ANIS

INDICATOR-BASED ANALYSIS OF
NATIONAL INNOVATION SYSTEMS

Botswana

Summarising Report
of the Determinants of the
Botswana Innovation System

INSTITUTE FOR
INNOVATION AND
TECHNOLOGY

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Institute for Innovation and Technology - iit

The Institute for Innovation and Technology (iit) offers tailor-made services to interested parties from politics, economy and science, to explore critical interfaces, quantify new innovation-related tools and models, investigate new paradigms for innovation and develop strategies to address the risks associated with investments in the respective fields. The aim of iit is to leverage the complementary expertise of academia, industry and government by facilitating new systems for innovation and collaborative processes on behalf of our clients. The work of iit is based on a broader understanding of innovation, which also deals, besides core technological developments themselves, with the economic and social preconditions and impacts of technological innovations. As a consequence, iit-experts are involved in many cross-disciplinary, cross-cultural and cross-organisational projects at national and international level.

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Preface

Regional and national competitiveness is not only driven by individual companies but increasingly accelerated by the innovative activities of entire industries and branches and has therefore become a key topic of economic and technology policies worldwide. As innovative firms grow faster than average and are more likely to survive during a recession, a strong innovation support policy may be a promising approach to enable companies to cope with any economic crisis.

However, the assets of innovation are not only limited to the original innovator. The innovation process itself generates knowledge spillover from which other firms can benefit and thus increase their productivity and innovation capacity. In turn this can create the conditions for a circular flow of economic growth from which the entire society may benefit.

Nowadays, innovation has become high priority within emerging and especially developing countries. Several innovation policy measures and support schemes have been implemented or are being designed, all of them with a different impact. These measures and schemes reflect the diversity of framework conditions, cultural preferences and political priorities. A smart innovation policy may establish favourable framework conditions for innovation. Thus, policy makers may foster the innovation capabilities of their national innovation system (NIS) by setting up appropriate framework conditions and by investing in infrastructure, education and funding R&D innovation programmes. All these measures and related efforts aim at improving the performance of an NIS.

The indicator-based Analysis of National Innovation Systems (ANIS) includes a comprehensive examination and evaluation of the status of existing national innovation systems. It is mainly intended for emerging and developing countries for which standard innovation benchmarking and monitoring approaches might not be sufficient as often the statistical data is missing or outdated. Policy makers from these countries can benefit from clear advice as regards to overcoming weaknesses of a national innovation system and to identifying those determinants that should receive special attention.

We are convinced that the ANIS approach will serve as a fact-based platform initiating discussions on how to improve innovation capabilities and competitiveness in the analysed countries.

Berlin, August 2010

Gerd Meier zu Köcker

Director Institute for Innovation and Technology (iit), Berlin

1 ANIS – Analysis of Botswana's National Innovation System

Innovation may be considered as one of the main drivers for economic competitiveness, growth and wealth creation. Therefore, innovation policy has become an important part of economic policy. The design of suitable framework conditions for innovation reflected by the maturity level of national innovation system (NIS) has been given high priority worldwide. Although there is no common definition of an NIS, the following comments may help to clarify what is meant by NIS:

> *Innovation may be defined as new solutions adding value to both customers and firms.[1] One distinguishes between incremental innovations (e.g. further development of existing products and technologies, often realised by SME without involving any R&D institutions) and radical innovations (completely new solutions, technologies or products not yet available on the market, usually involving R&D institutions).*
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> *A national innovation system may be defined as a network of institutions in public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies.[2] The main elements of an NIS in terms of education and research institutes, firms, industrial parks, incubators, governmental institution, etc. exists, but differs in terms of how they are coordinated or meshed.*
>
> *Innovation policy may be defined as the creation of framework conditions aiming at supporting innovation capabilities of companies and public entities. [3]*

The concept of an NIS relies on the premise that a good understanding of innovation actors' relationships is crucial to foster technology performance. Innovation and technical progress are indeed outcomes of a complex set of relationships among actors producing, distributing and implementing various kinds of knowledge. The innovative performance of a country broadly depends on the one hand on these actors' cooperation within a global knowledge creation system and on the other hand on the extent to which they utilise technologies. The actors are mainly private enterprises, universities and public research institutes. Their cooperation ranges from joint research to personnel exchanges, cross patenting, purchase of equipment and a variety of other channels.[4]

The number of theoretical models, reports and analyses of NIS has been increasing since the beginning of the 21st century. Because of the various factors impacting national innovation capacities, the assessment of a country's innovation system remains

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[1] Nordic Innovation Monitor, 2009, FORA.

[2] Freeman,1995.

[3] OECD, 2010.

[4] OECD, 1997.

a challenging exercise. For years, economists have tried to identify the reasons leading to the nations' competitiveness and growth, and as a consequence many NIS reports and analyses have been generated. Despite the high quality of these reports which describe the essential features of an NIS and summarise its main strengths and weaknesses, the benefits in terms of usable results were unfortunately limited. This is explained by the fact that the implemented methodologies did not sufficiently consider the way policy makers think and operate. Recommendations are neither prioritised nor ranked according to their complexity when turning into practice.

Policy makers, especially in emerging and developing countries, usually are looking for well structured descriptions of an NIS and clear recommendations how to improve the functionality of an NIS and the kind of specific measures recommended. They do not ask for receiving scientific models of the functionality of an NIS or how the single actors are linked. As far as embryonic or not well established NIS were analysed, they were mainly compared with those that are matured. The consequences are plenty of weaknesses found and recommendations made. Often, policy makers are confused, rather than getting a clear guideline on how to start corrective actions. Such reports have often failed to provide clear information or recommendations how to start and how to gain a high leverage effect (especially when public investments were limited). When it comes to concerns of the Federal German Ministry for Education and Research (BMBF) and Botswana Department for Research, Science and Technology (DRST), it is of interest to:

- **identify areas for improvement**

- **identify areas for regional cooperation and mutual learning across the southern African countries**

- **identify areas for bilateral cooperation between Zambia and Germany**

In addition, potential areas for bilateral cooperation between Botswana and Germany may be identified.

The ANIS approach fits into the new tradition of indicator-based studies relying on quantitative data generated by the evaluation of expert interviews. Such an approach differs from traditional benchmarking studies on innovation performance. The Global Competitiveness Report (GRC)[5] and the European Scoreboard or the Nordic Innovation Monitor are excellent approaches for measuring or benchmarking innovation-related performance indicators. However, since the statistical base is often insufficient, the latter is rather intended for well-matured economies than for developing or emerging countries' issues. The GRC uses a mix of statistical data and expert interviews but since it focuses on the competitiveness of nations, the issue of innovation is not sufficiently targeted.

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[5] Schwab, 2009.

The ANIS approach is based on the assumption that at national level an NIS is mainly influenced by 30 determinants.[6] ANIS takes up this challenge by providing an indicator-based assessment of these determinants, each of which reflects an aspect of the complex reality of the innovation system. The determinants may be grouped according to a three level hierarchy:

- **Macro Level: Innovation Policy Level**

- **Meso Level: Institutional Innovation Support Level and Programmatic Innovation Support Level**

