FEDERAL UNIVERSITY OF MINAS GERAIS

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SCIENCE, TECHNOLOGY AND INNOVATION

The challenges of strengthening the national innovation system of Angola

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ABSTRACT

Starting from the idea that a society's whole system is the product of its norms, values, practices, and history (KUADA, 2003), I believe that the process of innovation will depend on these elements for the success of sustainable development. As pointed out by the United Nations, sustainable development does not only concern the interdependent links between environment and development, but also includes a concern for issues such as human rights, population, housing, food security and gender that are important parts of sustainable human development (www.unesco.org, accessed in 11/11/2014). These elements underscore a range of knowledge and skills that will serve as a lever for the development of a society, through its scientific and technological actions.

The objective of this study was to analyze and discuss the specific challenges of strengthening a National System of Science, Technology and Innovation (NIS)[1] in Angola, in order to put the country into the pathway of development, and to reduce existing asymmetries between its people. Determinants such as culture, history, the struggle for independence, civil war, educational processes and the gaps among peripheral countries and the Organization of Economic Cooperation and Development (OECD) countries were crucial to answer the questions proposed for this work.

For this purpose, I investigated the Angolans who participated in the drafting of the National Policy on Science, Technology, and Innovation of Angola. In this vein, following several readings from various sources related to STIP, an attempt was made to perceive and analyze the strategies around the systematization of these policies for socio-economic development, taking into account the new socio-political scenario and Angola's aspirations for economic development in the period following the civil war that lasted 27 years.

Moreover, I augmented with a survey on three institutions located across the country in order to strengthening the approach around the difficulties they have been facing in the post civil war. One of the big issues is the struggle to rebuild infrastructure destroyed during that hard moment.

Several research techniques were combined: in-depth interviews with senior stakeholders from the Ministry of Science and Technology and Rectors, and an analysis of secondary sources. I also used a checklist to survey and verify statistical data.

The overall findings are that Angola still does not have in its structures, capabilities to effectively monitor, and control the challenges perpetrated by the global economic market. This landscape puts the country almost always in a lower position in the field of R&D, and knowledge transfer, including trade.

Thus, concluding, Angola's national system of innovation is currently incipient and its level of unpreparedness and instability requires improvements in its institutional structures and training in order to effect socio-economic development.

Keywords: innovation, innovation system, economic development, civil war, sustainable development, Angola.

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1 From a general perspective, Pavitt (1984) which provides a definition about the national innovation system as a set of institutions involved in the generation, commercialization, and diffusion of new and improved processes and services products. Also, in terms of incentive structure, Innovation System plays a core role to exert an influence on the rate and direction of change that will derive from the changes in technology institutions.

RESUMO

Partindo da ideia de que todo o sistema de uma sociedade é o produto de suas normas, valores, práticas e história (KUADA, 2003), acredito que o processo de inovação dependerá desses elementos para o sucesso do desenvolvimento sustentável. Como apontado pelas Nações Unidas, o desenvolvimento sustentável não diz apenas respeito às ligações interdependentes entre meio ambiente e desenvolvimento, mas inclui também uma preocupação com questões como os direitos humanos, população, habitação, segurança alimentar e de gênero que são partes importantes do desenvolvimento humano sustentável (www.unesco.org, acessado em 2014/11/11). Estes elementos sublinham uma gama de conhecimentos e habilidades que servirá como uma alavanca para o desenvolvimento de uma sociedade, por meio das suas ações científicas e tecnológicas.

O objetivo deste estudo foi analisar e discutir os desafios específicos de fortalecer o Sistema Nacional de Ciência, Tecnologia e Inovação (NIS) de Angola, a fim de colocar o país no caminho do desenvolvimento e reduzir as assimetrias existentes entre seus povos. Fatores determinantes, tais como a cultura, a história, a luta pela independência, a guerra civil, os processos de ensino e as lacunas entre os países periféricos e da Organização de Cooperação e Desenvolvimento Económico (OCDE) foram cruciais para responder as questões propostas neste trabalho.

Para essa finalidade, foram investigados angolanos que participaram na elaboração da Política Nacional de Ciência, Tecnologia e Inovação de Angola. Nesse sentido, foi feita uma sequência de leituras de diversas fontes, relacionadas com PCTI, como tentativa de perceber e analisar as estratégias em torno da sistematização dessas políticas para o desenvolvimento socioeconômico, tendo em conta o novo cenário sócio-político e as aspirações de Angola para desenvolvimento econômico no período que se seguiu à guerra civil que durou 27 anos.

Além disso, este trabalho foi robustecido com uma pesquisa em três instituições localizadas no país, a fim de reforçar a abordagem em torno das dificuldades que o país vem enfrentando neste momento de pós-guerra civil. Efetivamente, uma das grandes questões enquadra-se na luta para reconstruir as infraestruturas destruídas durante aquele difícil momento.

Várias técnicas de pesquisa foram combinados: entrevistas em profundidade com os participantes do Ministério da Ciência e Tecnologia e de Reitores, análises de documentos das instituições envolvidas e de fontes secundárias.

Os resultados indicam que Angola ainda não tem capacidade de efetivamente gerir e controlar os desafios perpetrados pelo mercado econômico global. Este cenário coloca os pais quase sempre em posição inferior nas áreas de P&D e transferência de conhecimento, incluindo o comércio.

Em conclusão, o sistema nacional de inovação de Angola atualmente é incipiente, necessitando de melhorias nas suas estruturas institucionais e de formação a fim de aumentar o desenvolvimento socioeconômico.

Palavras-chave: Inovação. Sistemas de Inovação. Desenvolvimento Socioeconômico. Guerra Civil. Desenvolvimento Sustentável. Angola.

ABBREVIATIONS

CFI	Canada Foundation of Innovation
ERA	European Research Area
DFG	*Deutsche Forschungsgemeinschaft* (German Research Foundation)
EU	European Union
HR	Human Resource
ISCED	International Standard Classification of Education
KIRD	Korea Institute of R&DB Human Resources Development
NIS	National Innovation System
OECD	Organization of Economic Cooperation and Development
PhD	Doctoral/Doctorate
Post-Doc	Post-Doctoral
R&D	Research and Development
S&T	Science and Technology
SI	Systems of Innovation

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1 INTRODUCTION

1.1 Challenges for developing countries

The presence of globalization and increased trade liberalization has created unprecedented opportunities for countries to diversify their economies and expand their products and knowledge abroad. Also, it has exposed countries to increased competition. In other words, it means a 'networked economy' and technology and knowledge transfer where processes shift from hierarchical constructs to ones that are vertically linked in an interconnected and flexible fashion, leading to a dramatic productivity increases (REICH, 1998). And this brings us to the reality that the world is witnessing major transformations – cultural, economic, social, political, and especially technological. This perspective requires experts, scientists, students of the humanities, and social sciences, to constantly rethink traditional practices and positions.

> As humans, the fact of thinking and rethinking our actions allows us to evaluate them, find their significance, and consider re-direction. We live in a world where actions and reactions cause networks and new ruling structures to emerge. The new economy, the informational global economy, and a new culture, the culture of virtual reality, have created an undeniable interdependence among societies aspiring to develop. The logic embedded in this economy, society and this culture, underlies the action of social institutions in an interdependent world (CASTELLS, 1996).

