lesotho	Namibia	Seychelles	Eswatini	Uganda
Increased range of products	n	2 139	158	23	19	7	32	2 370
	(%)	*(32,57)*	*(59,62)*	*(85,19)*	*(52,78)*	*(63,64)*	*(35,96)*	*(39,68)*
Replaced outdated products	n	1 992	105	0	13	7	22	1 579
	(%)	*(30,33)*	*(39,62)*	*(0,00)*	*(36,11)*	*(63,64)*	*(24,72)*	*(26,44)*
Entered new market	n	2 157	118	19	16	6	29	1 509
	(%)	*(32,85)*	*(44,53)*	*(70,37)*	*(44,44)*	*(54,55)*	*(32,58)*	*(25,26)*
Increase market share	n	1 868	128	20	14	4	36	1 784
	(%)	*(28,45)*	*(48,30)*	*N/A*	*(38,89)*	*(36,36)*	*(40,45)*	*(29,87)*
Improve quality	n	2 260	181	23	24	10	22	2 704
	(%)	*(34,41)*	*(68,30)*	*(74,07)*	*(66,67)*	*(90,91)*	*(24,72)*	*(45,27)*
Improve flexibility	n	1 406	134	23	22	7	29	1 882
	(%)	*(21,41)*	*(50,57)*	*(85,19)*	*(61,11)*	*(63,64)*	*(32,58)*	*(31,51)*
Increase capacity	n	1 671	147	21	19	8	29	1 753
	(%)	*(25,45)*	*(55,47)*	*(85,19)*	*(52,78)*	*(72,73)*	*(32,58)*	*(29,35)*
Reduce production	n	1 283	101	21	14	7	22	1 212
	(%)	*(19,54)*	*(38,11)*	*(77,78)*	*(38,89)*	*(63,64)*	*(24,72)*	*(20,29)*
Improve working conditions	n	1 242	123	16	17	9	21	1 546
	(%)	*(18,91)*	*(46,42*	*(77,78)*	*(47,22)*	*(81,82)*	*(23,60)*	*(25,88)*

As shown in Table 3.15, improving the quality of the product seems to be a major target for firms that innovate across all countries except for Eswatini where increasing the range of products is a major driver. These are closely followed by increased capacity and range of goods and entry into new markets. The differences between countries may be related to differences in the industries that were sampled (e.g. over half of the firms sampled in Eswatini were from the textile industry). Differences in domestic market conditions for example increased market share is important for Ethiopia) and meeting domestic regulations (e.g. improving working conditions is important for Seychelles – a high income country. Understanding the factors that encourage innovation at firm level is particularly key to designing measures that may spur further innovation in areas of interest such as opening new markets, improving working conditions, enhancing environmental sustainability and diversifying the economy.

3.8.2 Are the qualifications of employees and revenue favorable for firms to engage in innovation activities?

The workforce is one of the main assets that is critical for a firm to develop and implement new or significantly improved products or use new processes. In a way, the knowledge base of the firm is strongly related to its workforce experience, education and skills. The workforce participates in the sourcing of new ideas from within and outside the firm, and ways to implement the ideas. The innovation survey results on the composition of the workforce by headcount and qualifications for innovating and non-innovating firms is stated in Table 3.16.

Table 3. 16 Ratio of employees with degrees/diploma per firm

	Egypt	Ethiopia	Kenya	Lesotho	Namibia	Eswatini	Uganda
With innovation	24.6	0.7	38.9	0.7	41.1	135.2	1.0
Without innovation	4.5	0.7	12.6	0.8	24.1	112.6	0.4

Table 3.17 Employees with degrees/diploma per total employees

	Egypt	Ethiopia	Kenya	Lesotho	Namibia	Eswatini	Uganda
With innovation	4.2	112.1	5.5	26.9	7.6	1.0	56.6
Without innovation	7.1	79.3	4.7	25.6	9.1	0.6	48.8

In general, innovative firms had more employees with higher education qualifications per firm than non-innovative firms, except for Ethiopia and Lesotho where the numbers are even. The widest gap in employees per firm with diplomas and degrees between innovative and non-innovative firms was observed in Egypt (about five times) followed by Kenya and Uganda (about 3 times) (Table 3.17). The innovative firms had a higher concentration of highly educated staff per firm. In terms of size, Eswatini had the highest number of employees with degrees, or diplomas, followed by Namibia, Kenya and Egypt.

While one cannot conclude that firms that had more employees with diplomas, or degrees, are more innovative than those with less, innovative firms collectively employed more educated workers per firm. The number of workers with diplomas and degrees as a proportion of the total employees does not give any clear pattern, except for Ethiopia (Table 3.18).

Table 3.18 Percentage Distribution of Firms' Turnover and Staff Qualifications

Country	Turnover for Innovative Firms as % Total Turnover	Turnover for Non-Innovative Firms as % Total Turnover	Innovative Firms: Number Staff with Degree/Diploma		Non-Innovative Firms: Staff with Degree/Diploma	
			Number (n)	Percentage (%)	Number (n)	Percentage (%)
Ethiopia	84.1	15.9	4642	57.6	3419	42.4
Kenya	96.3	3.7	10298	88.0	1403	12.0
Lesotho	75.0	25.0	20	74.1	7	25.9
Namibia	59.5	40.5	1481	65.7	772	34.3
Eswatini	99.9	0.1	12031	64.0	6757	36.0
Uganda	97.1	2.9	6144	97.0	190	3.0

3.8.3 What sources of information do firms draw in order to innovate?

The innovation activities of a firm depend in part on the variety and structure of the firm's links with sources of information, knowledge base, technologies, practices and human and financial resources (OECD/Eurostat, 2005: 76). Firms are in different market environments and they need to respond to this context, in a way to shape the firm's innovation performance. Therefore, identifying the firm's sources of information that are important for innovation is key. For a firm, being present within a given location is not enough for the firm to absorb and use the information from other actors in the same environment: some form of learning must occur, either deliberately or unintended. There are different types of innovations namely product (good or service), process, organizational and marketing. Depending on the firm's strategic orientation it may require different types of information and its use to come up with different types of innovation (Ritala et. Al, 2013). Therefore, an innovation may be based on information from several sources selected based on the nature of the firm such as high-tech firms which are mostly linked with R&D institutions (Todtling, Lehner and Trippl, 2006), firm's innovation ambition (Schmidt, 2010) and complexity of innovation activities among many other factors (Oerlemans, Meeus and Boekema, 2001).

In general, the sources of information may be individuals (internal or external to the firm), teams, research findings, media, suppliers, customers, universities and competitors. While the source of information that instigated the innovation is important, it also reveals relationships, interactions and linkages between the innovative firms and the sources, and the relevance of the source. In which case, sources that are rated as important may be excelling in their quality of work and outreach, especially for the publicly funded organizations.

Sources of information are important for the innovation processes implemented and managed by business enterprises. For the 10 countries that submitted data on innovation, data provided by firms reveal that most innovative firms relied on their own internal sources of information to innovate (Table 3.19). Findings show that Lesotho (63%), Uganda (45%), Kenya (44%), Angola (41.5%) and Eswatini (34.2%) stand out in using sources of information that are internal to the firms as per the indicated percentages. This is probably easy because the information is freely accessible and some of it may be part of tacit knowledge among employees. Under the external sources of information, a significant number of firms in Lesotho (55.6%) and Seychelles (40%) reported utilizing information they get from suppliers of equipment. This is sometimes part of bulk purchasing of equipment for diagnostic laboratories or some equivalent setup that comes with training as a procurement package. Firms in Lesotho (69.4%), Seychelles (53.3%) and Kenya (35%) find the information that they obtain from their customers important for innovation. It is important to note that Lesotho scored highly across all sources of information. This may mean that the firms regard the sources of information equally important or may reflect differences in the relationships and interactions (e.g. contract manufacturer may be more open to all sources of information to inform the innovation).