- **Micro Level: Innovation Capacity Level**

The 30 determinants' level classification is shown in Figure 1. A comparison between the determinants of these different levels allows the identification of key policy areas requiring a potential intervention to strengthen the NIS. Please note that a further description of the methodology is given at the end of the document.
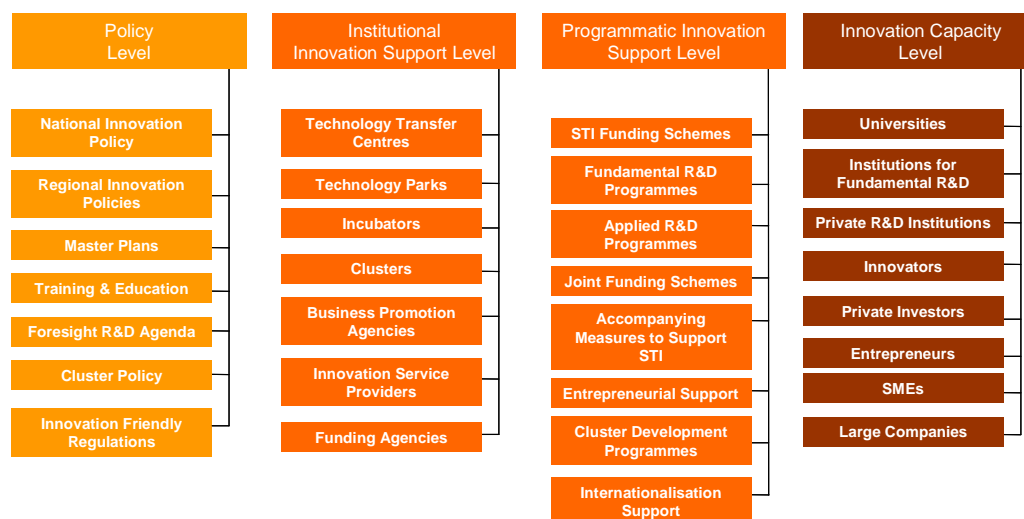
Policy Level	Institutional Innovation Support Level	Programmatic Innovation Support Level	Innovation Capacity Level
National Innovation Policy	Technology Transfer Centres	STI Funding Schemes	Universities
Regional Innovation Policies	Technology Parks	Fundamental R&D Programmes	Institutions for Fundamental R&D
Master Plans	Incubators	Applied R&D Programmes	Private R&D Institutions
Training & Education	Clusters	Joint Funding Schemes	Innovators
Foresight R&D Agenda	Business Promotion Agencies	Accompanying Measures to Support STI	Private Investors
Cluster Policy	Innovation Service Providers	Entrepreneurial Support	Entrepreneurs
Innovation Friendly Regulations	Funding Agencies	Cluster Development Programmes	SMEs
		Internationalisation Support	Large Companies

Figure 1   Main determinants of a national innovation system

The comparative portfolio, which is an integrated element of the ANIS approach, against which the determinants of the Botswana innovation system are benchmarked, consists of the corresponding data of countries having similar comparative economies. We used the classification based on the Global Competitiveness Report (GCR) of the World Economic Forum.[7] The GCR defines three different stages of economies. These are: factor-driven economy (stage 1), efficiency-driven economy (stage 2), and in-

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[6] We are fully aware that an NIS is also influenced by determinants outside of a country. However, as they need a different approach of adjustment, they are not regarded within our analysis. The number of determinants varies slightly according to situational contexts.

[7] Schwab, 2009.

novation-driven economy (stage 3). Countries that are situated in between these stages are called transition countries, either in transition from stage one to stage two or from stage two to stage three.

According to the GCR, factor-driven economies mainly rely on their facilities and basic competencies which mostly are "unskilled labour and natural resources".[8] Primarily, simple products and commodities are traded. Workers have very low incomes. The differentiation of the individual companies mainly happens through pricing. Furthermore, economic advancement is achieved through "well-functioning public and private institutions […], well-developed infrastructure […], a stable macro-economic framework […], and a healthy workforce that has received at least basic education […]."[9] Accordingly, the Botswana economy is defined as factor-driven economy.

In the comparative portfolio of this ANIS study not only countries with a factor-driven economy are regarded but also countries with economies that are in transition from factor-driven to efficiency-driven. This approach provided a broader statistical base for the comparative portfolio which consists of Egypt, Guatemala Honduras, Syria and Zambia. The data of these countries have also been collected by the iit with the ANIS tool. [10]

Besides assessing and benchmarking the determinants, policy makers prove to be much more interested in receiving guidance for action. Therefore, the full ANIS report provides comprehensive recommendations for improvement, taking into account the realistic efforts Botswana policy makers or third party donors are able and willing to provide. At the end of the report, some areas for policy interventions are pointed out. These areas may range from those providing a high impact on the national innovation system to those that do not require much public investments or political intervention for a successful implementation.

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[8] Schwab, 2009.

[9] Ibid.

[10] The individual country reports are available at www.iit-berlin.de/exchange.

2 Botswana's Economic Situation in Brief

According to the CIA world fact book the Republic of Botswana has one of the highest economic growth rates in the world. Botswana can be seen as a middle income country that has advanced from once being one of the poorest countries in the world to being a competitive nation. This progress is mainly due to the industry of diamond mining and diamonds as major export good. Furthermore, the government has established a consistent fiscal policy which has also led to this economic growth. Botswana is ranked number 66 of 132 countries by the Global Competitiveness Report of 2009.

Botswana is located landlocked north of South-Africa. The natural resources of Botswana are diamonds, nickel, salt, soda ash, potash, coal, iron ore, silver. 0.65% of Botswana's land is arable. Botswana has to deal with limited fresh water resources, desertification and overgrazing. However, according to the African Economic Outlook Botswana is taking efforts to ensure a broad access to drinking water. The access to safe drinking water increased from 77% of the population in 1996 to 96% in 2006.

Botswana's demographic numbers are clearly marked by the high prevalence of HIV/AIDS. Of the adults aged 15-49 23.9% are infected with HIV/AIDS. This is number 2 in the world ranking list (CIA WFB).[11] This and other infectious diseases have a major impact on Botswana's workforce and economic strength.

In 1966 Botswana became independent from the United Kingdom. The current chief of state and head of government is President Seretse Khama Ian Khama. The political situation is said to be the most stable of sub-Saharan Africa (GCR).[12] Democracy, free media, and independent judicial system characterise Botswana. As regards to foreign affairs Botswana holds good relations to other countries. 71% of the population are of Christian religion.

The gross domestic product growth rate was between 3 and 6% during the last years. However, with the economic crisis it has turned to -12% in 2009. This is mainly due to the fact that Botswana must rely on the export of one single luxury good. The GDP per capita is currently at 12.100 USD. Concerning the GDP of 2007 1.9% derive from agriculture, 55.2% from industry and 42.9% derive from services (ACR).[13] The industry sector includes diamonds, copper, nickel, salt, soda ash, potash, livestock processing, and textiles. Due to the economic crisis which hit Botswana quite hard, the growth rate in industry sector in 2009 was minus 28%. Products that derive from agriculture are livestock, sorghum, maize, millet, beans, sunflowers and groundnuts. Major export commodities are diamonds, copper and nickel, but also soda ash, textiles and meat. On the other hand major import articles are foodstuff, machinery, electrical goods,

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[11] The CIA World Factbook, 2010.

[12] Schwab, 2009.

[13] World Economic Forum, World Bank & African Development Bank, 2009.

transport equipment, textiles, fuels and petroleum wood, paper products, metal, metal products.
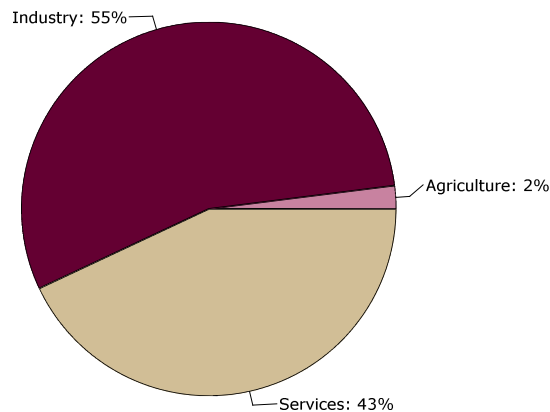
Industry: 55%

Agriculture: 2%

Services: 43%

Figure 2   GDP Allocation (Source: Africa Competitiveness Report 2009)

Agriculture is the major income sector for the majority of the labour force. Therefore, the government has started some initiatives in order to improve the conditions in this sector. Among them are the National Master Plan for Arable and Dairy Development and the Integrated Support Programme for Arable Agriculture Development. These initiatives aim at utilising new technologies, carefully use of the water resources, facilitating access to financing and moving the sector to a business-oriented field. This is done through providing training to the farmers. Furthermore, initiatives that help to improve the infrastructure for livestocks are carried out by the government. Additionally, insurance schemes for natural hazards are introduced. Regarding to the infrastructure, Botswana is investing in the improvement of roads and also the major airport. The unemployment rate of Botswana was 17.6% in 2005 (African Economic Outlook).