At the same time, this reality comes out with news and hope, causing feelings of fear and insecurity as well. Because, parallel to the emergence of a new society, there are structural changes in the relations of production, power, and experience. These changes also lead to a substantial modification of social forms of space and time and the emergence of a new culture (Castells, 1996) than 'old' societies. New values and behaviours rise up with different languages.

This new worldwide reality is a driving force for the preparation and performance of the most innovative, competitive, and productive actions among professionals and the labour market. For this purpose, a flexible approach in learning about scientific and technological developments should be taken. In this token, according to Castells

(1996), the use of information technology is critical for the success of a strong economy.

Hence, the study developed here is a small sample of this globalizing transformation of consciousness which challenges us to obtain the capabilities to face it properly. This study analyzes some determinants such as history, culture, and educational processes, that influence the development of Angola through science, technology and innovation. As well, it examines the challenges to strengthening the national system of science, technology, and innovation of Angola.

1.2 Research Question

This thesis tackles these issues by answering the main question posed: ***To what extent do various determinants such as history, striving for independence, civil war, lack of policies and educational processes influence the strengthening of the NIS for the socio-economic development of Angola?*** It turns to the experience of the most developing countries which strive to have a feasible development that meet the several problems that plague their populations as whole. Specifically, it looks at understanding the uneven level among developing and developed countries.

In-depth research and analyses were conducted to analyse innovation[2] experts, such as Lundvall, Arraw, Nelson, Edquist, and NIS approaches, lack of policies and infrastructure that can influence the development of R&D[3] and the socio-economic welfare.

The major discrepancies between the wealthy developed and very poor developing countries forced me to enhance a discussion on how to overcome these problems which put those countries into the backwardness of development and welfare of its populations. On this token, this study examines the issues posed above beginning

2 A creation of new or better ways of doing valued things. I relied on the Oslo Manual definition of innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization, or external relations" (OECD/Eurostat, 2005).

3 The study adopted the definitions of R&D from the OECD's Frascati Manual: "Research and experimental development (R&D) comprise work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications" (OECD, 2002).

from the mid-1970s with a particular focus on the 2002 – 2013 timeframe. I chose this time period as important events occurred globally and locally which can help to understand the context of difficulties of strengthening the NIS and developing the country. In the mid-1970s Angola was focus of struggle for the independence. However, in the mid-cold war, it emerged right away in a civil war that lasted until 2002.

1.3 Thesis Overview

I found that it is of paramount importance to make sure that the nature of this work dictates an interdisciplinary approach because a rich body of literature was used to explain NIS, R&D, including approaches found in economic, social sciences and humanities. Thereby, this study is divided into 5 parts as it follows bellow.

PART I informs the reader about the methods and analysis used in the thesis. Moreover, it explains the research methods used for the study and case studies chosen to explain why Angola relies on the current situations such as a weak NIS and non-industrialized country. In this vein, the study also considers the subjects interviewed who were involved in the process of drafting the National Policy of Science, Technology, and Innovation – PNCTI (acronym in Portuguese). The interviews recorded gave various perceptions regarding the importance of science, technology and innovation to developing Angola in this new scenario. This is important because they revealed the current landscape and cultural influences on scientific, technological, and innovative development.

The research relied on qualitative approach, taking into account the interviews, some official documents, the indicators of science, technology[4] and innovation and the recent Policy of STI. On the other hand, there was a quantitative analysis on some institutions, as well Research Centers and Productive Sectors in order to notice the situation of R&D throughout the country. Hence, I did the analysis on interviews, and

4 The study relied on the definition of S&T which “encompasses disciplines in the natural sciences (the study of nature); the social sciences, humanities, and health sciences (the study of human beings); and engineering (the creation and study of artifacts and systems),” and includes consideration of the “myriad connections from science to technology and vice versa” (CCA, 2006, 2012a).

to give support to the study, I am also referring to the content analysis, and/or adopting among others, the contributions of Bruner (1997) on the paradigmatic and narrative thinking.

PART II and III explores the thesis themes, examining the various debates underway in the field of National Innovation Systems, Research and Development, Technology Development and Technology adoption. The objective is, moreover, to provide more theoretical grounding in order to assess the applicability of such material in explaining what is occurring in developed countries rather than in less developed countries.

PART IV informs the historic contextual overview of Angola, aiming at exposing the issues that characterize the country as an African country, which strives for a better welfare for its population.

PART V and VI, regarding findings in interviews and surveys, is divided into two chapters. The first chapter focuses on the state of the National System of Science, Technology, and Innovation of Angola through the interviews. Despite efforts by the government, they provide information which answers the questions posed in this study. One of the findings is that Angola remains the country that has the lowest rates in terms of scientific and technological performance and the lowest rates in Higher Education. The second chapter turns on the results of the survey undertaken on three institutions across the country. The overall current state of NIS in Angola, including the lack of funding of research activities and the lack of high-level human capital has been detrimental to boosting the development of R&D institutions and hindering the development of entrepreneurial enterprises across the country. In addition, the lack of essential documents establishing guidelines, principles, rules and procedures, and evaluation procedures, has not allowed the harmonization of sectorial programs and collective initiatives on R&D. (PNCTI, 2011).

PART VII concludes the thesis, bringing back the discussion to answering the overarching research questions posed – ***To what extent do various determinants such as history, striving for independence, civil war, lack of policies and***

educational processes influence the strengthening of the NIS for the socio-economic development of Angola?

1.4 Conclusion

To summarize, the overall current state of NIS in Angola, including the lack of funding of research activities and the lack of high-level human capital has been detrimental to boosting the development of R&D institutions and hindering the development of entrepreneurial enterprises across the country. In addition, the lack of essential documents establishing guidelines, principles, rules and procedures, and evaluation procedures, has not allowed the harmonization of sectorial programs and collective initiatives (PNCTI, 2011) in order to strengthen the NIS of Angola.

Moreover, the overall approach between experts and the contextual landscape of Angola was crucial to finding the answers posed by the research questions. Hence, taking into account this challenge, the next section is the overall research methods and analyses techniques.

PART I: METHODOLOGY

2 RESEARCH METHODS AND ANALYSIS TECHNIQUES

2.1 Introduction

The purpose of this chapter is to enlighten the reader concerning the design, methods, and analytical tools and parameters of the dissertation. The first section focuses on discussions considering methods at a more general level, suggesting that one's ontology shapes how research is conducted, including concepts and methods chosen.

The second section focuses on the idea that the one of many problems stem from the previous studies on National Innovation Systems (NIS) in developing countries, especially in the African Continent and, properly, Angola. In this sense, the research was conducted at the meso-level, especially in some public institutions across the country because (MALLETT, 2009) it offers a new methodological approach, which can shed further insights into this area of study.