No country surveyed for this indicator had 50% or more of the firms rating consultants, universities or technical colleges, and government public research institutions as important sources of information for their innovation. Universities and government public research institutions are particularly rated low by firms from all the ten countries. This is an important result for the much talked about university-industry linkages and the increased investment in R&D. This is a policy information that shall allow respective governments to request universities to provide solutions to various challenges that firms are experiencing in willing to improve existing products, process and both organisational and commercialisation methods.

Table 3.19 Source of Information for Innovation by Firms

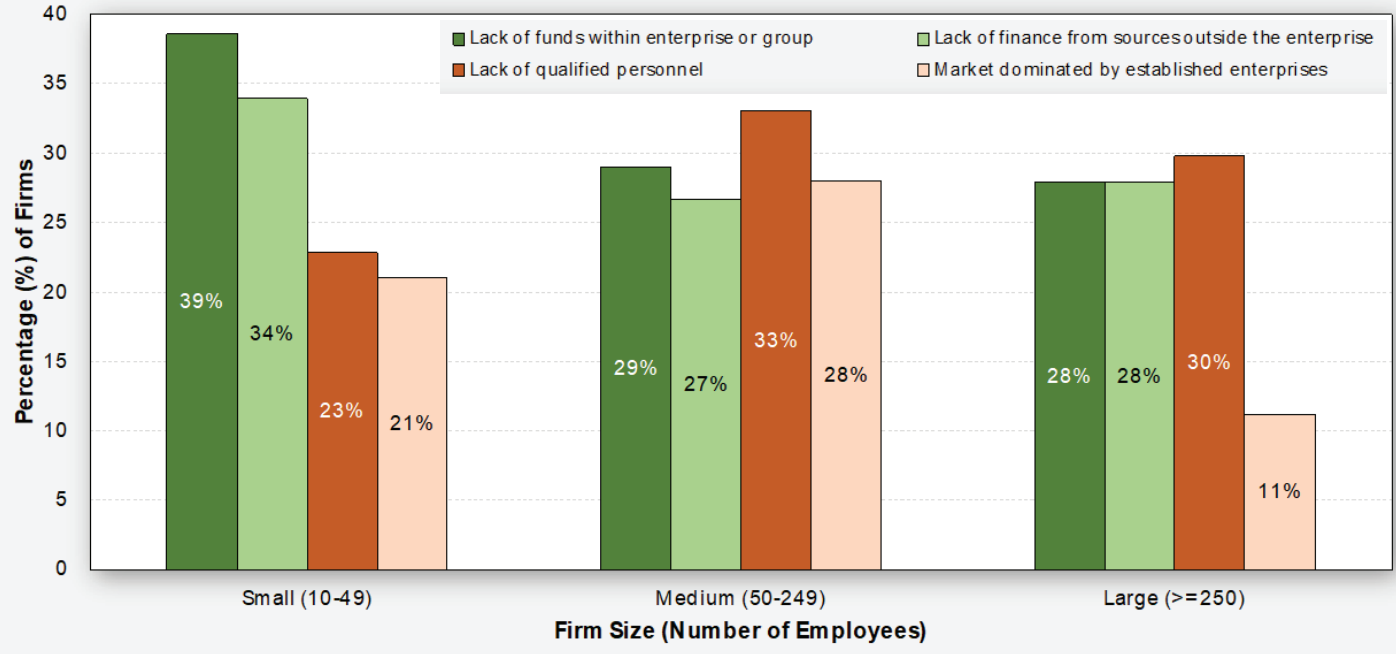
		Source of Information for Innovation																			
	Total Number of Firms	Internal Source		External Sources (Market)								External Sources (Institutional)				External Sources (Other)					
		Sources within Firm		Suppliers of equipment		Clients/Customers		Competitors		Consultants		Universities/ Tech		Government/ PRI		Conferences		Sci Journals		Professional associations	
Country	(*n*)	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Angola	41	17	41.5	12	29.3	11	26.8	4	9.8	3	7.3	1	2.4	4	9.8	6	14.6	3	7.3	2	4.9
Cabo Verde	3067	16	0.5	11	0.4	10	0.3	7	0.2	1	0.0	1	0.0	1	0.0	2	0.1	3	0.1	1	0.0
Egypt	2985	736	24.7	411	13.8	324	10.9	199	6.7	59	2.0	27	0.9	25	0.8	159	5.3	113	3.8	38	1.3
Eswatini	149	51	34.2	36	24.2	36	24.2	27	18.1	25	16.8	13	8.7	17	11.4	12	8.1	7	4.7	15	10.1
Ethiopia	10740	3 038	28.3	1 330	12.4	2 465	23.0	1 133	10.5	222	2.1	198	1.8	268	2.5	833	7.8	331	3.1	198	1.8
Kenya	376	169	44.9	108	28.7	134	35.6	77	20.5	45	12.0	36	9.6	48	12.8	73	19.4	41	10.9	58	15.4
Lesotho	36	23	63.9	20	55.6	25	69.4	19	52.8	13	36.1	12	33.3	16	44.4	18	50.0	19	52.8	18	50.0
Namibia	68	21	30.9	17	25.0	12	17.6	8	11.8	9	13.2	3	4.4	1	1.5	5	7.4	4	5.9	6	8.8
Seychelles	15	5	33.3	6	40.0	8	53.3	2	13.3	3	20.0	0	0.0	1	6.7	4	26.7	3	20.0	3	20.0
Uganda	6475	2921	45.1	1451	22.4	1 243	19.2	1 492	23.0	758	11.7	519	8.0	500	7.7	850	13.1	608	9.4	730	11.3

It is equally important to know if the source of information that inspired the innovation was domestic, regional or global. The location of the source often reveals the trade, investment and industrial relationships between domestic firms and other players. For export-oriented or countries that wish to encourage exports, sources of information about overseas markets may be key in informing domestic firms of new policies and regulatory developments, as well as the changing consumer preferences. The geographical location of the sources of information may also be useful to policy makers and business service providers in developing support mechanisms.

3.9 What are the major factors that hamper innovation?

The data on factors impeding innovation is presented as sorted frequency distribution of respondents. When a few factors obstructing innovation are presented disaggregated by firm size, the results are shown in Figure 3.3. The lack of funds within an enterprise is more prominent within the small to medium firms than in large firms. But these results ignore the contribution of firms who felt otherwise (only considered the respondents who highly rated the factor).

Fig. 3. 3 Proportion of Firms (out of total business sector target population) that Highly Rated the selected Barriers to Innovation Disaggregated by Innovative Firm Size for Ethiopia



When all the 16 factors hampering innovation are presented regardless of the size of the firms; the high costs for innovation, lack of funds within the enterprise, and the lack of finance from sources outside the enterprises are prominent within the cost category. Within the knowledge category, the lack of technology, followed by lack of qualified personnel and lack of information on market are most important barriers to innovation. Another important category that stands out is the domination of the market by established enterprises, followed by the uncertainty of the demand of product innovations.

The factors hampering innovation were disaggregated by size of firm starting with the small firms that employed 10-49 people. The results showed that more than 50% of the small firms identified cost factors as important barriers to innovation. Of importance, were the high costs of innovation and lack of funds within enterprises, followed by the lack of finance from sources outside the enterprise. This pattern was similar to that observed for all firms. Under the knowledge category, the lack of information on technology was preferentially considered the most important barrier to innovation, followed by the equally rated lack of qualified personnel and lack of information on the market. The next category, in order of importance, was market factors particularly the dominance of established enterprises and to a lesser extent the uncertain demand for innovative goods and services. All these factors typically have more influence on the innovation within small enterprises since these firms do not have a strong capital base.