According to the GCR[14], Botswana is in transition between being factor driven and efficiency driven. This means that on the one hand participants of the economy mainly compete with given factors, e.g. trading products that mainly derive from natural resources, employing unskilled labour force, and on the other hand efficiency becomes more and more the competing factor, e.g. through higher education, developed labour markets, use of existing technologies, more efficient production processes.

Botswana belongs to the most competitive countries in sub-Saharan Africa. Reasons for this positive standing are according to the Global Competitiveness Report the care-

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[14] Schwab, 2009.

ful spending of the resources by the government, judicial independence; trust in politicians and public institutions as well as low corruption rate. However, the educational system and also the participation in the educational system are not among the high ranked factors. Thus, they still need improvement.

The GDP of Botswana in 2008 was 13.5 Billion USD. The GDP per capita was 7554.2 USD in 2008. According to the GCR, poor work ethic in national labour force is mentioned to be the most difficult factor in terms of doing business as well as inadequately educated workforce. Furthermore, access to financing seems to play a major hurdle in doing business.

The OECD has estimated the growth rate of Botswana in 2009 with 2.9%. This is a significant decrease which is mainly due to the worldwide economic crisis but in particular to higher prices of oil, imported food and electricity. Furthermore, the falling prices for commodities in 2008, such as copper and nickel have led to a decrease in the GDP. As diamonds are the major export article (70% of the export, OECD) of Botswana, they are also the major factor that determines the economic wealth. Furthermore, the tourism sector will be negatively influenced by the global crisis. The OECD states that Botswana must diversify its economy to be less dependent on the diamond production.

Regarding to agriculture, several initiatives have been launched by the government in order to foster the economic output of this sector. The Southern African Development Community (SADC) supports the regional development in Africa and prepares the regions for global competition. With the recently installed "Free Trade Area", goods and services can be transported freely in the South African region in order to support local producers.

Botswana suffered from electricity shortages in 2008 and therefore had to deal with higher electricity prices which had negative impact on the utilities sector. Currently, the service sector and the public sector have grown which is mainly due to an increasing competition in commercial banking and by relating the non-bank sector. Furthermore, transport, post and telecommunication are currently growing.

Botswana has initiated the Private Sector Development Strategy in order to enhance the positive influence of the private sector on the economy, such as a good business climate, and more involvement in trade. Trading across borders is one of the trading activities that can be improved with regard to doing business. Furthermore, Botswana has implemented a National Development Plan (currently lasting until 2016) that mainly aims at the diversification of the economy. In this respect six so called development hubs were installed that focus on the involvement of the private sector in the fields of "education, transportation, diamonds, innovation, health and agriculture" (OECD). Furthermore, a privatisation policy has been implemented by the government. This includes the establishment of public-private partnerships, new financial instruments and mediating institutions, such as an Investment Trust Fund.

As insufficiently educated workforce is hindering competitiveness, one of the major investments Botswana is aiming at is education including further expansion of the universities of Botswana and offering academic study as well as vocational training. In 2008, Botswana has implemented a National Human Resource Development Strategy

which includes guidelines and aims for educating the population at all levels and for all ages from primary to adult education aiming at lifelong learning.

3 Botswana Innovation System Organisations

Policy Level

- Ministry for Infrastructure, Science and Technology
- Ministry of Communications, Science and Technology
- Department of Agricultural Research
- Ministry of Education and Skill Development
- Ministry of Minerals, Energy and Water Affairs
- Ministry of Trade and Industry
- Department of Secondary Education
- Tertiary Education Council
- ...

Meso Level

- RIPCO Rural Industries Promotion Company
- LEA Local Enterprise Authorities
- BOTEC Botswana Technology Center
- CEDA Citizen Entrepreneurial Development Agency
- Botswana Development Corporation
- Botswana Export Development and Investment Authority (BEDIA)
- BNPC Botswana National Productivity Center
- Diamond Technology Center (Sector Techno Park)
- BIE Botswana Institution for Engineering
- BOCCIM Botswana Confederation of Commerce Industry and Manpower
- Botswana Innovation Hub (under planning)
- ...

Micro Level

- University of Botswana
- National Food Technology Research Center
- Botswana University for Science and Technology (under construction)
- BOTEC Botswana Technology Center
- ...

Programmatic Level

- e.g. through LEA: Entrepreneurial Development Training (EDT), Consulting Services
- BNPC (Enterprise Support Programme (ESP)
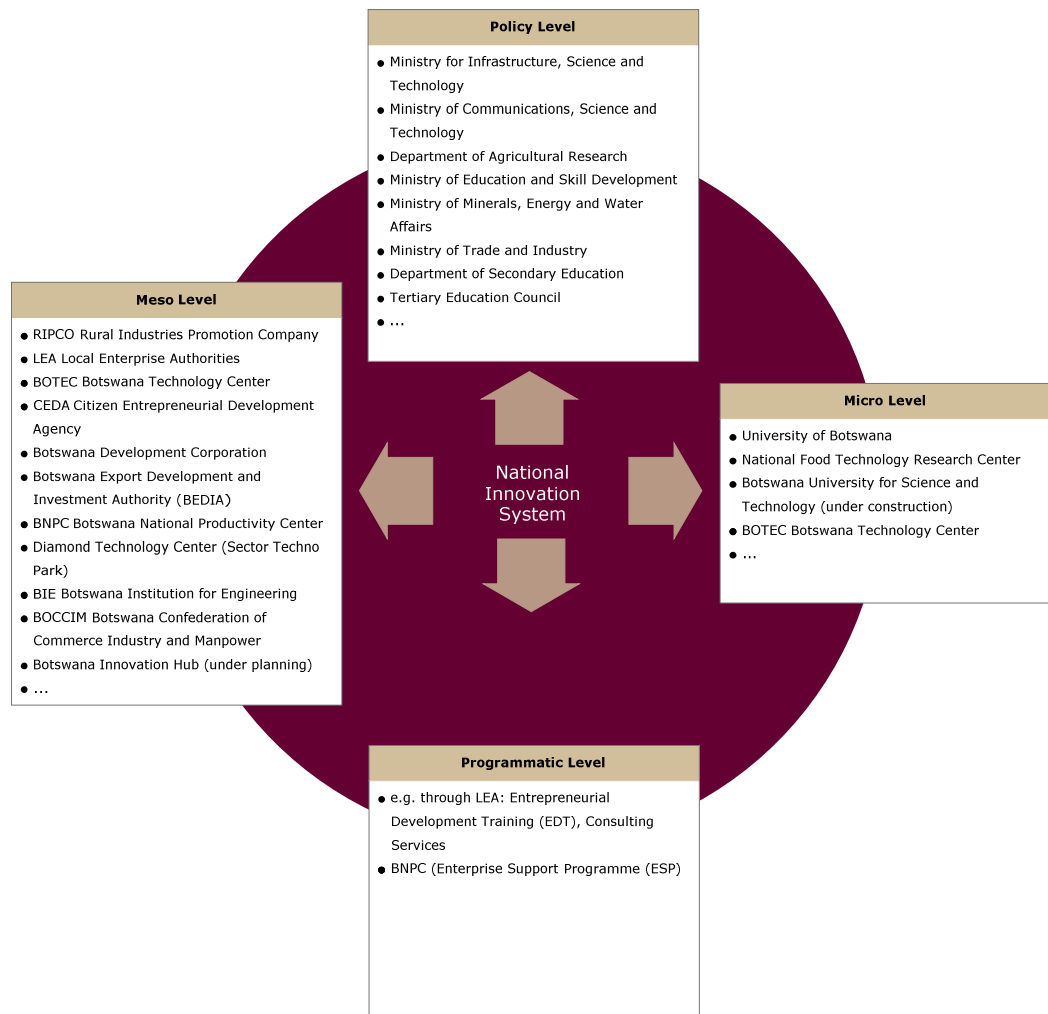
National Innovation System

Figure 3 The main players in the Botswana innovation system (except industrial micro level actors)

The main actors of the Botswana NIS are mentioned in Figure 3. In the following the main findings, based on the assessed 28 determinants are displayed.