The third section of this chapter emphasises on the research methods and analysis used for this study, which was largely based on qualitative methods, but reinforced with quantitative data. For various reasons, I chose to base my research from evidence obtained through qualitative interviews and codes. On the one hand, these approaches are exploratory, and emphasize the importance of context and setting. On the other hand, by capturing numerous aspects in a setting – technical, economic, as well as social and cultural, they (MALLETT, 2009) provide a deeper understanding of phenomena. In other words, the participatory approach permits one to analyze the participation of the actors involved, a process which allows them to understand the meaning that others give to their own situations more clearly. In addition, by using these techniques, researchers are more equipped to develop concepts that recognize differences in settings.

2.2 Methods Used to Examine the NIS of Angola – The Impact on Technologic, and Socio-Economic Development

There are a few methods to examine any situation given its nature. Considering the subject of my research, I have had some thoughts and challenges to formulate a feasible conclusion. Thus, philosophically, the discussion that had place within the notion of doing a research is undoubtedly broad.

Knowing that each individual person has different ways of understanding the social world than the another, this study relied on, first hand, qualitative research in order to get the most relevant data to answer the research questions. It is also important to consider that in qualitative research, there is a relationship that creates a similar turning point in data collection, which affects the relationship between a researcher, a field setting, and individuals being observed or interviewed.

In this qualitative approach, a semi-structured interview has been enhanced, because depending on (SILVERMAN & PATTERSON, 2014) the research setting, the process of collecting data and the results of subsequent analysis can be used as tools for empowerment and social change.

As qualitative research has a great concern with a serious relationship about what data are represented, some other discussions for the same effect must be taken into consideration. However, despite of some other opposite views, this is the pathway of producing feasible and useful knowledge. It will be stressed on chapters ahead the idea of strengthening a National Innovation Systems in any country which is focused on interaction and relationships. This means that neither companies and knowledge institutions, nor persons, innovate alone. Having this mindset is essential for researchers so that one can have on display essential tools to choose the best methods and theoretical frameworks.

In some circumstances, a more quantitatively-based assessment would be useful to answer a certain research question. However for this study, I turned to systemic approaches to answer my research questions because they help me to understand how national features motivate (or not motivate) Angolan police-makers to accept and follow a feasible pathway towards development, and consequently, a welfare of the population. An empiricism approach helped me to interpret why Angola has difficulties in building a strong National Innovation System. Also, it enabled me to identify feasible paths to put the country in the pathway of the development.

Thereby, in 2013, there was a summit of the African Union[5] (AU) in Addis Ababa, Ethiopia, which undertook an intensive planning exercise for the next 50 years. They realized that, even though there are advances in some areas such as new universities, infrastructures and so on, Africa still has not seen much improvement as a whole. Too many problems still plague the mainland, putting its population in a whole state of poverty and misfortune. Even though some other countries in Africa have had some economic and social improvements compared to others, most of them remain in a low position of development. In addition, water shortages, and devastation of forests continue to affect food production. Civil wars, which stem from disagreements among Africans, ethnic groups, and religion strikes, and financial system instability brings the continent below others in terms of welfare. It is making the income, life expectancy, education, and the development of science, technology and innovation, worse, especially in sub-Saharan Africa.

Regarding this plethora of issues, I have decided firstly, to turn to qualitative methods because, based on its features, it lays out the conditions for the researcher to arrive at an understanding or interpretation of social phenomena, based on perspectives, documents, and field research. Secondly, this study was augmented with quantitative aspects that allowed me to address these above points to get more confident data and enrich the discussion.

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5 The African Union (UA) formerly (1963–2002) Organization of African Unity, intergovernmental organization, was established in 2002, to promote unity and solidarity of African states, to spur economic development, and to promote international cooperation. The African Union (AU) replaced the Organization of African Unity (OAU). Its headquarters are in Addis Ababa, Ethiopia. It has the objective to achieve greater unity among African States; to defend states' integrity and independence; to accelerate political, social, and economic integration; to encourage international cooperation; to promote democratic principles and institutions (Encyclopaedia Britanica&African Union, 2015).

Although (MALLETT, 2009) quantitatively-based studies comparing indicators from developing countries are considered advantageous as they are less costly and more efficient, some difficulties have taken place. For instance, data provided by some developing country governments to populate their statistical studies, in some levels, do not reflect the reality on the ground. Luckily, having been part of a group who drafted the Science Technology and Innovation Policy of Angola, it was easier for me to get through some departments and easier to get data across the country.

2.3 Objectives

The genesis of these ideas stems from the perspective of Lundvall (1988); Rosemberg (1982), Arrow (1962) and Nelson (2005), in which the performance of individuals or institutions in adverse contexts requires the actors to develop selective capabilities and systematization of their actions to confront and solve local phenomena. In addition, it stems from the importance of examining science and technology as a system, hence, the three-pronged approach targeting the NIS strengthening in Angola.

Therefore, before these approaches are explained, and to have the best results, I posed the following questions:

I. To what extent do various socio-economic, educational processes and historical factors such as striving for independence, civil war, and lack of policies, influence the strengthening the NIS and Development in Angola?
II. What is the individual perception of each respondent about the PNCTI statute and the challenges to foster R&D and innovation in Angola?

2.3.1 General Objective

To consider the historical-cultural and educational process that Angola has experienced, and the challenges of strengthening the National System of Science,

Technology and Innovation to develop Angola, with a particular focus on the post Civil War.

2.3.2 Specific Objectives

- Analyze the historical, cultural and socio-economic aspects regarding the challenge of the systematization of science, technology, and innovation of Angola.
- Understand the vision of actors who participated in the Drafting of the National Policy on Science, Technology, and Innovation of Angola related to scientific, technological and innovative development;
- Analyze the research practices in the sub-system of higher education, R&D's institutes, and the landscape of the productive sector – key roles of industries, enterprises, government agencies, and the relevance of science, technology, and innovation for the development of the country;

Therefore, I relied on two premises. The first assumption is that it is more than apparent that the learning that leads to technical knowledge and a good direction entails the promotion of skills and innovation, more jobs, wage improvements, and the welfare of the people. In other words, learning is the key dynamic mechanism for knowledge accumulation, innovation, and growth (WANGWE, 2003, p. 77). The second premise stems from the notion that learning has an institutional dimension through which one can ascertain and assess findings which aim at creating innovation, which fits the Angolan targets of development. In other words, the institutions – firms, R&D institutes, and universities or government agencies, mark boundaries, which have an influence on uncertainty and on the direction of learning (WANGWE, 2003).

Overall, as I have stressed earlier, unlike the purports that recreate features of innovation systems found in OECD countries in the African context, the challenge is to find ways of adapting some aspects of the NIS framework to suit the development conditions in Angola. Because, not only Angola, but many governments in developing countries are very limited in terms of resources, and face acute socio-economic

problems such as extreme poverty, famine, and macro-economic weakness augmented by political instability, external debt, and so forth. In other words:

> […] national systems are postulated to differ in respect of the structure of the production system and the institutional set-up hence the national idiosyncrasies. These may include internal organization of firms, inter-firm relationships, the role of the public sector, institutional arrangements in specific sectors such as the financial sectors and R&D activity (WANGWE, 2003).