In comparison to the medium sized firms (50-249), the knowledge and market factors were more pronounced as barriers to innovation. For example, the high innovation costs are more prominent than the equally rated lack of finance from sources outside the enterprise and the lack of funds within the enterprise. In the knowledge factors category, lack of information on technology is more prominent than it was in the small firms. The other three factors namely lack of qualified personnel, lack of information about the market, and difficulties in finding cooperation partners were rated equally important. In the market category, the issue of markets dominated by established enterprises were rated most important barriers to innovation.

The picture on barriers to innovation for large firms is different from that of small and medium firms. Although the cost factors remained important for large firms, they are not seen as barriers to the same extent as in small and medium firms. All businesses require financing from internal and external sources. It is important to note that less than 50% of large firms identified high innovation costs, lack of funds from within the firm and sources of finance from outside as important barriers to innovation. The knowledge factors emerged as the most important barriers to innovation for large firms, particularly the lack of qualified personnel. In most cases, more firms innovate than do R&D, and that finding is size dependent. The other factors, such as lack of information on technology and information on the market, were still important barriers but to a lesser extent when compared small and medium enterprises. Large companies are expected to dominate the market and have financial resources to invest in most of the innovation supporting activities than the small and medium firms.

In all size ranges, the limitations of science and technology public policies was not identified as a barrier to innovation by most firms. It may mean that the existing STI policies are not impeding innovation at firm level or the STI policy measures are not clearly understood by firms. May be the STI policies should include coming up with programmes that encourage more experimental development research aimed at producing goods and services for the market.

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ANNEX

Table 3A 1 **Disaggregated Data on Innovation Rate, Ongoing and Abandoned Innovation Activities by Product and Process Innovations for Ethiopia**

Innovation Rates, Ongoing and Abandoned Innovation Activities	(n)	(%) with respect to targeted business sector size
All Firms	**10740**	**100.00**
Innovative Firms	6381	59.41
Firms with Ongoing Innovation Activities	2114	19.68
Firms with Abandoned Innovation Activities	561	5.22
Firms with ONLY Ongoing Innovation Activities	1738	16.18
Firms with ONLY Abandoned Innovation Activities	185	1.72
Firms with BOTH Ongoing and Abandoned Innovation Activities	376	3.50
Firms with NEITHER Ongoing nor Abandoned Innovation Activities	8441	78.59
Firms with Product Innovations	**2545**	**23.70**
Firms with Ongoing Innovation Activities	1166	10.86
Firms with Abandoned Innovation Activities	370	3.45
Firms with ONLY Ongoing Innovation Activities	903	8.41
Firms with ONLY Abandoned Innovation Activities	107	1.00
Firms with BOTH Ongoing and Abandoned Innovation Activities	263	2.45
Firms with NEITHER Ongoing nor Abandoned Innovation Activities	1272	11.84
Firms with Process Innovations	**3208**	**29.87**
Firms with Ongoing Innovation Activities	1432	13.33
Firms with Abandoned Innovation Activities	387	3.60
Firms with ONLY Ongoing Innovation Activities	1137	10.59
Firms with ONLY Abandoned Innovation Activities	92	0.86
Firms with BOTH Ongoing and Abandoned Innovation Activities	295	2.75
Firms with NEITHER Ongoing nor Abandoned Innovation Activities	1684	15.68
Firms with ONLY Product Innovations	**108**	**1.01**
Firms with Ongoing Innovation Activities	30	0.28
Firms with Abandoned Innovation Activities	2	0.02
Firms with ONLY Ongoing Innovation Activities	30	0.28
Firms with ONLY Abandoned Innovation Activities	2	0.02
Firms with BOTH Ongoing and Abandoned Innovation Activities	0	0.00
Firms with NEITHER Ongoing nor Abandoned Innovation Activities	76	0.71
Firms with ONLY Process Innovations	**149**	**1.39**
Firms with Ongoing Innovation Activities	21	0.20
Firms with Abandoned Innovation Activities	20	0.19
Firms with ONLY Ongoing Innovation Activities	9	0.08
Firms with ONLY Abandoned Innovation Activities	8	0.07
Firms with BOTH Ongoing and Abandoned Innovation Activities	12	0.11
Firms with NEITHER Ongoing nor Abandoned Innovation Activities	120	1.12
Firms with BOTH Product and Process Innovations	**1824**	**16.98**
Firms with Ongoing Innovation Activities	968	9.01
Firms with Abandoned Innovation Activities	287	2.67
Firms with ONLY Ongoing Innovation Activities	751	6.99
Firms with ONLY Abandoned Innovation Activities	70	0.65
Firms with BOTH Ongoing and Abandoned Innovation Activities	217	2.02
Firms with NEITHER Ongoing nor Abandoned Innovation Activities	786	7.32
Non-Innovative Firms	**4359**	**40.59**
Firms with Ongoing Innovation Activities	170	1.58
Firms with Abandoned Innovation Activities	19	0.18
Firms with ONLY Ongoing Innovation Activities	167	1.55
Firms with ONLY Abandoned Innovation Activities	16	0.15
Firms with BOTH Ongoing and Abandoned Innovation Activities	3	0.03
Firms with NEITHER Ongoing nor Abandoned Innovation Activities	4173	38.85

Table 3A 2 Innovation Rate for Firms in the Agriculture, Manufacturing and Construction Sectors (Eswatini)

Industry Sector	Number of Firms	Innovative Firms		Firms with Ongoing and Abandoned Innovation Activities	
	n	*n*	%	*n*	%
Agriculture	**11**	**5**	**45.5**	**2**	**18.2**
[1]Crop and animal production	8	3	37.5	1	12.5
Forestry and logging	3	2	66.7	1	33.3
Manufacturing	**23**	**18**	**78.3**	**7**	**30.4**
Manufacture of food products	5	4	80.0	1	20.0
Manufacture of beverages	1	1	100.0	0	0.0
Manufacture of textiles	2	2	100.0	2	100.0
Manufacture of paper and paper products	1	1	100.0	1	100.0
Manufacture of coke and refined petroleum products	1	1	100.0	1	100.0
Manufacture of rubber and plastics products	1	1	100.0	0	0.0
Manufacture of other non-metallic mineral products	1	1	100.0	1	100.0
Manufacture of furniture	2	2	100.0	1	50.0
[2]Other manufacturing	5	3	60.0	0	0.0
Repair and installation of machinery and equipment	4	2	50.0	0	0.0
Construction	**13**	**5**	**38.5**	**0**	**0.0**
Construction of buildings	9	3	33.3	0	0.0
Specialized construction activities	4	2	50.0	0	0.0
Service	**102**	**61**	**59.8**	**2**	**2.0**
Electricity, gas, steam and air conditioning supply	5	3	60.0	0	0.0
Water collection, treatment and supply	1	1	100.0	0	0.0
Sewerage	1	1	100.0	0	0.0
Remediation activities and other waste management services	1	1	100.0	0	0.0
[3]Wholesale and retail trade and repair of motor vehicles	3	2	66.7	0	0.0
Wholesale trade, except of motor vehicles and motorcycles	3	2	66.7	0	0.0
Retail trade, except of motor vehicles and motorcycles	4	4	100.0	0	0.0
Warehousing and support activities for transportation	3	3	100.0	0	0.0
Accommodation	8	6	75.0	0	0.0
Food and beverage service activities	2	2	100.0	0	0.0
Programming and broadcasting activities	6	3	50.0	0	0.0
Telecommunications	5	3	60.0	0	0.0
Computer programming, consultancy activities	5	2	40.0	0	0.0
[4]Information service activities	4	2	50.0	0	0.0
[5]Financial service activities	8	1	12.5	0	0.0
[6]Insurance, reinsurance and pension funding	2	1	50.0	0	0.0
Activities auxiliary to financial and insurance services	4	1	25.0	0	0.0
Real estate activities	3	1	33.3	0	0.0
Legal and accounting activities	5	2	40.0	0	0.0
Activities of head offices and management of consultancy activities	1	1	100.0	0	0.0
Architectural and engineering activities, technical testing & analysis	1	1	100.0	0	0.0
Other professional, scientific & technical activities	4	3	75.0	0	0.0
Veterinary activities	1	1	100.0	0	0.0
Travel agency, tour operator, reservations and related activities	3	2	66.7	1	33.3
Security and investigation activities	2	1	50.0	0	0.0
Human health activities	2	2	100.0	0	0.0
Creative, arts and entertainment activities	5	4	80.0	0	0.0
Activities of membership organizations	1	1	100.0	1	100.0
Repair of computers and personal and household goods	3	2	66.7	0	0.0
Other personal service activities	4	1	25.0	0	0.0
Activities of households as employers of domestic personnel	2	1	50.0	0	0.0