4 Assessment Results for Botswana

4.1 Scope, Data Generation and Self-Assessment of Botswana Innovation System Representatives

This report was drawn up based on information gathered between December 2009 and January 2010. The following sources were used:

- Expert (self-) assessments from high ranking (executive level) representatives and practitioners on the actor, meso and policy maker level of the Botswana innovation system.

- Expertise from DRST experts, especially with regard to programmatic innovation support

This input information was discussed during a one day workshop, held in the Boipuso Hall in Gaborone on Jan 26, 2010. This workshop was initiated and organised by the Ministry for Infrastructure, Science and Technology/DRST, while its structure and content followed the ANIS concept. 60 high ranking representatives from innovations system organisations contributed to these workshops through presentations, discussions or written input.[15]

The workshop was organised in parallel sessions to cover and join experts from the policy maker, meso and micro level. These presented and assessed the quality of the respective levels in a consensus oriented manner. Finally, the session members congregated to present and discuss their findings.

The primary objective on Botswana behalf was to identify these interventions, to be included in the Science and Technology Implementation Plan. In the same instance, priorities for the cooperation with Germany were extracted from the list of ideas for intervention.

4.2 Results

Botswana is currently reviewing its Science and Technology Policy with a specific view to coordination and implementation aspects. A wide range of issues has been identified and is about to be addressed: On all levels, a number of concepts and measures for improvement are under design or in early phases of implementation. Nevertheless, it shall be noted that only approved policies and realised facts were respected for the assessment rating.

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[15] In distinction to this consensus discussion oriented self-assessment, the second pillar of the meso level – the programmatic determinants – were assessed through expert assessment by the DRST.

4.2.1 Macro Level: Innovation Policy Level

Within an NIS, the policy level very much influences the framework conditions for innovation as well as for the actors operating in the NIS. The status of maturity is described by six determinants. Figure 4 shows the pattern of the values across the six determinants of the policy level.

A dedicated national innovation policy has existed for more than a decade now. While it is understood to give thematic direction, policy awareness, relevance and implementation are considered serious issues and to be of urgency. Organisations and structures are needed to address these issues. Moreover, coordination in between the funding and guiding ministries is lacking. Coordination needs to be strongly and authoritatively guided. Currently, the National Science and Technology Policy is under review with participation of major stakeholders in Botswana's Innovation System.

Regional (inner-country) approaches are not specifically detailed in the national policy, but regarded in the service portfolios of the LEAs and RIPCOs meso level actors. Regional – international, southern African – relations are sought and pursued on policy level. E.g. currently a new MoU with South Africa´s CSIR has been signed. The second pillar of regional cooperation is SADC related.

There is no specific cluster or cluster management policy. While there are appropriate targets, a dedicated clustering policy to network, bundle and exploit e.g. Botswana's dairy potential has not been addressed, yet. The lack of awareness of the importance of innovation is a major challenge that is envisaged to be tackled intensively.

With regard to intellectual property rights, Botswana enacted the Industrial Property Act in 1996. Under the surveillance of the Ministry of Trade and Industry, it is realised through the office of the Register of companies, business names, patents, trademarks, utility models and industrial designs. However, it is being considered as an issue that this act and its potential for inventors and entrepreneurs is not widely known.

In addition to these, there are hardly any innovation friendly regulations known, and tax or subsidy incentives are not used as a method to enhance innovation. Curricula are rather outdated than designed according to the national (innovation) needs. They are hardly giving impulses to innovation in Botswana. Specific curricula with regard to innovation are few.

In comparison to Botswana's peers[16], the assessment shows the following results:

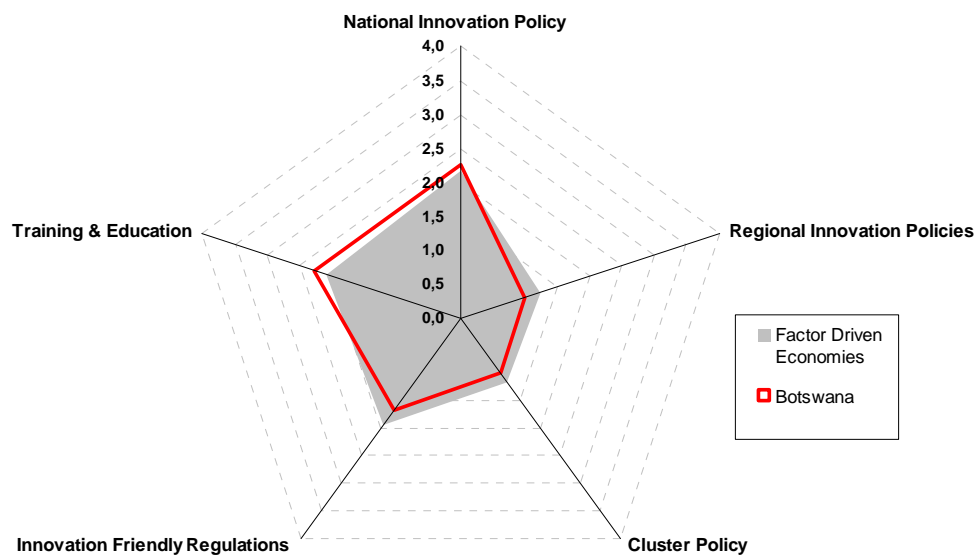[16] The comparative portfolio is described in chapter 1.

Figure 4 Pattern of the determinants on policy level – Botswana, compared to the average of factor driven economies

Botswana has a well defined national science and technology policy. Although it is considered to be of too little relevance to the innovation activity, the quality is still considered higher than at its peers. Cluster policy does not exist, just like regional (national district-oriented) innovation policies, being responsible for a below average rating. With regard to training and education, Botswana is rating comparatively high, given university and educational policies and systems at national level. With its Industrial Property Act, Botswana is at eye level with its peers.
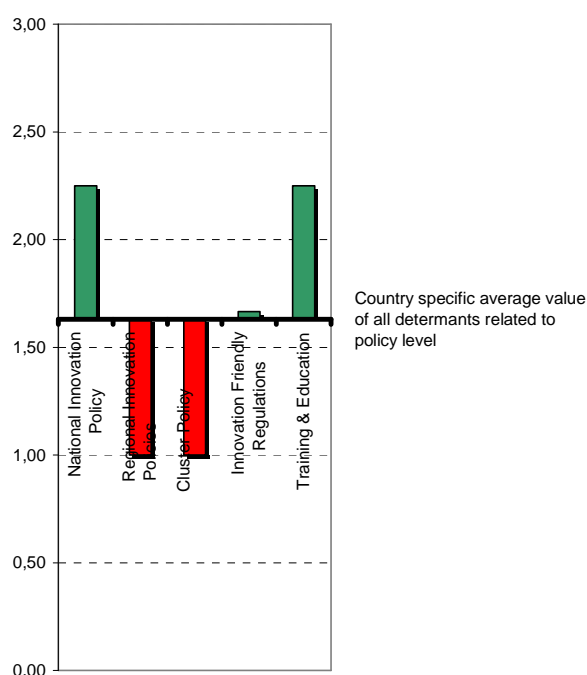
Figure 5   The five determinants compared to the Innovation Policy Level average

Consequently, the policy rating for Botswana shows an unbalanced result. The lack of regional policies as well as the lack of – usually also region and sector based – cluster policies become evident in the chart (figure 5). In distinction to these, training and education as well as the National Innovation Policy score high.