Many social studies of science, technology, and innovation from a sociological perspective, have been conducted which accentuate the importance of understanding the technological changes with the focus on the actors and their actions in relation to technological development. Moreover, economic studies have shown that scientific and technological changes are seen as the key factor of economic competitiveness and performance of business success. Therefore, to have such success, as I have mentioned above, learning plays a core role because it is the basis for knowledge accumulation, innovation, competitiveness, growth and/or economic success (CHAMINADE at all, 2009).

From a Schumpeterian perspective, the performance of individuals or institutions in adverse contexts requires the actors to develop selective capabilities and systematization of their actions to confront these local phenomena. Schumpeter has referred to this process as creative destruction through which some actions must be taken into consideration such as *learning by doing* (ARROW, 1962); *learning by using* (ROSENBERG, 1982) and; *learning by interaction* (LUNDVALL, 1988) and Learning by Study and learning by solving problems (AROCENA & SUTZ, 2010).

This emphasis on utilizing and fostering local knowledge, expertise and goods and services in combination with conventional metrics of science, technology, and innovation is the pathway to experiencing innovation in developing countries as a whole. Otherwise, these countries can remain in the backwardness of science, technology, and innovation, hindering the sustainable development. As Viotti (2002) says, most innovation taking place in developing countries is related to the absorption of technology and competence-building, rather than resulting in introductions of new-to-the-world innovations.

As stressed above, some issues such as the civil war that plagued the Angola for 27 years and the acute socio-economic problems such as poverty, famine, macroeconomic instability, and external debt contribute to Angola's delay in innovation. A *habitus*[6] which stems from this landscape promotes a systematic delay of science, technology innovation in the country.

Nevertheless, some actions within Angolan PNCTI's recommendation must be taken with the utmost endeavour. There is some disagreement among the major authors, GLENDA, 2012; LUNDVALL, 2003; PAVITT, 1984; MOWERY, 2005; NELSON, 2005; FREEMAN, 2008 relating to the imposition of innovation policies and innovation system-building as primarily part of the industrial and economic growth. Hence, it is important to draw a policy that systematizes innovation holistically, without neglecting cultural, historical, sociological, anthropological, and contextual local issues.

2.4 Proposition

Taking into account the above approach, this study is based on the proposition that the National Innovation System in Angola is conditioned to those above mentioned *habitus*. The innovation activity is static, and national, provincial, and local institutions work isolated within a weak framework – the education system, in particular, the sub-system of higher education, the productive public sector and private institutions (enterprises, firms). In other words, regarding that the most institutions across the country function in an isolated framework, by definition, it is quite impossible to undertake innovation properly which promote development.

Although there is already the Science, Technology, and Innovation Policy of Angola or Política Nacional de Ciência, Tecnologia e Inovação de Angola (PNCTI), many of those phenomena hamper the strengthening of the National Innovation System of

6 Here, I stressed down Habitus relying on Bourdieu's concepts. It refers to the physical embodiment of cultural feature or cultural capital, to the deeply ingrained habits, skills, and dispositions that we possess during our life experiences. Bourdieu considers that habitus is a social creation integrated to specific contexts and over time, referring to the lifestyle, values, dispositions and expectations of particular social groups that are acquired through the activities and experiences of life history (BOURDIEU, 2008).

Angola. Consequently, Innovation activity is hampered as well. So the long and short of it is, and despite this emphasis on systematizing STI through this over-arching policy in 2011, due to Angola's institutional context, culture and *habitus*, the creation of this policy itself is likely to bring about desired results in terms of spurring innovation and socio-economic growth in country.

2.5 Characterization of Research

As pointed out earlier, in order to respond to the two questions and the objectives above, and taking into account the Angolan complexity as a developing country, I opted to a qualitative approach augmented by quantitative approach. This is all to clarify that this research is made up of a combination of qualitative and quantitative constructs (NEWMAN & BENZ, 1998).

a) Qualitative Research

Primarily, I decided to go this way because qualitative research (BERG, 2004) refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things. It gave me conditions to arrive at an understanding and interpretation of the Angolan phenomena that hinders the National System of Innovation (NIS) building. Of particular relevance is the phenomenon of stagnant productivity in the field of sciences, technology, and innovation which has its back roots, on one hand, on weak education understanding among some policy-makers across the country. On other hand, there is a gap which stems from chronic and acute socio-economic problems such as poverty, famine, macroeconomic instability, and external debt (WANGWE, 2003), putting Angola in a state of decline.

Altenburg (2009) points out that developing countries are often trapped in a vicious circle through which poverty limits the scope for investments in innovative capacities, as well as for building up efficient institutions. Thus, taking into account these realities, the qualitative method was of particular relevance to discover answers to the questions I have posed early because people create meanings according to their realities and perspectives. In social sciences, meanings derive from the social

process of people or groups of people interacting (BERG, 2004). In doing so, learning about the subjects' life experiences was one of tools to get the data because it include emotions, motivations, symbols, and their meanings, empathy, and other subjective aspects associated with naturally evolving lives of individuals and groups (BERG, 2004). In other words, in social sciences, qualitative research stems from traditions in anthropology and sociology, where the philosophy emphasizes the phenomenological basis of a study, that elaborate description of the meaning of phenomena for the people or culture under examination (NEWMAN & BENZ, 1998, p. 9).

In the meantime, it is important to ensure that I do not have a goal to create a theory around national innovation system. Instead, I rely on Berg (2004) who affirms that a theory might represent attempts to develop explanations about reality or ways to classify and organize events, or even to predict future occurrences of events. In other words, this study tries to put into the forefront, discussions around Angolan socio-economic and welfare challenges through STI as a mean to put this country into the path of the future.

b) Quantitative Research

Secondly, I used the quantitative research in Angolan institutions such as the Ministry of Science and Technology and three companies across the country, which enabled me to have some data of the current situation of R&D and other productive institutions. However, as I pointed out earlier, it is important to stress that all behavioral research is made up of a combination of qualitative and quantitative. In a positivist view, quantitative research provides rigorous, reliable, and verifiably large aggregates of data and statistical testing of empirical hypotheses (BERG, 2004). However, as NEWMAN & BENZ, (1998) say, both co-exist in the world of inquiry, and together they form an interactive continuum. In other words, both are needed to conceptualize research as a whole.

c) Descriptive Research

For the purpose of this study, I relied on descriptive research to identify and typify the institutional processes of the respondents. Because, descriptive research exposes characteristics of a given population or certain phenomenon, one can also set variable correlations and define its nature. It has no commitment to explain phenomena that it describes, although it serves as a basis for such an explanation (VERGARA, 2007, p. 47). In other words, it enabled me to identify and obtain information on the characteristics of the difficulties the interviewees have had on NIS building in Angola. According to Berg (2004), an exploratory study, rather than having propositions, may have a stated purpose or criteria that provides guidance and a kind of operating framework for the case study to follow.