Table 3A 3 Innovation Rate by industry sector (Mining, Manufacturing & Construction) in Ethiopia

Innovation Rate by Industry Sector for Ethiopia							
Industry Sector	**Number of Firms (*n*)**	**Innovative Firms**		**Firms with Ongoing Innovation Activities**		**Firms with Abandoned Innovation Activities**	
		n	%	*n*	%	*n*	%
Mining	**118**	**61**	**51.7**	**27**	**22.9**	**9**	**7.6**
Mining of coal and lignite; extraction of peat	45	27	60.0	18	40.0	9	20.0
Other mining and quarrying	73	34	46.6	9	12.3	0	0.0
Manufacturing	**5438**	**3680**	**67.7**	**1444**	**26.6**	**520**	**9.6**
Manufacture of food products and beverages	565	332	58.8	92	16.3	24	4.2
Manufacture of textiles	183	145	79.2	32	17.5	17	9.3
Manufacture of wearing apparel; dressing and dyeing of fur	101	61	60.4	30	29.7	29	28.7
[1]Tanning and dressing of leather; manufacture of luggage	330	239	72.4	199	60.3	69	20.9
[2]Manufacture of wood and of products of wood and cork	991	889	89.7	326	32.9	78	7.9
Manufacture of paper and paper products	10	10	100.0	2	20.0	0	0.0
Publishing, printing and reproduction of recorded media	247	176	71.3	47	19.0	25	10.1
[3]Manufacture of coke, refined petroleum products	1	0	0.0	0	0.0	0	0.0
Manufacture of chemicals and chemical products	133	113	85.0	57	42.9	18	13.5
Manufacture of rubber and plastics products	192	114	59.4	46	24.0	12	6.3
Manufacture of other non-metallic mineral products	607	312	51.4	92	15.2	44	7.2
Manufacture of basic metals	198	156	78.8	76	38.4	54	27.3
[4]Manufacture of fabricated metal products	153	117	76.5	78	51.0	8	5.2
Manufacture of machinery and equipment n.e.c.	290	150	51.7	64	22.1	0	0.0
Manufacture of motor vehicles, trailers and semi-trailers	2	2	100.0	2	100.0	2	100.0
Manufacture of furniture; manufacturing n.e.c.	1429	864	60.5	301	21.1	134	9.4
Recycling	6	0	0.0	0	0.0	6	100.0
Construction	**1866**	**955**	**51.2**	**250**	**13.4**	**16**	**0.9**
Service	**3318**	**1685**	**50.8**	**393**	**11.8**	**16**	**0.5**
Collection, purification and distribution of water	6	6	100.0	0	0.0	0	0.0
[5]Sale, maintenance and repair of motor vehicles	416	104	25.0	0	0.0	0	0.0
[6]Wholesale trade and commission trade	209	209	100.0	0	0.0	0	0.0
[6]Retail trade; repair of personal and household goods	605	0	0.0	0	0.0	0	0.0
Hotels and restaurants	983	643	65.4	213	21.7	7	0.7
Land transport; transport via pipelines	1	1	100.0	0	0.0	0	0.0
[7]Supporting and auxiliary transport activities	114	0	0.0	0	0.0	0	0.0
Post and telecommunications	4	2	50.0	1	25.0	1	25.0
[8]Financial intermediation	32	30	93.8	20	62.5	6	18.8
[9]Insurance and pension funding	25	5	20.0	4	16.0	0	0.0
Activities auxiliary to financial intermediation	34	1	2.9	0	0.0	0	0.0
Real estate activities	1	0	0.0	0	0.0	0	0.0
Computer and related activities	148	148	100.0	148	100.0	0	0.0
[10]Other business activities	28	12	42.9	6	21.4	2	7.1
Public administration and defence; compulsory social security	1	1	100.0	1	100.0	0	0.0
Health and social work	11	11	100.0	0	0.0	0	0.0
[11]Sewage and refuse disposal, sanitation	33	0	0.0	0	0.0	0	0.0
Activities of membership organizations n.e.c.	28	0	0.0	0	0.0	0	0.0
Other service activities	295	168	56.9	0	0.0	0	0.0
[12]Undifferentiated service-producing activities	344	344	100.0	0	0.0	0	0.0

[1]This includes manufacture of handbags, saddlery, harness and footwear
[2]Also include manufacture of articles of straw and plaiting materials but excludes furniture
[3]This includes nuclear fuel
[4]This excludes machinery and equipment
[5]This includes sales of motorcycles and retail sale of automotive fuel
[6]This excludes sale of motor vehicles and motorcycles
[7]This includes activities of travel agencies
[8]This excludes insurance and pension funding
[9]This excludes compulsory social security
[10]This includes legal, architectural, advertising etc., services
[11]This includes other similar sanitation activities
[12]These are activities of private households for own use

Table 3A 4 Innovation Rate by Industry Sector for Uganda

Industry Sector	Number of Firms	Innovative Firms		Firms with Ongoing and Abandoned Innovation Activities	
	n	*n*	%	*n*	%
Mining	**53**	**53**	**100.0**	**18**	**34.0**
Mining of metal ores	18	18	100.0	18	100.0
Other mining and quarrying	35	35	100.0	0	0.0
Manufacturing	**1285**	**1218**	**94.8**	**997**	**77.6**
Manufacture of food products	556	508	91.4	441	79.3
Manufacture of beverages	57	57	100.0	38	66.7
Manufacture of wearing apparel	19	9	47.4	10	52.6
[1]Manufacture of wood and of products of wood and cork	38	29	76.3	29	76.3
Manufacture of paper and paper products	28	28	100.0	28	100.0
Printing and reproduction of recorded media	77	77	100.0	77	100.0
Manufacture of chemicals and chemical products	38	38	100.0	19	50.0
[2]Manufacture of pharmaceuticals	29	29	100.0	29	100.0
Manufacture of other non-metallic mineral products	29	29	100.0	19	65.5
Manufacture of basic metals	67	67	100.0	38	56.7
[3]Manufacture of fabricated metal products	144	144	100.0	125	86.8
Manufacture of machinery and equipment	10	10	100.0	0	0.0
Manufacture of other transport equipment	10	10	100.0	0	0.0
Manufacture of furniture	144	144	100.0	125	86.8
Other manufacturing	29	29	100.0	19	65.5
Repair and installation of machinery and equipment	10	10	100.0	0	0.0
Construction	**411**	**411**	**100.0**	**260**	**63.3**
Construction of buildings	151	151	100.0	87	57.6
Civil engineering	173	173	100.0	130	75.1
Specialized construction activities	87	87	100.0	43	49.4
Service	**4726**	**4291**	**90.8**	**2705**	**57.2**
Electricity, gas, steam and air conditioning supply	25	25	100.0	25	100.0
[4]Wholesale and retail trade and repair of motor vehicles	731	646	88.4	488	66.8
Wholesale trade, except of motor vehicles and motorcycles	1220	1061	87.0	500	41.0
Retail trade, except of motor vehicles and motorcycles	439	426	97.0	182	41.5
Land transport and transport via pipelines	99	99	100.0	74	74.7
Warehousing and support activities for transportation	209	197	94.3	123	58.9
Accommodation	649	576	88.8	392	60.4
Food and beverage service activities	355	343	96.6	245	69.0
Publishing activities	14	14	100.0	0	0.0
Telecommunications	41	41	100.0	27	65.9
Computer programming, consultancy and related activities	27	27	100.0	27	100.0
Financial service activities, except insurance and pension funding	624	579	92.8	501	80.3
Real estate activities	182	146	80.2	36	19.8
Legal and accounting activities	17	17	100.0	6	35.3
Activities of head offices; Management consultancy activities	22	22	100.0	17	77.3
[5]Architectural and engineering activities	22	22	100.0	22	100.0
Scientific research and development	11	11	100.0	6	54.5
Advertising and marketing research	17	17	100.0	17	100.0
Other professional, scientific and technical activities	22	22	100.0	17	77.3