4.2.2   Meso Level: Institutional Innovation Support

Botswana has, given its comparatively small size, a remarkable number of dedicated technology transfer and business development organisations. Most "programmes" are initiatives of these organisations. For practical reasons, they are covered in the "institutional innovation support" chapter.

RIPCO, the Rural Industries Promotion Company, has different tasks in technology adaption and transfer, but also runs an incubating scheme with five incubators running and two under planning. LEA Local Enterprise Authority is running one incubator in Bilan for mechanical engineering. This one is very young, but it has started to actively address students at universities. Gaborone has a multi-theme incubator called BOTEC Botswana Technology Centre. There is one for ICT related founders as well. The incubators act as part of the national policy. Funding for the incubators is considered a little too low though for the existing ones, the RIPCO ones are understaffed and underequipped; the others do a little better.

A technology park does not exist currently, but there is one planned. A technology park following a science park scheme is under planning (Botswana Innovation Hub).

One example for an agglomeration similar to a technology park is the diamond technology centre where many trading companies are located under one roof.

RIPCO Technology Transfer is excellently designed and BOTEC is (yet) considered to be less well designed. Technology transfer is part of national policy, and attached to some research organisations as well (e.g. Botswana University).

Technology transfer centres and incubators are considered to have a high potential to play an important role for the national innovation system, but due to the limited availability, design and resources, they do not act up to their potential.

Factual clusters do exist, as well in industry areas (e.g. Oil), just as well as in craftsmanship areas. Isolated singular activities exist, basically executed through business associations on a regional level. There is no cluster policy in place in Botswana. Basically, the LEAs and the sector and region focused RIPCOs do perform measures that are similar to cluster management organisations.

Hatab (Hospitality and Tourism Association of Botswana), BOCCIM (Botswana Confederation of Commerce Industry and Manpower) and BIE (Botswana Institute for Engineering are examples of active business associations representing the interest of their members and the private sector commerce in general. Others, like Botswana Exporters and Manufacturers association, are examples for an association that is struggling for survival, rather than expanding on innovation issues.

LEA the Local Enterprise Authority has 13 branches all over Botswana. Its task is widespread support, including the support with regard to financing sources as well as the support in export matters etc. LEA is also an example for a type of organisation that is well equipped and has sufficient resources. LEA depends on public authorities, but also on the private sector influence.

The BDC Botswana Development Corporation and CEDA (Citizen Entrepreneur Development Agency) are organisations that distribute government support funds. A small community of private venture capital funds exists in Botswana. The amount of public funds is considered low. Innovation service providers are existing, but not in a sufficient number. Their relevance and impact is considered low, e.g. with regard to the proactive rising of awareness for IPR issues.

In comparison to Botswana's peers[17], the assessment shows the following results:

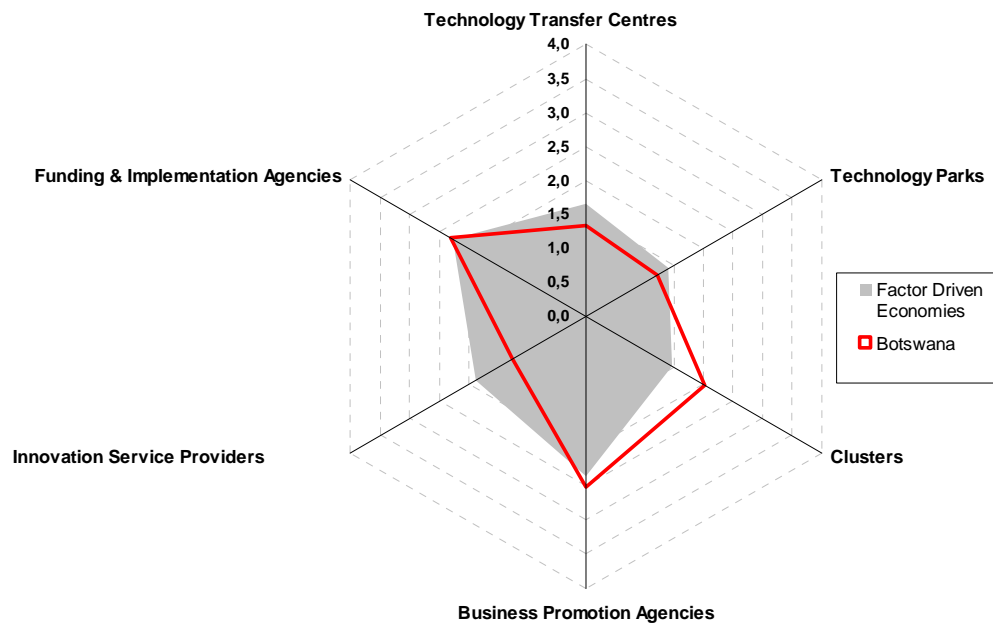[17] The comparative portfolio is described in chapter 1.

Figure 6 Pattern of the determinants on organisational innovation support on the meso level – Botswana, compared to other factor driven economies

In the self assessment, it becomes evident that technology parks are comparatively few in the peer group. Given the number of technology transfer centres and their activities, the comparatively low self-assessment of Botswana, in the eyes of the author, rather shows the view on the large potentials to be explored rather than the already remarkable grade of maturity. Quality, number and role of funding and implementation agencies are considered average in the peer group. The community of innovations service providers is considered to be very weak. More than in other countries, cluster management functions are performed.
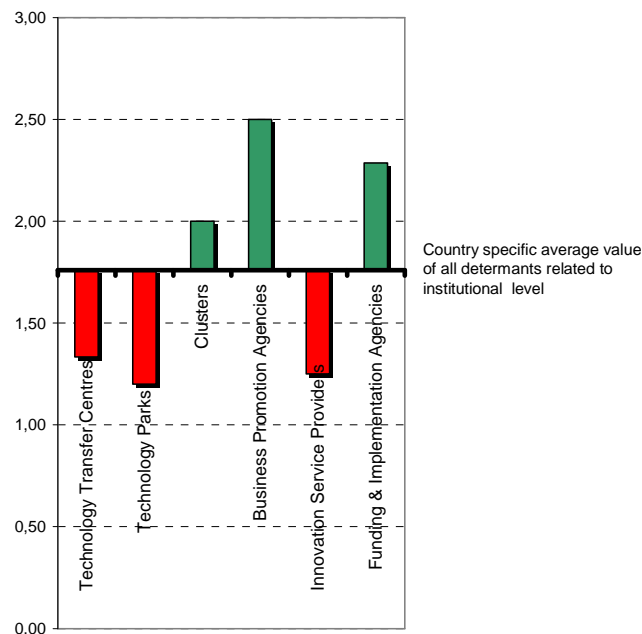
Figure 7   **The six determinants of the Institutional Innovation Support Level average**

Consequently, the rating for the "balance " of meso level support in Botswana shows a result with comparative highs in business promotion and cluster management activities. Dedicated technology transfer centres, technology parks and innovation support providers are understood to be comparatively less well developed.

4.2.3   Meso Level: Programmatic Innovation Support

There are very few examples of programme-approaches to science, technology and innovation funding in Botswana. A programme in the ANIS sense indicates a targeted, time bound set of funds to support research or innovation in order to implement the national science and technology policy - through projects that result from several competitive calls, a practice that is quite common in matured science and technology administrations. However, the specific situation of Botswana – as a small country with a limited set of innovation actors – makes this approach at least partially a questionable one. While common thematic targets are necessary for the coordination and alignment of the resources, competitive bidding in a community with monopolistic research structures may rightfully be considered redundant. In that sense, the non-existence of programmatic approaches is not always equal to development potential.

Consequently, fundamental and applied research through the limited number of dedicated institutions is rather funded through institutional funding than through competitive programmes. This funding though is considered too low and not in every sense connected to science and technology policy goals, and not particularly enhancing technology transfer activity or alignment to a common policy. There are success stories of impact through funding of research.

The absence of collaborative schemes reveals a specific lack of SME involvement with research institutions.