2.5.1 Case Study

Taking into account the depth of study, with the assumption that the National Innovation System of Angola is quite weak, I relied on a case study[7]. This procedure enabled me, indeed, to understand the plethora of problems which plague the institutions and hinder the socio-economic development of the country. As Berg (2004) points out, a case study may focus on an individual, a group, or an entire community and may utilize a number of data-gathering technologies such as life histories, documents, oral histories, in-depth interviews, and participant observation. Therefore, I noticed that one can get knowledge of the studied phenomenon from the intense exploration of a single case, as its use applies to the study of events, processes, organizations, groups and communities.

Hence, with the fear of overlooking some data, regarding the importance of the case study, I took care of the idiosyncratic landscape of Angola such as culture, language, behaviour, and the actual politic context. Angola is a country situated in the

7 As Vergara (2007, p. 49) points out, a case study is confined to one or a few units, such as person, family, product, company, government agency, community or even country. It has a depth and details character. It may or not be performed in the setting. In doing so, for this study, the case study approach served as a means through which data was organized, preserving the object studied as its unitary character. Therefore, the aim is to investigate, as a unit, the important features for the object of the research study, knowing that the case study is an empirical investigation and comprises a comprehensive method, with the logic of planning, gathering and analyzing data (YIN, 1994).

Southwest African Continent with particular features which must be taken into account. Those features have implications for innovation in Africa. Undertaking a case study in Angola, the researcher must take into account, specifically, the cultural factors that influence individual and organizational characteristics which shape the innovative process, resulting in a socio-economic and technological development.

The results of a case study must convey both the findings of the study and the relationship of the study team to the case (SCHOLTZ, 2002, p. 335). Thus, in order to give an end to the information provided by the interviewees about the topic of this study, I conducted an audit of selected scientific research institutions and companies in the Angolan productive sector in order to assess the state of scientific research and technological development and their constraints.

2.6 Techniques of Data Collections

2.6.1 The Interview

In-Depth Interviews

Now that I have shown the purposes of this study, I can now turn my attention to the various techniques that were employed for data collection in my field work. The first means through which I collected data was through a series of in-depth interviews.

Hence, to effectively capture the way these people see themselves within their experiences and practices, I relied on historical, economical, and sociological approaches to understand the social and human phenomena which hinder the National Innovation System in Angola. The idea of this case study was crucial, considering the implied prospects, actions, and different discourses among the interviewees, recognizing them in all dimensions.

Therefore, understanding the life experiences of the respondents and specific social background of each of them was *sine qua non* for the benefit and the quality of the interview. Such understanding contributed to the endeavour of the research,

providing a detailed description of the social environment (GASKELL and BAUER, 2008, p. 65). Given the importance of this research, I opted for the in-depth interview method because this technique allowed me to gather as much, and as detailed, information as possible in order to grasp the totality of a situation.

In doing so, through individual interviews, it enabled me to examine the social origins and previous experiences of the interviewees, as well as their particular opinions on current issues. In order to conduct an interview, it is necessary to take into account some parameters to guide the focus of research. One is the type of the interview, and second is the choice of subjects to be investigated.

As pointed out early, semi-structured interviews involve sorts of key questions through which one can define and strengthen the result to be reached.
However, the clear-cut assumption that Bergs (2004) points out is that the question of the interview must reflect an awareness that individuals understand the world in varying ways. In other words, the researchers who would fall under the semi-structured interview based on the above criteria are able to understand fully that their (interviewer and interviewee) culture, experience, history, and so on impact the research work they undertake and thus, the results of their work.

Thereby, aiming at gathering (MINAYO, 2006b) the information that needed to clarify the object of this study, I conducted individual interviews, taking into account the scientific knowledge produced in the theoretical perspective. In addition, the empirical reality was also crucial to reach the objectives of the study. In doing so, I had access to the interior and the particular reality of each one of these interviewees, which led to capture these individuals experiences, their practices and motivations. Also individual interviews enabled me to have a multiple view of their experiences. Finally, the participatory relationship led me to analyze the participation of the respondents involved in the PNCTI building. It allowed me to understand the meaning that each one gives to his own situations more clearly.

In concluding this section, regarding these approaches, I decided to run a semi-structured interview with the National Authorising Officers of the Ministry of Science and Technology and the Rectors of two Universities of Angola. They formed part of

the working group that drafted the governing instruments of the National Policy on Science, Technology and Innovation for the Angolan government – PNCTI. Other reasons for choosing them are explained in the following sections.

2.7 Selection of Research Subjects

In qualitative research, the selection of interviewees cannot follow the procedures of quantitative research for a number of reasons. One of them is that the real purpose of qualitative research is not to count people or opinions, but rather to explore the spectrum of opinions, different representations of the subject matter.

In order to have safety and security of the subject of the research, and not to run the risk of conducting focus group research, the present study relied necessarily on individual in-depth interviews augmented by a survey in some institutions. I also did documentary research in order to get the most recent data written in some official documents as the National Science, Technology and innovation Policy of Angola (PNCTI).

For the interviews, as pointed out above, I selected the National Authorising Officers of the Ministry of Science and Technology and Rectors of Universities of Angola. They made part of the working group that drafted the governing instruments of the PNCTI. I opted to work with this group of professionals due to the fact that they were crucial elements in the institutionalization of PNCTI. Also because they have a close relationship with other different ministries of the state, Higher Educations and R&D's Public and Private institutions across the country.

I pointed out earlier that Angola suffers from a great lack of in-country experts. Moreover, regarding the difficulties in terms of communications across the country, I had, at some points, to conduct the interview through direct calling / emails. Also, I had a support and courtesy from the ministry of Science and Technology.

2.7.1 Ethic Principles

Knowing that ethics emerge from value conflicts, the individuals' rights to privacy versus the undesirability of manipulation, openness and replication versus confidentiality, future welfare versus immediate relief, and others, each decision made in research involves a potential compromise of one value for another.

Thus, researchers must counterbalance their various social responsibilities to themselves, their profession, to pursuit of knowledge, the society, and their subjects (BERG, 2004). In this sense, to avoid a consent slip, before booking an appointment with interviewees, the confidentiality and anonymity were put on the forefront of my first contact.

In doing so, the subjects are identified with the initials of the names and their respective institutional positions as it follows below:

1. **Dn** – National Director of Scientific Research - DNACIC;
2. **Ar** – National Director of the National Center for Scientific Research - CNIC;
3. **Al** – National Director of the National Fund for Scientific and Technological Development - FUNDECIT;
4. **Gm** – National Director of Technological Development and Innovation - DNDTI;
5. **Rm** – Executive Director of National Council of Science, Technology and Innovation.
6. **Af** – Rector of the University Katiavala Buila.
7. **Rs** – Manager of National Technological Centre.

Thus, as previously mentioned, according to the difficulties across the country, I chose these seven individuals because they are very knowledgeable and active in Science Technology and Innovation and Education across the country. They are directly committed with the development of the National System of Innovation in Angola.

2.8 TECHNIQUES OF DATA ANALYSIS - CONTENT ANALYSIS

2.8.1. Analysis Techniques

As discussed above, data were collected with the objective of answering the research and sub-research questions. It was mainly analyzed through an in-depth evaluation and interpretation of information supplied through primary and secondary-sources.