1 This excludes furniture; manufacture of articles of straw and plaiting materials | 2This includes medicinal chemical and botanical products | 3This excludes manufacture of machinery and equipment | 4 This includes wholesale and retail of motorcycles | 5This includes technical testing and analysis excludes machinery and equipment

Table 3A 5 Total of Innovation-active firms performing R&D or not performing R&D

Country	Innovation-active firms (1)		Firms with No innovation activities (2)	Total firms (3= 1+ 2)
	B1: Innovative firms or innovators	*B2: Firms with ongoing and/or abandoned activities ONLY*	*A: Non-innovation-active firms*	*(1)+(2)+(3) = (B1+B2+A) = (C)*
R&D performed	Number of Firms	Number of Firms	Number of Firms	
R&D not performed	Number of Firms	Number of Firms	* No data required	
Total firms	**Number of Firms**	**Number of Firms**	**Number of Firms**	**Number of Firms**

CHAPTER 4: NEW MEASUREMENT IN THE HORIZONS

4.1 Introduction

A number of African countries are taking part in building the human and institutional capacities needed to produce internationally comparable indicators and conducting surveys of research and innovation at national levels to measure their innovation activities through ASTII (AU-NEPAD, 2010). In all three phases of the ASTII Project, innovation was measured in the business sector only. This aligned with policy interest in the creation of jobs and economic growth and the survey questionnaire used was adapted from the one used in South Africa which in turn, was modelled on the EU Community Innovation Survey.

While methodological differences ruled out country comparisons, there were common features identified in participating African countries, as innovation was pervasive, even in smaller firms, and more firms looked more innovated than did R&D. Both findings raised policy questions. How was innovation in smaller[15] firms to be promoted and what policy interventions were appropriate for firms that did not perform R&D?

In future surveys of innovation in the business sector, the challenge is to bring greater uniformity to the survey methodology. This will allow closer comparisons among countries in Africa and with the rest of the world. Another question to be addressed is whether the employment cut-off should be standardized at 10 employees, or a lower number. There are other questions which can be found in the ***African Innovation Outlook.***

A major characteristic of most African economies is that their Gross Domestic Product is dominated by the public sector with a relatively weak business sector. This has given rise to interest in the public sector innovation. Another area of interest is the Household sector which can have business activities which may be in the formal or informal economy and which can include innovation (Charmes et al., 2016).

4.2 Measuring Innovation in all Sectors of the Economy

While there have been international standard definitions of innovation in the business sector for statistical purposes since 1992 and the first ***Oslo Manual*** (OECD 1992), these definitions have evolved through three revisions of the Manual (OECD/Eurostat, 1997; 2005, 2018). As a result, there are now comparable international definitions of innovation in the public and household sectors.

There is a substantial body of empirical work on innovation in both sectors reviewed Gault (Gault, 2013, 2015). The public sector is discussed in Arundel et al. (2016), Arundel and Huber (2013) and Bloch (2013), while the household sector is examined by de Jong (2016a, 2016b) and de Jong and von Hippel (2013). For statistical purposes definitions of innovation in the business sector are used as defined in the 1980s before they were codified in the first ***Oslo Manual*** (OECD, 1992). To bring some coherence to the subject of definitions of innovation that are applicable in all economic sectors of the SNA, there have been proposals made by authors (Gault 2015, 2016) to encourage debate, leading to manuals for innovation in sectors not covered by the ***Oslo Manual***.

[15]A standard size classification of firms is micro (1-9 employees), small (10-49 employees) and medium (50-99 employees). See KNBS (2016). One of the reasons why countries could not be ranked by innovation performance was that the survey employment cut off for the sample ranged from 2 to 20, for countries that used employment to determine their sample. Most used a cut off of 10 employees which meant that they could analyse innovation in small and medium firms, but not micro firms. See NPCA (2014).

A key difference between the concept of innovation in the business sector and in other sectors is the place of the market. For a product to be an innovation in the business sector, it must be "introduced on the market" (OECD/Eurostat 2005, para. 150). As the market and selling at 'economically significant prices' are not characteristics of innovation in sectors other than the business sector the suggestion has been made that "introduced on the market" be replaced by and "made available to potential users" (Gault 2012). In the business sector, the means of making a product available to potential users is the market in most cases so there would be little change to current practice. The only difference would apply to firms that made products available at lower than economically significant prices, such as Linux products, email addresses, or cloud storage. These issues could be resolved. For other sectors, "made available to potential users" makes it possible to infer the activity of innovation from survey questions about the behavior of the institutions.

As definitions for measurement purposes are statistical issues, the economic sectors are taken directly from the System of National Accounts Manual, 2008 (EC et al. 2009) with a minor difference in terminology. The Business sector, the term of choice in this chapter, represents the SNA Non-financial corporations' sector and the financial corporations' sector. The Public sector is the General government sector and public corporations (EC et al., 2009: para 22.41). The point has already been made that the Frascati Manual includes a Higher education sector for reasons of policy relevance and past practice. These are not issues in the measurement of innovation.

A generalized definition of innovation in SNA sectors has been introduced in the fourth edition of the ***Oslo manual*** (OECD/Eurostat, 2018: 20-21) and could be applied for the measurement of innovation in the public sector and the household sector in Africa. That would be a task for any group with a mandate to share knowledge of measuring innovation in Africa.

4.3 Innovation in the informal economy

The preceding section made it clear that innovation can occur in any economic sector but most of the statistical measurement deals with institutions in the formal economy. In developed economies, the argument is that most of the economic activity takes place in the formal economy, but this argument does not apply to most countries in Africa where there are firms and households, including individuals, trading in the informal economy. These activities, including innovation, are sources of job creation and are areas where policy intervention could make a difference (African Development Bank, 2013).

Kramer-Mbula and Wunsch-Vincent (2016) have reviewed the informal economy in developing nations, including the role of innovation, and their book provides case studies with examples of innovation. Of relevance here is the description of the informal economy and the history of its definition provided by Charmes (2016) and the discussion of the measurement of innovation in the informal economy in Charmes et al. (2016) where combinations of household surveys and business surveys are discussed as a means of measuring the activity of innovation in the informal economy.

A recent example of measuring innovation in the informal economy using a household and a business survey is provided by the Kenya Micro, Small and Medium Enterprise (MSME) Survey (KNBS 2016)[16]. The survey covers the micro, small and medium sectors of Kenyan establishments (MSME sectors). Micro firms are those establishments[17] that have 1-9 employees; small firms, with 10-49 employees; and medium firms, with 50-99 employees.

The Kenyan survey reveals many interesting characteristics of the informal sector in Kenya which for the purposes of the survey, is considered to be all micro businesses (whether licensed or not). This can be regarded as an upper bound on the size of the informal

[16]https://www.datafirst.uct.ac.za/dataportal/index.php/catalog/647/study-description
[17]The survey uses firms, establishments, businesses and enterprises interchangeably.

sector as there will be some micro firms that operate in the formal sector. First there are some basic characteristics of the informal sector in Kenya (see also Box 4.1).