Support for entrepreneurs, start ups and technology transfer is arranged through the infrastructure of LEAs, RIPCOs and other intermediary organisations (see above chapter institutional support). They partly run their own programmes. In addition, one example of a programmatic approach to a directed and dedicated funding has been named, the "young farmers fund", an integrated sector oriented measure with consulting, training and funding components, run by CEDA.

"Accompanying Measures" are part of the activities of the intermediaries named above, e.g. organisation and financing of trade fair appearances. Internationalisation support schemes are not existent in Botswana. Public understanding of science, entrepreneurial spirit and innovation are understood to be an issue, which is currently addressed by the president himself.

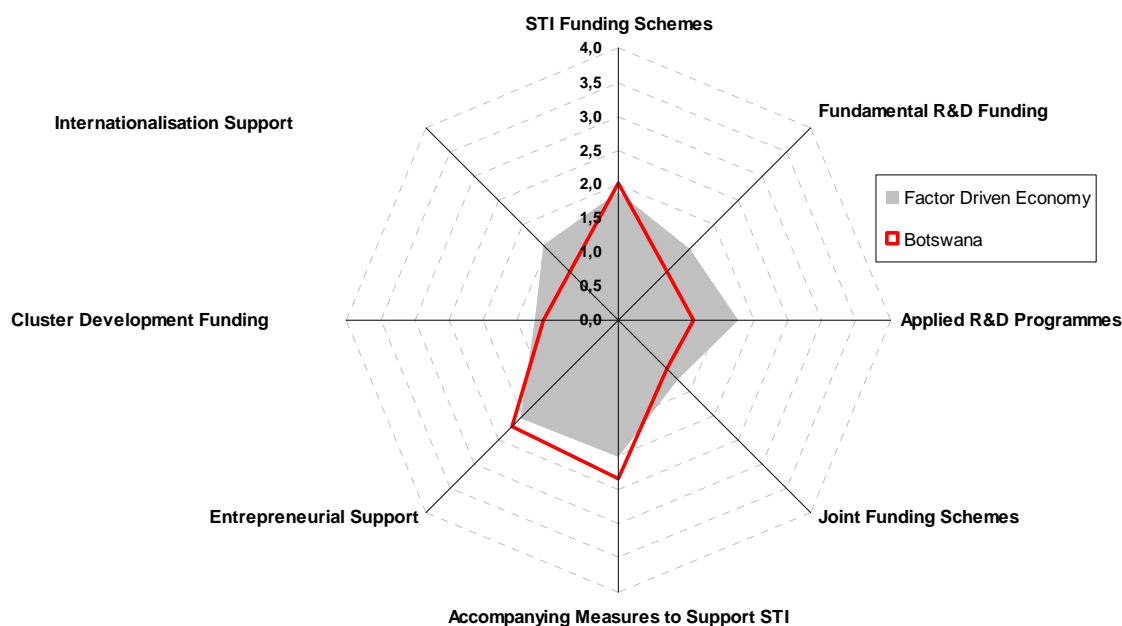In comparison to Botswana's peers[18], the assessment shows the following results:

Figure 8   **Pattern of the determinants on programmatic innovation support level - Botswana, compared to other factor-driven economies**

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[18] The comparative portfolio is described in chapter 1.

Botswana is rating low with regard to the programmatic approaches towards innovation enhancement. Fundamental, applied or collaborative research funding schemes hardly exist at all. With regard to entrepreneurial support and accompanying measures, Botswana scores comparatively high. Programmatic internationalisation support is non existent and as such below average.
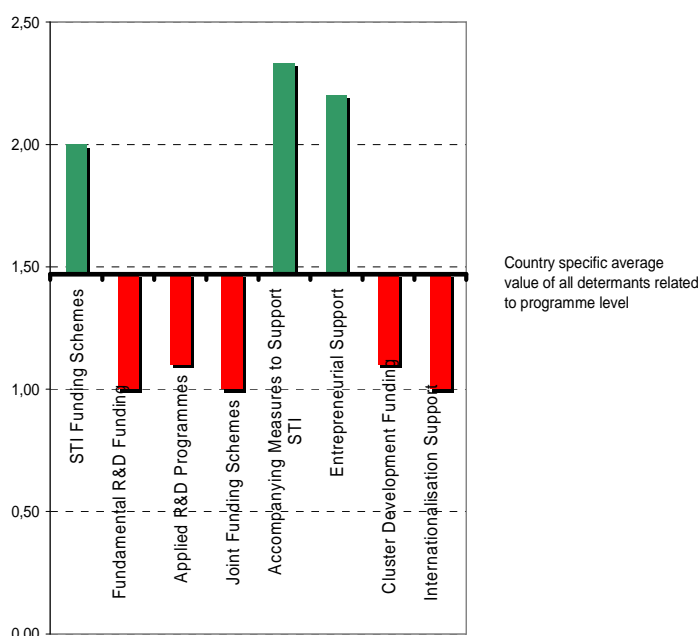

Figure 9   The eight determinants compared to the Programmatic Innovation Support Level average

Consequently, according to the standardised ANIS "balance" rating, fundamental, collaborative and applied research support seem underrepresented. While this is not necessarily an issue, the underrepresented internationalisation support for R&D may be one. On the positive side, the entrepreneurial support is comparatively well developed.

4.2.4   Micro Level: Innovation Capacity Level

The determinants reflect the status of the main actors' development of the Botswana NIS. Botswana has public universities. Although qualified staff is lacking in many places, the quality of the research is considered excellent in some cases. International visibility, networking and citations are low. It is difficult to attract students to stay for research and/or PhD. Ideas are sought, e.g. to attract considerable numbers of PhD students. Cooperation with industry is poor in research as well as in the coordination of demand and/or innovation oriented curricula. In total, the universities play a weak role for innovation, not acting up to their potential.

There is a large number of research and development organisations like BOTEC, the Botswana Technology Centre and RIPCO the Rural Industries Promotion companies.

They are dedicated technology transfer centres that are designed to cater the regional and sectoral demands. This is also the case for the National Institute of Vaccines, the National Food Technology Research Centre. They are not organised competitively. Generally, they are not well equipped and staffed. They play an important role in the national innovation system. They are addressing rather applied than basic research, and target national clients. As such, their international visibility consequently is low. A lack of funding for some of the organisations is stated. With regard to practical relevance, a good track record exists. The other side of the coin is the marginal evidence of scientific excellence,

as it is usually expressed through appearances in international conferences, citations in written scientific publications etc.

Although, addressed by the widespread landscape of technology transfer organisations, the interaction between research organisations and SMEs is low. The quality of the products is considered below average. Companies seldom undertake internal R&D activities. This is often due to the fact that the internal market is small. In the process of starting to export, companies are forced to modernise through the application of international quality standards as a first step of innovation.

Supporting the productivity enhancement and internal R&D at companies is an issue though, just as the potential foundation of private or PPP research organisations is an issue. There is a need of alignment of the scientific resources to the national needs as laid out in the national science and technology policy. Especially indigenous knowledge research is a topic to be enhanced on many levels, also with regard to the association of actors in this field. Need for alignment of R&D because there are overlaps/redundancies.