In this token, content analysis allowed me to (BAUER, 1979) rebuild indicators and worldviews, values, attitudes, opinions, preconceptions and stereotypes and compare them among the researched.

Therefore, with the aim of identifying technical and informational elements, I also performed, as previously discussed, a survey in scientific research and R&D's institutions, universities and the productive sector to get the utmost of knowledge of the current state of science, technology and innovation in Angola.

In doing so, I undertook visits *in situ*[8] to some R&D's institutes, universities and Enterprises to realize the technical profile of the actors involved in those institutions. Indeed, relied on the perspective of *Doing, Using* and *Interacting* (DUI) (LUNDVALL, 2003), I enhanced an in-depth analysis to perceive the organizational layout and its planning around research, considering the following items, which enabled me to collect the information required for the study:

1. Type of Institution; 2. Services rendered; 3. Human Resources; 4. Carrier research; 5. Infrastructures; 6.Technology; 7.Maintenance of technology and equipment; 8. lines of research and technological development; 9. Scientific Production.

2.8.2 Documentary Research

8 Some of the visits at R&D and productive institutions were undertook in the framework of a series of visits by the Ministry of Science Technology of Angola. In that moment I was working as a National Director at the State Secretary Office of Science Technology and Innovation.

Finally, I opted for document analysis in order to understand the nuances (elements) of documents used during the process of the National Science, Technology and Innovation Policy drafting of Angola (PNCTI). In addition to assessing the overarching STI policy of Angola, I also examined documents resulting from applied research in some institutions for scientific research and technological development inside and abroad.

For the case of this study, to facilitate the integrity of information, the analyzed documents such as official documents, laws, letters and reports were crucial. In this token, primary sources enabled me to get as close as possible to what happened properly with the subjects in drafting the PNCTI and with the institutions surveyed. Because (YIN, 1994) primary sources are first-hand information from a person's experience, and they may be related to individual acts or, conversely, acts of political life, municipal, state or national reach. The present research relied on elements present in those documents whose characteristics facilitated on setting to get the utmost data.

For this work is essentially qualitative, the processing of data obtained in the interviews, I defined categories that allowed to get the answers to the posed problem. By the other hand, as second sources, I took into consideration the data collected in the field's properly in R&D and public and private institutions across the country.

2.9 Conclusion

To summarize, I explained in this chapter the research design, methods and analysis used in the study and the basis for choosing them. Relying in some scholars, conferences, congresses, tireless and endless discussions, I therefore turned to systemic approach, which has been proposed as an alternative lens through which to understand National Innovation System (NIS) uptake, knowing that to date there has been little discussion and application of them in practice in this area, to answer my research questions:

I. To what extent do various socio-economic, educational processes and historical factors such as striving for independence, civil war, and lack of policies, influence the strengthening the NIS and Development in Angola?
II. What is the individual perception of each respondent about the PNCTI statute and the challenges to foster R&D and innovation in Angola?

In answering this question, I chose qualitative approaches because they provide a better way through which to understand how choices and decisions influence the development of a National Innovation System in order to have a connectivity among the actors across the country. Moreover, qualitative techniques (MALLET, 2009) also offered a number of advantages including a more in-depth view of phenomena, and a better reflection of the subjectivity involved in conducting the research. In this vein, enough time was given to uptake data in order to develop the discussion and release feasible information, which can be a means for future studies. Moreover, there was also a lack of funding available to facilitate this research.

Finally, in order to account for data limitations, especially with transportation and communication, I used a number of sources 1) information from the companies themselves, 2) information provided by the VIP Angolan agents at the national and provincial levels, 3) information provided by other studies conducted in this area and 4) Official documents. Moreover, this thesis looks at knowledge, and finding pathways and good policies to boost the science, technology and innovation in Angola. Thus, considering all these explanations upon the scope NIS, R&D and innovation in Angola, the next PART is Angolan contextual overview.

PART II: LITERATURE REVIEW

3 THE INNOVATION SYSTEMS

3.1 Introduction

Initially, this chapter attempts to understand the concept of innovation, and the National Innovation Systems as essential for the development of the institutions of modern societies. And finally, a foray into the literature of science and technology will be undertaken.

3.2 Concepts of Innovation

According to ABDI (Agência Brasileira de Desenvolvimento Industrial), the development of innovation in institutions or on a personal level, should play a central role in all activities. Innovation must be seen as a major factor for economic and social development (ABDI, 2012). People have been forced to seek strategies to improve their levels of relationship among their neighbours. In doing so, they can have success in social, economic, and mental spheres.

> In today's world, innovation is a subject of great importance because it stimulates sustainable growth in a highly competitive market. Scholars across the world are studying innovation in great detail and trying to determine the different parameters that influence its behaviour. Actors such as institutions, industry, academia, and government, along with factors such as R&D, funding, incubation, mentoring, infrastructure, markets, and businesses, have all been identified as crucial to any innovation ecosystem. But at the heart of all innovation lies the human factor, identified as its soul and purpose. [9]

Companies, in general, are also driven to seek strategies to fit and stay on the market, studying and planning their actions around their business. They are impelled to develop their innovative skills and establish policies to strengthen and innovate their products and processes, and thus be competitive in the market.

9 http://www.globalinnovationindex.org. Accessed in 12/09/2014.

Joseph Schumpeter (1985), one of the icons of the theory of economic phenomena, developed discussions on innovation around the development of the economic system. He described innovation as the introduction of a new, natural product with distinct quality. He also described innovation as the introduction of new methods of production and the establishment of new forms of economic organization, new forms of job relationship.

Given this perspective, the same author makes five points:

1) Introduction of a new good - that is, a good which consumers are not yet familiar - or of a new quality of a product as well
2) Introduction of a new production method, ie a method that has not yet been tested by experience in its own branch of the manufacturing industry, which somehow needs to be based on a scientifically news**,** and can also be about discovering new way of handling a commodity commercially
3) Opening of a new market, or a market in which the particular branch of manufacturing industry of the country in question has not yet come, whether this market has existed before or not
4) Achievement of a new source of supply of raw materials or semi-manufactured goods, again irrespective of whether this source already existed or had to be created
5) Establishment of a new organization of any industry, like the creation of a monopoly position or fragmentation of a monopoly position (Schumpeter, 1985, p.76).

Several other authors such as Lundvall, Glenda, Edquist, Nelson, and so on (many of them considered to be neo-Schumpeterians) have developed their approaches by applying it in different spheres, not only in the field of economic development, but in social sciences and science, technology, and innovation. These approaches put the issues of market competition as a motivating dynamic processes and assets for technological innovation among companies as a way to enhance a leadership between them.

In the same idea, Santelices (2010) states:

> In general it is considered that innovation is the first application of science and technology in a new way with commercial success. Technological innovation includes new products and processes, as well as the important technological changes in products and processes. There is talk of innovation production when marketing a product has undergone a technological modification by which the design features of a new product is improved. There is talk of process innovation when it introduces an important modification to the production of an article technology. One can deal with a new team of new methods of management or organization or both types of exchanges as innovation expands through diffusion. Without diffusion, innovation has no economic impact. (SANTELICES, 2010, p.34)

For the embodiment of innovation (in both product and process), there are many tools that must be taken into account, how to relate technical and empirical knowledge and stay tuned to demands and opportunities. This is a strengthening of Schumpeterian view in which innovation carries out new combinations of knowledge.