This comprehensive survey of MSMEs in Kenya is actually two surveys, one covering the small and medium firms (10-99 employees), based on a household-based master sampling drawn for the business register, and the other covering micro firms based on samples drawn from the 2009 Kenya Population and Housing Census. The small and medium firm survey is based on a sample of 50,043 licensed establishments, while the micro firm survey is based on a sample of 14,400 households to cover unlicensed establishments. The response rates were high, with the following percentages: 92.6% and 91.7% for small and medium firms respectively.

According to the survey, in 2015, Kenyan MSMEs employed an estimated 3,465,100 persons in licensed micro establishments (less than 10 employees) plus 8,617,800 unlicensed micro establishments, amounting to 12,082,900 people. The Kenyan labour force in the same year was estimated as 17.5 million people. The informal sector (micro firms) thus accounts for about 69% of total employment in the country. This is very much in line with an estimate that "informal employment accounts for 72% of non-agricultural employment in sub-Saharan Africa, and for 78% when South Africa is excluded" (Kraemer-Mbula and Watu Wamae, 2010).

Innovation in the informal economy in Kenya

The Kenya Survey has questions about innovation (KNBS, 2016: 157), including the micro sector which is a proxy for the informal sector. The questions are as follows:

a. During the period 2013 to 2015, did you introduce new, or significantly improved, goods or services? Yes/No;

b. During the period 2013 to 2015, did you introduce new, or significantly improved, methods of manufacturing or producing goods or services?

c. During the period 2013 to 2015, did you implement a new marketing method involving significant changes in realms such as product design or packaging, product placement, promotion, or pricing?

d. Please estimate the total turnover of goods and services which innovations introduced in 2013 (Kenya shillings).

The results are shown in Tables 4.3, 4.4 and 4.5 (Box 4.2). The sample data results in Table 4.3 show that an activity of innovation is highest in medium sized firms, followed by small and micro firms. Furthermore, the data reveal that product innovation is quite frequent in the MSME sector, irrespective of size, followed by considerably less innovation activities when it comes to process and marketing.

With respect to the informal economy, the micro firms, the findings show that about 10% of micro firms innovate, compared to about 20% for the small firms, and 26% for the medium firms. However, if these data are adjusted for by a number of establishments in each size group, the result is that an overwhelming number of innovation activities in the MSME sector occur in the informal sector (Tables 4.4 and 4.5). The survey outcome shows that over 82% of all types of innovation in the MSME sector occur in the informal sector, a finding with implications for innovation policies in Kenya.

[18]The informal economy is thus of great significance in Sub-Saharan Africa. Other estimates report figures as high as 93% in Benin and 83% in Zambia. It is estimated that the contribution of the informal economy to GDP is over 42% in the case of Sub-Saharan Africa (Kraemer-Mbula and Watu Wamae 2010).

Box 4. 1 Kenya 2016 MSME Survey: Basic Characteristics

The Kenyan Survey is based on two sizeable samples: one amounting to 50,043 for the licensed establishments, and the other amounting to 14,400 households to cover the unlicensed establishments. The response rates were high.

The size of the informal sector in terms of establishments:
According to the MSME Survey, there were 7.41 million Micro, Small and Medium firms in Kenya (2015), of which 1.56 million (21.1%) were licensed, and 5.85 million (78.9%) were unlicensed. For purposes of the Survey, the micro sector (with both licensed and unlicensed establishments) is used as a proxy for the informal economy. The Survey covers all ISIC sectors of the economy. It is estimated that the licensed MSME firms make up about 99% of all licensed firms in Kenya in 2016. The majority (65.9%) of the licensed MSMEs are in the service sector (defined as wholesale and retail trade, vehicle reparation, and accommodation & food). Of the unlicensed firms, the equivalent share is 72%. It should be stressed that "licensed" is not the same as "registered". Thus only 21.8% of the licensed micro establishment were also registered.

Tab. 4. 1 The MSME sector in terms of number of establishments by size (000)

Size	Total	%	Licensed	%	Unlicensed	%
Micro	7,288.4	98.3	1,438.1	92.2	5,850.3	100.0
Small	110.9	1.5	110.9	7.1	-	-
Medium	11.5	0.2	11.5	0.7	-	-
Total	7,410.8	100.0	1,560.5	100.0	5,850.3	100.0

Source: KNBS 2016: Based on Tables 4.2 and 4.5 of the Kenyan Survey – Basic report

These figures give an idea of the importance of the informal sector in Kenya. In terms of employment (Table 4.2 below), it is estimated that the informal sector (12.08 million) accounts for over three thirds (68.4%) of the total labour force (17.52 million).

Tab. 4. 2 The MSME sector in terms of employment by size of establishments (000)

Size	Total	%	Licensed	%	Unlicensed	%
Micro	12,082.9	81.1	3,465.1	55.2	8,617.8	100.0
Small	2,027.8	13.6	2,027.8	32.3	-	-
Medium	787.6	5.3	787.6	12.5	-	-
Total	14,898.3	100.0	6,280.5	100.0	8,617.8	100.0

Source: KNBS 2016: Based on Table 5.1 of the Kenya survey – Basic report

Box 4. 2 Kenya 2016 MSME Survey: Innovation Active Establishments

Tab. 4. 3 Licensed Establishments that are Innovation-Active by Size Group (%)

Size	Product	Process	Marketing
Micro	10.0	3.9	5.7
Small	19.9	10.1	13.3
Medium	26.3	10.4	19.1
Total	10.8	4.4	6.3

Source: KNBS 2016: Calculated from Table 6.10 of the Kenyan Survey – Basic report

Table 4.3 shows that, taken without distinction from all licensed-establishments, only 10.8 were innovative-active with product innovations, 4.4% with process and 6.3 with marketing innovations. Among those which were Micro, only 10.0% implemented product innovations. Therefore, there is no need to make a simple calculation for each column as each line from Micro to Total has its own interpretation.

The sample data results in Table 4.1 show- not surprisingly – that innovation activity is the highest medium sized firms, followed by small and micro firms. However, if these data are adjusted by the total estimated number of establishments in each size group, the result is that an overwhelming of innovation activities occur in the informal sector (Tables 4.2 and 4.3).

Tab. 4. 4 Total Number of Innovation-Active Licensed Establishments by Size Group (000)

Size	Total	Product	Process	Marketing
Micro	1,438.1	144.1	56.8	81.7
Small	110.9	22.1	11.2	14.7
Medium	11.5	2.9	1.2	2.2
Total	1,560.5	169.1	69.2	98.6

Source: KNBS 2016: Calculated from table 6.10 of the Kenyan Survey – Basic Report and Table 4.3 above

Tab. 4. 5 Innovation-Active Licensed Establishments by Size Group (%)

Size	Product	Process	Marketing
Micro	85.2	82.1	82.9
Small	13.1	16.2	14.9
Medium	1.7	1.7	2.2
Total	100.0	100.0	100.0

Source: KNBS 2016: Table 4.3 above

Almost 85% of all product innovations are done in the micro sector; so are 82% of all process innovations; and 83% of all marketing innovations.

4.4 Social Innovation

In contrast to household and public sector innovation, social innovation is not restricted to one sector. It can occur in many sectors, viz: the non-profit sector, the public sector, the informal economy, and even the business sector, even if social innovation is, as a rule, linked to non-profits and carried out by social entrepreneurs, or in social enterprises. Interest in social innovations and social entrepreneurship has increased during the last decade, and after the economic and financial crisis that began in 2008. One reason of concern in the civil society is that there are increasing problems that are not solved, nor attended to, by either the public, or the private sector. The last decade has seen increasing income gaps in both the developed and the developing worlds. Social innovations could be part of the solution to many problems facing people today, not least in the developing world (Brundenius 2016).