In comparison to Botswana's peers[19], the assessment shows the following results:

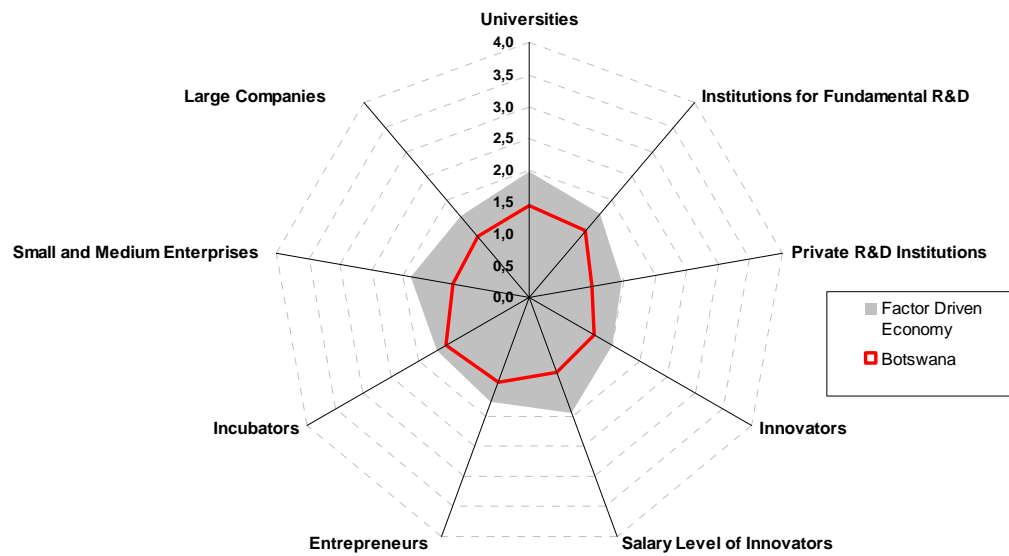[19] The comparative portfolio is described in chapter 1.

Figure 10   Pattern of the innovation capacity on actor level. Botswana compared to other factor driven economies

During the self assessments workshop, Botswana's innovation actors stated a very low maturity on almost all determinants and in respect of most details. This leads to a picture that shows Botswana lagging behind all peers.
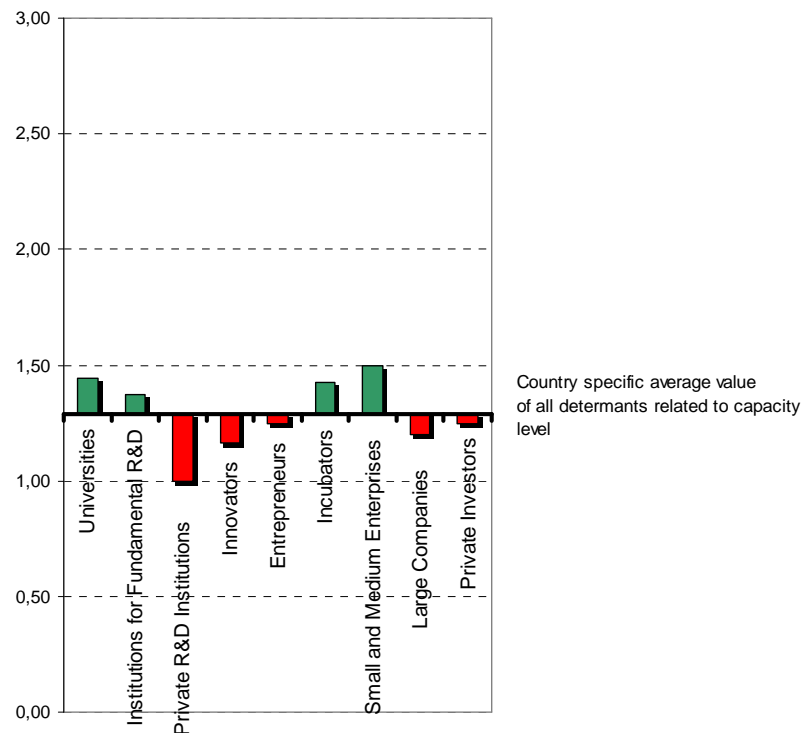
Figure 11   The nine determinants compared to the Innovation Capacity Level average

The rating for innovation on the actor level shows only slight fluctuations on comparable low level (Figure 11). SMEs and universities are considered to be overage, whereas private R&D institutions are assessed to be quite low developed.

5 Main Challenges and Interventions

The status of maturity of an NIS as well as the performance of its actors can be improved by policy measures and their implementation addressing single determinants or a group of them. The potential impact can be expected on several determinants, also vertically on meso and actor level if policy targets them adequately - and implants them.

In Botswana, the assessment workshop was used to immediately list main challenges and ideas for interventions. Here is a comprehensive overview:

No.	Challenge	Intervention
1	Upgrading the universities role for innovation Overcome low funding Lack of guiding policy - no coordination.	a) Assure a modular system of curricula which are more relevant to societal needs b) Diversify the subjects on offer and introduce research fellows to link with the industry c) Retrain university staff d) Create a more conducive environment for research e) A clear policy at national level to support economic development of the country. f) Tertiary education council TEC policy should be applied to all tertiary institutions and made mandatory and function as a control measure for training purposes. g) Marketing language for Universities should packaged in such a way that is more enticing in order to interest the business sector.
2	Fundamental R&D Lack of Vision and Focus on research Lack of funds Lack to access market - thus lack of link to industry	a) Need for HR audits in order to get relevant personnel b) Develop a framework for vision & focus, road mapping, coordination and alignment (avoid duplication of efforts), including linkages between R&D institutions and industry
3	Innovators: Lack of culture and awareness for innovation Indigenous knowledge systems not exploited to	a) Promoting knowledge as resource and use it for economic development b) Create awareness for Indigenous Knowledge Systems (IKS) and add value to IK by employment of technology

	its potential		c) Create structures and initiatives for the fostering of innovations (including e.g. registries as known for engineers, innovators, funding of promising ideas)
	Lack of recognition of innovation and creativity of research at national level		
	Lack of appreciation of local innovations		
	Lack of professional association for innovators		

No.	Challenge	Intervention
4	SMEs The local market is small, export is a priority and quality is low Lack of IPR protection / promotion	a) Improve the quality of products in order to enhance export potential (adherence to quality standards) b) Create and enhance Cluster networking, and support these structures
5	Inadequate IPR protection awareness Inadequate IPR support structures	a) Create awareness and professional support services for IPR protection, especially for SMEs and RTOs/universities b) Encouragement scheme for patent filing for scientists and inventors
6	Low innovation/entrepreneurial culture	Innovation fostering curricula are needed from elementary level. It means a general change in mindset because education is for work, not for innovation nowadays. It should be also part of level assessment to test innovation skills.
7	Lack of retention of R&D experts	Research fellows shall be attracted in higher number. Put up structures/incentives to attract and retain researchers
8	Lack of policy – e.g. cluster, innovation, IPR, TT NIS Fragmented/Weak/lack of coherence MIST Mandate on R&D unclear Lack of policy implementation strategies/capacity	a) Develop (or continue updating) relevant policies and ensure implementation b) Strengthening MIST (in its role) for coordination and alignment

No.	Challenge	Intervention

9	Minimal/lack of private sector participation in R&D activities Funding structure as implementation instrument of policy is not coherent/ and also inadequate	Develop structures, incentives/funding schemes to stimulate RTO & Academia to engage in collaborative R&D and diffuse inventions to private sector
10	Lack of individual experienced coaching of young entrepreneurs	Regional network of senior experts to mentor young entrepreneurs
	Additional Challenges	**Intervention**
	Large enterprises and private investors (venture capital and R&D spending of private persons): Lack of legal framework that encourage to support innovation and research	Develop legal framework to encourage and support innovation and research, e.g. conducive environments like the Botswana innovation hub
	Cluster: A cultural problem is the low motivation/mindset to cooperate in between equals e.g. to manage larger tenders	Creation of awareness for benefits from cooperation in between companies (e.g. through cluster schemes)
	Shortage of appropriate manpower – in R&D	Targeted training to meet needs in relation to R&D capability (e.g. to align needs and offers between university, RTO and industry)

Table 1   Challenges and interventions Botswana

Most of these interventions are considered of high/very high importance for realisation, which was regarded as relevant input for the policy implementation plan.

In order to prioritise the measures in view of scarce resources, a portfolio analysis is undertaken to distinct effective measures from those that are rich in effort and high in risk with regard to implementation.

On the vertical scale, the "Quality+Quantity of Impact" accounts for innovation support quality multiplied with diffusion enhancement of the measure, as an indicator of the effectiveness of expected impact on innovation.

On the horizontal scale, "Effort+Risk" accounts for the cost of measure and its implementation risk. Implementation risk includes e.g. difficulties in coordination between ministries, insufficient authority to implement measures, or complexity of a measure, making it risky to realise.