In fact, for Nelson and Winter (2005, p.197), this combinations gives a useful understanding of innovation because innovation in the economic system – and indeed in creating any kind of novelty in the arts, sciences, or in practical life – consists a large extent on the recombination of conceptual and physical materials that previously existed.

The truth is that over the years, many questions have arisen from some situations around the needs to improve the performance of industrial machines due to the economic demands that are imposed. There was, therefore, a need for systematic application in industries in response to the challenges imposed at that time. In this context, "science shall supply technology not only specific findings, but also with the increasingly widespread use of the scientific method of investigation, laboratory techniques and their certainty of the importance of research in solving problems on the productive sector". (LONGO, 2004 p.6)

It is important to know that societies are always challenged to improve the living conditions of their populations, frequently innovating to meet these needs. By technological means, they always had in mind the desire to overcome their technological deficiencies and the necessity to conquer other places and peoples, by exchange or by belligerent manner. Necessity is the mother of invention. There were emerging forms of trade, labour, and social divisions, but it was competition that created great innovations and industrial revolutions.

For Freeman (2008), the division of labour in manufacturing facilitated the use of new machinery and the accumulation of specialized skills on the part of workers. The opening of markets and reducing barriers to trade within and among countries have allowed industrial producers to compete, innovate, broaden their markets, and obtain economies of scale for their products. In doing so, it gave them the possibility of a greater division of labour.

In Schumpeter's view, the prevailing institutions and/or firms in a competitive market depend on an evolutionary process, because they require creations and radical innovations, those that cause severe disruptions by changing the knowledge base. Also they require incremental innovations, those that will continue the process of change without changing knowledge bases. And to Corsato (2010), the lines of thought of Schumpeter and his followers are geared strictly to technological innovations with an economic point of view. This mindset, with a focus on technological inventions, highlights several effects of the development of innovative enterprises, such as behavioral and social aspects, which are the evolutionary theories that have contributed to the systematization of technological paradigms.

3.3 Types of Innovation

With regard to the types of innovation, there is on one hand, the main innovation types presented by Oslo Manual, and on the other hand, the paradigmatic types of innovation characterized by Prahalad.

In this vein, here are the main types of innovation taken from the Oslo Manual (2005, p.57-61):

i. product - refers to the introduction of a product/service new or significantly improved as to its characteristics or intended use;
ii. process - dealing with the implementation of new or improved methods of production, including changes in techniques, equipment, or software;

iii. marketing - featuring new ways of working in marketing with significant changes in the design of the product, its packaging, the positioning of this product on the market in form of promotion or pricing and;
iv. organizational innovations - which are well recognized when implementing new organizational method in business practices of the company, the local labour organization or external relations.

Taking into account that Angola suffers with many problems such as water treatment, sanitation, health, weak education, agriculture, lack of energy, food and nutrition, security and climate change, the above types of innovation would be useful to diminish these problems. Strengthening links between applied research and the development of enterprises and communities, and encouraging them to enroll in science and technology, is the best way to improve, industrialize, and commercialize local products.

On the other hand, Prahalad (2008, p.16), during the global forum of strategies Hierarchical Storage Management (HSM), proposes new paradigms for innovation with a new vision. He proposes many ways to think and find sustainable solutions to overcome world poverty without departing out of the Oslo Manual. They are:

i) innovation in products / services – those that bring in their design attention to the new paradigm of sustainability
ii) innovations to construct this new paradigm
iii) innovations in the work process – aimed at generating employment, income, and respect for people in their living environments
iv) innovations in business models – with the same perspective of sustainability
v) innovations in the use of technology – with due responsibility and critical sense of such technology does not bring destructive elements per se;
vi) innovations in governance – that can bring effective construction of socio-political capital;
vii) innovations in the private sector and public health – in search of better conditions for the preservation of life.

It is important to understand that these types of innovation must be submitted and harmonized according to the local challenges of Angola. Regarding the current moment, after the civil war, harmonized policies, legislation, strategies, programs, and action plans for STI has been the issues of conversations among some scholars in SADEC[10] in order to accelerate the progress towards establishing a knowledge-based economy across its States members. In doing so, strengthening collaboration among partners and regional initiatives in order to optimize the use of resources and ensure sustainability of the various interventions has been sent to each government. Because it is considered a point of departure to support innovation to create jobs for the youth and possibilities for the next generations.

3.4 National Innovation Systems

Previously, there was an approach to understand the idea of innovation and its role in the economic development of societies. Also, for the materialization of innovation, both product and process, there are many tools that should be taken into account, such as how to relate technical knowledge of scientific, empirical, and stay tuned to the opportunities facing the market. These tools, ideal for development, definitely lead to an effective systematization of actions surrounding their productions and innovations that may be feasible.

From a general perspective, Pavitt (1984) provides a definition about the national innovation system as a set of institutions involved in the generation, commercialization, and diffusion of new and improved processes and services products. Also, in terms of incentive structure, Innovation System plays a core role to exert an influence on the rate and direction of change that will derive from the changes in technology institutions.

Besides Pavit's perspective, to better understand the National Innovation System, other neo-Schumpeterians authors, such as Freeman (2004), Dosi (1997) and

10 The Southern African Development Community (SADC) was established as a development coordinating conference (SADCC) in 1980 and transformed into a development community in 1992. It is an inter-governmental organisation whose goal is to promote sustainable and equitable economic growth and socio-economic development through efficient productive systems, deeper co-operation and integration, good governance and durable peace and security among fifteen Southern African Member States (http://www.sadc).

Lundvall (2003), bring more of a contextual perspective. In the case of Lundvall (2003), there is a concern in discussing effective systematization of innovation, considering national and local plans and their peculiarities. This is important because, each country (in the case of Angola) has different places (provinces, Municipalities**,** and villages) which must be considered in terms of their local idiosyncrasies.

To Albuquerque (2003), the National Innovation System is an institutional arrangement involving multiple participants:

1 - firms and their networks of cooperation and interaction
2 - universities and research institutes
3 - educational institutions
4 - financial systems
5 - legal systems
6 - market and non-market selection mechanisms
7 - governments
8 - coordination mechanisms and institutions

This perspective rests on postulates of Lundvall and is the most comprehensive in terms of conceiving the National Innovation System – NIS as opposed to the known and simplistic Triple Helix approach whose design focuses only on universities, governments, and businesses taken as the three poles important in a dynamic interaction (LUNDVAL, 2003).

Taking into account these several approaches, there is an effort to broaden the understanding of NIS. Thus, for Björn and Lundvall (2003), innovation is seen as a cumulative continuous process, involving not only radical and incremental innovation, but also the diffusion, absorption, and use of innovation. Secondly, a wider range of sources of innovation must be taken into account. Thus, innovation is seen as a reflection, beyond science and R&D, where interactive learning taking place in connection with ongoing activities in procurement, production, and sales.