Social innovation as a concept emerged in the 1960s, used by management theorists such as Peter Drucker and Michael Young, the latter was father of social entrepreneurship and later on the founder of the Open University. Social innovation was originally a concept used to distinguish such innovations from innovations in general, meaning technological solutions to resolve economic problems, or technological innovations. Another distinction is that a social innovation does not necessarily have to be implemented by being introduced in a market, as specified by the ***Oslo Manual*** (OECD/Eurostat 2005) as it was discussed earlier.

There are many definitions of social innovation (Mouaert et al. 2013). Some examples are as follows:

- "A social innovation is a novel solution to a social problem that is more effective, efficient, sustainable, or just than present solutions, and for which the value created accrues primarily to society as a whole rather than private individuals" (Stanford Centre for Social Innovation).
- "Social innovations are new ideas (products, services and models) that simultaneously meet social needs (more effectively than alternatives) and create new social relationships or collaborations" (Murray et al. 2010).
- "Social innovation is an innovation that is explicitly used for the social and public good. It is an innovation inspired by the desire to meet social needs that can be neglected by forms of private market provision and which have often been poorly served or unresolved by services organized by the state" (NESTA quoted in Murray et al. 2010).

OECD's LEED Program states that "social innovation seeks new answers to social problems by (a) identifying and delivering new services to improve the quality of life of individuals and communities; (b) identifying and implementing new labor market integration processes; (c) new competencies, new jobs, and new forms of participation, as diverse elements that each one contributes to improving the position of individuals in the workforce" (OECD, 2007)

Social innovation also differentiates itself from business innovations that are as a rule driven and diffused by profit maximization. Social innovation is however, not a sector. It is a restricted innovation since it must be related to social needs. The performer is, as a rule, a social entrepreneur or a social enterprise. Social innovation can occur and be applied in all sectors: the public sector, the household sector, the nonprofit sector, and the informal sector. It can also occur in the traditional business sector, as a division, or affiliate, of a large – usually a multinational - company.

Mulgan et al, (2007) noted that "no country has a serious strategy for social innovation comparable to strategies for innovation in business and technology". But, since then, there has been a tendency for a growing commitment by governments and international organizations as to the role of social innovation and the importance of involving civil society in this work. In August 2009, for example, President Obama created a White House Office of Social Innovation and Civic Participation[19].

[19]http://www.npr.org/templates/story/story.php?storyId=104648050

In March 2011, José Manuel Barroso stated that "social innovation is about meeting unmet social needs and improving social outcomes", and social innovation is tapping creativity "to find new ways of meeting pressing needs, which are not adequately met by the market, or the public sector, and are directed to vulnerable groups in society" (Barroso 2011, quoted in Godin 2012). Barroso was at the time the EU Commission President and was launching the Social Innovation Europe Initiative.

The Nordic Council of Ministers (NCM) appointed a working group in 2013 to "survey initiatives that support social entrepreneurship and social innovation" (NCM 2015). The report sees social innovation closely connected with the social entrepreneur. Social entrepreneurship is characterized by the following characteristics: (1) targeted at a social objective where there is an unmet welfare need; (2) contributes as innovative solutions to these challenges; (3) driven by the social results, but also by a business model that can make the enterprise viable and sustainable. Another important aspect is the "involvement of the target group for the social entrepreneurial work, the employees and other key stakeholders (and) cooperation across disciplines and business models" (NCM 2015).

Social Innovation and Community Surveys in Sub-Saharan Africa

In post-apartheid South Africa, for example, the importance of social innovation was already recognized in the 1996 White paper on Science and Technology. However, despite the good intention, the concept of social innovation has not been actively implemented nor has it been much diffused in South Africa. Lately the Human Sciences Research Council (HSRC) has initiated a series of research projects and surveys oriented towards the assessment of the impact of rural and community innovation activities (Hart et al. 2012).

One challenge is that there is not much awareness of the concept of social innovation. Only 22% of the respondent rural enterprises are aware of the idea of social innovation. The awareness was highest (37%) among the public enterprises. Among private and nonprofit enterprises, only 22% were aware of social innovation. These figures may seem disappointing and reinforce the impression that social innovation has not been actively promoted in rural areas since its initial inclusion into South African innovation policy. However, on the positive side, it is perhaps not so important that respondents are familiar with the concept, and more important that they actually carry on innovation activities oriented towards 'social and human welfare' – as seems to be the case in the rural areas.

The survey was carried out in four rural low-income communities (district municipalities) in South Africa (Jacobs et al. 2014). Of the 473 rural enterprises interviewed, 43% reported that they were active in innovation directed at improving social and human welfare, while 57% of the interviewed answered that they innovated foremost for commercial purposes.

African universities are also becoming increasingly engaged with innovation in marginalized communities. Examples are listed in Kruss & Gastrow (2015), Kruss (2016) for South Africa, and Diyamett & Thomas (2016), for universities and social innovation in Tanzania.

4.5 Innovation and Policy: Restricted Innovation

The chapter has discussed the measurement of innovation in all SNA sectors as part of an agenda for future work, and it has introduced the measurement of innovation, at least in the business sector, the household sector, the informal economy. It further discussed the importance of understanding the concept of social innovation broadly and the economic and social implications for policy intervention.

The measurement so far discussed shows that in the business sector, a firm could have a product, process, organizational, or marketing innovation. However, governments and policy makers are interested in policy questions such as the extent to which innovation is sustainable, inclusive, green, or promotes (or impedes) equity. There are also questions of whether innovation generates jobs and economic growth while retaining the characteristics just mentioned (Gault 2008). Answering these questions adds to the measurement challenge, but the results increase the value addition to the policy relevance of the activity.

These policy relevant topics can be declared as intentions by survey respondents, but the measurement question is to what extent were the intentions realized. A product innovation needs only be introduced on the market. It needs not make money. That is a separate question and it is answered in some surveys which ask about the percentage of turnover in the last three years that can be attributed to new ways of significantly improving products introduced on the market. Questions can also be put about change in operating costs due to a new, or significantly improved, process or organizational change, providing an efficiency measure as an outcome.

The creation of value, if value can be defined, greater inclusiveness, or reduced income inequality, can only be confirmed after the innovation has been analyzed from answers provided by participants to survey questions. This requires additional surveys which could be business or social surveys. For those surveys to happen, government policy makers must be willing to invest in measurement to monitor and evaluate their policies in order to learn from what has been done. This is discussed in STISA 2024 (AUC 2014) and in AOSTI (2013).

4.6 Sharing Knowledge: Governance and Platform

Over the last decade, experts from countries involved in the three phases of ASTII project have participated in training sessions on survey methods and analysis, as well as the use of standards that govern the measuring and interpretation of data on R&D and on innovation. Experts have met to present their data and reviewed data quality before the production of the ***African Innovation Outlook*** reports. In the course of these meetings, knowledge has been shared and a community has grown that has the capacity to help other countries to conduct surveys, interpret and analyze data, produce country reports, and contribute towards a Pan-African publication like the African Innovation Outlook.

The question is the extent of this knowledge sharing, and its contribution to policy. This is an important question as the ASTII Project completes its first decade and when governments are considering how to align their S&T and their innovation policies and measurement activities with STISA 2024. There are possibilities for consideration.

Within the Africa Union, the then African Ministerial Conference on Science and Technology (AMCOST), and Conference of Ministers of Education of the African Union (COMEDAF), have been merged and replaced by the Specialised Technical Committee on

Education, Science and Technology (STC-EST) who support the implementation of both STISA, 2024 and CESA16-25. Ministers from AU member States involved in STC-EST are under the coordination of the Committee of Ten Heads of State and Government Champions of Education, Science and Technology (C10). The C10 came into being by the Assembly Decision of June 2015 to allow human resources development, and science and technoiogy to remain the primary instruments and tools of enhancing Africa's long term effective implementation of Agenda 2063.