As a result, the measures in the upper right quadruple are the promising ones, recommended to be executed as quick wins – high in quality and impact and low in effort and implementation risk.
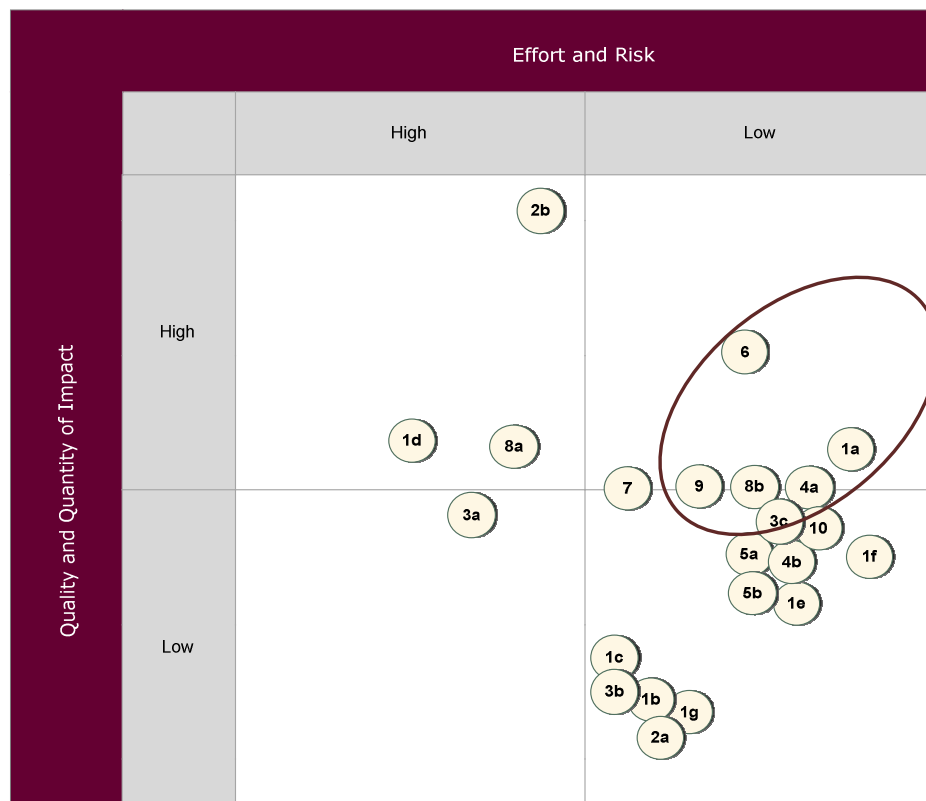

Figure 12   Portfolio – Scope of intervention in Botswana

The upper right quarter of the portfolio shows the interventions that are most probably suitable for "quick wins". On the other hand, systemic approaches may result in synergetic effects with impacts that vary from the ones shown here

6 Analytical Design of ANIS

These are the major objectives for the ANIS studies:

- Analysing of existing literature regarding NIS

- Conducting interviews with experts regarding NIS

- Evaluating and measuring of the outcomes

- Identifying determinants having a high impact with little costs

- Formulating recommendations to improve the prioritised determinants

ANIS takes up this challenge by providing an indicator-based assessment of these determinants, each of which reflects an aspect of the complex reality of the innovation system. The determinants can be grouped according to a three-level hierarchy. Table 2 describes the different dimensions and its actors.

Level		Actors	Functionality within an NIS
Macro	Policy	Public authorities, policy makers	Governing and setting up framework conditions of an NIS
Meso	Institutional innovation support Programmatic innovation support	Institutional innovation support organisations or public funded initiatives / programmes	Institutions and initiatives are tools to turn innovation policies into practice
Micro	Innovation capacity	Firms, academia, educational institutions, etc.	Main beneficiaries of support measures and main producers of knowledge, innovation, technologies, products

Table 2   Levels and actors within a national innovation system

Macro Level – Innovation Policy Level

In macro-dimension, national and regional innovation policies directly influence the framework conditions of an NIS. Laws, decrees and regulations, etc. at that level may often be path breaking, in a positive or a negative way. Public investment in innovation directly relies on decisions made at a policy level. However such political decisions may only influence the framework conditions for innovation and might not turn innovation into practice.

Meso Level - Institutional Innovation Support Level

Institutions operating at meso level are typically technology transfer centres, clusters, innovation service providers and funding agencies. They may be considered as the relevant tools to turn any political decision regarding innovation into practice. In emerging countries such institutions are often publicly-owned. They mainly aim at fos-

tering stakeholders' competitiveness and capability to innovate. Rather than own different programmes to support innovation, those institutions usually provide in-kind contributions such as training, consultation, conducting applied R&D or products' improvement. These institutions remain a key instrument for improving and encouraging the innovation capabilities of firms, especially in countries where public investment is limited.

Meso Level: Programmatic Innovation Support Level

Programmatic innovation support includes public funding programmes and initiatives which aim at turning innovation policy into practice. This represents the second pillar in improving the innovation capabilities of stakeholders within an NIS. Such programmes might be managed either by policy makers or by innovation support institutions. Any measures at that level would require significant public investments.

Micro Level: Innovation Capacity Level

The micro level provides an umbrella for the main actors and enablers within an NIS such as SMEs, entrepreneurs, universities, public or private R&D institutions, innovators or financial organisations.

Identifying the Determinants of National Innovation Systems

The different dimensions may be influenced by some determinants. As far as our research analysis is concerned, these determinants require our special attention since they can be improved with appropriate measures. To sum it up, all four levels of the pattern of determinants affect an NIS. Although we use the four levels separately, we acknowledge that there are plenty of interdependencies and links between them. However, it might be appropriate to consider these levels separately during the analytical phase. Besides, each one of the determinants may differently influence an NIS. The ideal way for a country to improve the outcomes of its NIS will not necessarily be the same as for any other country. Furthermore, it is important to point out that an NIS may be influenced by factors coming from outside the country. Within a globalised world all NIS may be affected by external influences. Therefore, in this analysis we will not consider the external factors that may affect NIS, since they cannot be controlled by national policy makers and actors of an NIS.

In total, we identified a core set of 30 determinants grouped into three levels to support this analysis. All of them may directly influence the efficiency of an NIS (Figure 1). By means of different approaches of measuring all determinants may directly be addressed. In the short term, some of them would only require low input whereas others would need longer periods of time for improvement, combined with significant investment. Improving any determinant might generate magnified positive impacts.

A set of three to five questions has been elaborated to characterise the 30 determinants properly and assess their stage of development. In assessment practice, single determinants that are less relevant may be excluded from specific examination, or combined with others.

7 References

African Development Bank Group (2010), *Topics and Sectors* [online], available at: http://www.afdb.org/en/, [accessed: 19 February 2010].

CIA World Fact Book (2010), *Botswana* [online], available at: https://www.cia.gov/library/publications/the-world-factbook/, [accessed: 19 February 2010].

Freeman, C. (1995), *The National System of Innovation in Historical Perspective,* in: Cambridge Journal of Economics, No. 19, 1995, Cambridge.

Nordic Council of Ministers (2009), *Nordic Innovation Monitor,* Copenhagen: FORA.

OECD (1997), *National Innovation Systems,* Paris.

OECD (2010). *SMEs, Entrepreneurship and Innovation. In: OECD Studies on SMEs and Entrepreneurship*. Secretariat of the OECD Centre for Entrepreneurship, SMEs and Local Development.

Schwab, K. (ed.) (2009), *The Global Competitiveness Report 2009-2010*, Geneva: World Economic Forum.

World Bank (2009), *Key Development Data Statistics* [online], available at: http://www.worldbank.org/, [accessed: 19 February 2010].

World Economic Forum, World Bank & African Development Bank (2009), *The Africa Competitiveness Report 2009*, Geneva: World Economic Forum.