The Ministerial Committee (STC-EST) oversees the work of experts who handle data and statistics for Education and Training and Science and Technology under the Specialised Technical Group on Education, Science and Technology Statistics (STG-EST) which aligns indicators not only with exisiting continental strategies but also with regard to the African Charter on Statistics[20] and the Strategy for the Strategy for the Harminisation of Statistics in Africa (ShaSA)[21].

The importance of monitoring and evaluation aligns with the African Charter on Statistics and SHaSA (AUC, 2012; African Union Commission et al., 2010) as the Charter encourages African policy makers to use statistics as a base for policy formulation, monitoring, evaluation, and decision making' (AUC 2012:41).

Since STG-EST provides a forum for the sharing of knowledge on statistical measurement and the interpretation and analysis of the resulting data, its mandate is similar to the OECD counterpart of National Experts on Science and Technology Indicators (OECD/ NESTI). As this is mainly a statistical undertaking, discussion could be initiated with the International Statistical Institute (ISI) on capacity building[22] which would fit well with the needs of the SNA, particularly now that R&D has been capitalized (EC et al., 2009).

Representatives of the ASTII Project and of the African Observatory for Science, Technology and Innovation (AOSTI) have, since 2007, observer status at the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) which provides a forum for knowledge sharing among OECD Member Countries, observer countries and institutions. Greater use could be made of the NESTI forum, and that could link to work of the STG-STE. There remains only a question of how the sharing would be coordinated and how the data gathered by countries could be archived for use by researchers.

4.7 Future work

The principal activity for the future is the continuation of the R&D and innovation surveys in order to provide the information needed to monitor and evaluate science and technology and innovation activities as part of STISA -2024 (AUC, 2014: 48).

To support the principal activity which have been forums are required to share knowledge gained by countries that have participated in the ASTII Project. An institutional home found that can archive data and produce pan-African reports such as the AIO.

Going beyond what has been achieved since 2007, thought should be given to measuring innovation in economic sectors other than the business sector. This is an ongoing global discussion and it would be opportune for experts from African countries to participate in it.

Finally, social innovation is being discussed globally and there are opportunities to participate in that discussion so as to work with policy makers to arrive at definitions which make possible statistical measurement in Africa to support relevant social policy.

[20]https://au.int/en/treaties/african-charter-statistics
[21]https://au.int/en/ea/statistics/shasa
[22]https://www.isi-web.org/index.php/news-from-isi/5245-statistical-capacity-building-2

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CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

R&D data submitted as part of the third phase of the ASTII programme reveal that there is no country which has spent the 1% target of its GDP in R&D activities. With the exception of South Africa, the high spending in research has been made through public research institutions, mainly the government sector. This sector alone represents in minimum 35% of GERD in terms of source of R&D funding. The combination of both government and higher education sectors goes beyond 50% for most countries. Compared to R&D capital expenditures, except Ethiopia, most countries spent more on labour costs, and the figures vary between 34% and 59% of GERD out of all costs either current or capital expenditures.

The trend on personnel involved in R&D shows a weak representation in the business sectors. Researchers represent more than half of the total R&D personnel in full-time equivalent (FTE). The concentration of age groups involved in R&D shows people in the range of 24-34 and 35-44 years old. Among researchers, women are still below 50% in all countries. More than half of researchers in each country are doctoral degree holders (ISCED8) with a very high concentration in the following field of R&D (FoRD): natural sciences in Botswana and Gabon, engineering and technology in Seychelles, medical and health sciences in Egypt, agricultural sciences in Ethiopia and social sciences in Mozambique and Namibia.

The key findings stated in AIO-3 which were also previously reported in AIO-1 and 2, are as follows: more firms do not have the capacity to do R&D in order to support innovation; universities and government research institutions are particularly low-rated as sources of information for innovation; and innovative firms invest more in machinery and equipment than in R&D activities. The first two findings are common to almost all countries in the world, while the third one is unique to African countries with policy implications.

5.1 Enhanced Data Quality and Coverage of Sectors by Member States

The production of this AIO-3 indicates that there is a great deal of work that needs to be undertaken to put in place data management and analysis systems in place so that Member States have comparable statistics of good quality and coverage across the continent.

Recommendations:

a. A comprehensive training and capacity development programme should continue to be offered targeting more officials from different government entities such as the Ministries of Finance, Trade, Industry and the National Statistics Offices.

b. The training programme should cover relevant topics and offer an in-depth understanding of national development plans and different policies that provide the framework and enabling conditions for R&D and innovation in different sectors.

c. The training programme should include in the team of trainers some countries which are already conducting surveys and other relevant stakeholders within the national STI system.

d. Develop national Data Infrastructure Systems to enhance data quality.

e. Create a culture of collecting and analysing R&D and innovation survey data and continuously improving the questionnaires used to collect data.

f. Set up Communities of Practice to encourage dialogue among countries on good practices as a strategic learning process.

5.2 Analysis and Use of Data from the R&D and Innovation Surveys

One of the objectives of ASTII is to support African Union Member States to produce and use reliable and accurate information in policy making processes.

Recommendations for African Union Member States with lead support from the African Union Development Agency (AUDA-NEPAD) should:

a) Address aspects which are relevant to the African economic context, STI indicators that help with analysis of the framework conditions for R&D and Innovation as part of future work for the ASTII initiative;

b) Produce credible STI data and information from the R&D and Innovation surveys to inform policy and decision-making processes in all sectors of the economy;

c) Routinely disseminate data through information briefs on topical issues and the African Innovation Outlook series;

d) Make use of the policy options discussed during the AIO-3 validation meeting recommending Table 5.1 which categorises firms according to their innovation activities. [Firms can have none (A), they can have some innovation activities but they are not innovative (B) and (C) or they can innovate without R&D (D), which is the majority position, or they can perform R&D and innovate (E). Policy options start with “How”].

e) Utilise data to understand the allocation of the limited resources which are available for R&D in the Government and Higher Education sectors by:

- Identifying and assessing which areas of science, technology and innovation contribute to strategic national development goals/agenda;
- Ensuring that Member States together with other actors within the R&D and innovation systems have a deep understanding of development priority areas that require R&D and innovation for improved business growth and competitiveness;
- Making sure that Agencies within the R&D and innovation system need to understand the financing landscape for both R&D and innovation activities to establish the gaps and design national programmes;
- Encouraging Advocacy for increased R&D funding should be at different levels within a national STI system;
- Ensuring that Member States need to familiarise themselves with the indicators for STISA 2024 that relate to Agenda 2063 and the SGCs; and
- Ensuring that Member States need to coordinate and link STI data with other sources of data (macro and micro economic data) that are not usually covered by the national R&D and Innovation surveys.

5.3 Ownership of Data and Data Processes by all AU Member States

The success of the ASTII initiative is dependent on the active participation of countries through ownership of the programme, as well as understanding the importance of the R&D and innovation data to the development processes of the Member States. Member States need to include indicators that monitor the contribution of STI in different sectors of the national economy using STISA 2024 indicators as the starting point.

Recommendations:

a) Firstly, a data infrastructure system should be developed as part of ASTII to encourage African Union Member States to join and consistently participate in the initiative; and

b) Secondly, African Union Members States should continue to mobilise domestic resources and stakeholders to ensure ownership and sustainability of the ASTII programme at both national and regional levels.

Annex 1
COORDINATION: ASTII Coordinators & Focal points (ASTII Phase 3)

During the third phase of ASTII, the following countries benefited from technical support through training, 23 of them provided data that has been published in the Outlook.

COUNTRY	ASTII NATIONAL FOCAL PERSONS (Between 2014 and 2019)
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05 **BURKINA FASO**	**Prof. Issa Tapsoba :** Directeur Général de la Recherche Scientifique et de l'Innovation, Ouagadougou | e-mail: issa.tapsoba@gmail.com
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