Thus, it is noteworthy that despite the different approaches regarding the national innovation system, as recalled above, there is a convergence (BJÖRN & LUNDVALL, 2003) in understanding.

The *first common* feature is hypothesized that national systems differ in terms of specialization in production, trade, and knowledge. For Björn and Lundvall (2003), this is not a contradiction – for instance, neo-classical trade theory could lead us to a similar hypothesis. An important difference from the neoclassical[11] theory, however, is that among analysts of NIS, the focus is on the co-evolution between what countries do, and what people and businesses in these countries know how to do well.

Thus, distancing from the neo-classical economic theory and its preconceived idea of human-centered social development theories, it is reasonable that capital formation, capital, and technologies are pre-requisites to the actualization of human-centered social development. This implies that the structure of production and knowledge will change slowly and this change involves learning and structural change (BJÖRN & LUNDVALL (2003).

The *second common* assumption behind the different approaches of innovation systems is that important elements of knowledge to economic activity are centrally located and not easily moved from one place to another. In this perspective, the common assumption behind the perspective of the innovation system is something more than information and it includes tacit elements (BJÖRN & LUNDVALL, 2003).

The *third hypothesis* that is more noticeable is that important elements of knowledge are embedded in the minds and bodies of the agents in a routine of enterprises, not least in the relations between people and organizations (BJÖRN & LUNDVALL, 2003).

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11 The first step towards the actualization of a human-centred social development programme is for the state or corporate entity to first accumulate capital and technologies with the view to using same for the provision of health schemes, nutritional regimes, educational systems that will eventually grant all citizens or guarantee citizens, longevity, quantitative and/or qualitative education, sustainable environment and high or acceptable standard of living.

The *fourth central* hypothesis of the idea of innovation systems is focused on interaction and relationships. This means that neither companies, nor knowledge institutions, nor persons innovate alone. This is perhaps the most basic feature of the approach of the innovation system whose main idea is interactionism (BJÖRN & LUNDVALL, 2003).

Therefore, from these approaches, it appears that the opposite of neo-classical theory, whose vision is to impose rules in innovation systems regardless of time and space, the institutional approach, recognizes that the history and context make a difference when consideration is given to how actors interact and learn (BJÖRN & LUNDVAL, 2003). From this perspective, one can rely on the definitions of Vedovelho (2005) in which the National Innovation System refers to a set of institutions, mechanisms, and actors that will support and determine the course of the innovations to be implemented in societies. This interaction is only from the successive development of learning skills and effective production of knowledge, and it reinforces what Björn & Lundvall (2003, p. 16) evoke "the context of the learning and knowledge economy." That is, the knowledge, nowadays, has been subject of heated debates around which this is seen as a crucial factor to the development of societies and economies.

As such, learning within societies must be seen as a mean to get capabilities for the success of any innovation. This is because "we can think of the learning process as the formation of preconditions for innovation. Not always learning results in innovation, but there would be no knowledge without learning to introduce the innovation economy. And capacity building involves interactive learning by individuals and organizations taking part in the innovation process of different types". (BJÖRN & LUNDVALL, 2003 p. 20).

This is the idea that interactionism is necessary to understand the historical and temporal nuances, such as,

- on the first hand, a contextual *Tacit Knowledge* that goes beyond theoretical and basic causal knowledge to include experiential knowledge about how to do things

and how to think about things in ways that are imported through both classroom teaching and interpersonal mentoring and coaching (DOERN & STONEY, 2009).

On the other hand, there is *Traditional Knowledge* (TK) which plays, in general, a key role in the preservation and sustainable use of biodiversity, not only to those who depend upon it for their survival, but also to modern industry and agriculture, and to sustainable development (UNCTAD, 2000). Also TK has a key role to benefit the present and future generations of local communities, and to promote its continued use through recognition of its value and inter-community exchanges. Now, it is more than apparent that the learning that leads to technical and directed knowledge entails the promotion of skills and innovation, more jobs, wage improvements, and welfare of the people. In general concept, knowledge may be taken as a research, and dissemination of research, of various users. It must be seen broadly as a knowledge transfer which consists of services rendered and transferred through teaching, research, and service of other kinds (DOERN & STONEY, 2009).

3.5 National Learning Systems NLS

From the perspective of Lea Velho (2011), several countries have different views on how to develop a knowledge-based society due in part to the stories, traditions, institutional structures, cultural values, and styles of government of each.

However, the majority of NIS's studies (especially from the more developed countries) do not contemplate a feasible understanding in dealing with the late industrializing economies features. As pointed out earlier, the performance of individuals or institutions in adverse contexts requires the actors to develop selective capabilities and systematization of their actions to confront these local phenomena. In this perspective, as discussed earlier, this study relies mainly on paradigmatic ideas of *learning by doing*; *learning by using* and; *learning by interaction*.

Thereby, regarding the picture of Angola as a non-industrialized economy or less developed country, these paradigmatic ideas must deeply be taken into account as a means to strengthen the NIS of Angola. In this token, some scholars, such as Arocena & Sutz (2010) and Viotti (2002), propose a kind of a National Learning

Systems in which all activities must be undertaken in tandem with all actors of the NIS, associated to *learning*, rather than to *innovation* per se.

Whereas innovation is the engine of the capitalist development as a whole (VIOTTI, 2010), processes of technical change led by innovations are usually a privilege of developed countries. In this sense, the process of technical change of developing countries are limitedly to the absorption and improvement of innovation undertaken in the developing countries. It strengthens the idea through which learning is of utmost importance to obtaining endogenous knowledge which allow any one to deal with already existing knowledge or techniques. Overall, learning is the absorption of already existing knowledge or techniques which can foster innovations. In other words, (VIOTTI, 2010) learning should be the absorption of innovations produced elsewhere, and the generation of improvements in the vicinity of acquired knowledge or techniques

Unfortunately, knowledge is the "*Achilles wheel*" in developing countries, because it is still a weak lever for the development. This is a problem that hinders the innovation and weakens the NIS, because there is no an awareness of investing deeply in learning. Nevertheless, learning is a lever towards obtaining knowledge (even importing knowledge), because in turn it will likely foster a strong relationship between actors of the NIS.

In this vein, the National Learning System comes up as a first step towards a strong National Innovation System, in which the actors' activities should be centered, above all, in *learning* rather than to *innovation.* This is all to say that the innovation system is the centrality of collaboration among all actors such as researchers, firms, government, and companies because of the rising complexity of new technologies and economic trends. In doing so, it requires strong policies and a fusion of several disciplines and large outlays on research, testing, certification, and building of both experimental and production facilities (YUSUF, 2003).

3.6 Learning by studying and Learning by solving problems.

On the above NLS approach, I stressed the utmost importance of learning as a lever to develop any country. Also it is an important way towards economic growth. Nevertheless, the problem of knowledge for development in less developed countries hugely persists, because the process of formal learning is still something more difficult than in developed countries. In this token, Arocena and Sutz (2010) present an interesting prospect to get knowledge useful for the development of the less developed countries – *Learning by studying and Learning by Solving Problems.*

- ***Learning by studying***

Learning by studying is related to knowledge supply (AROCENA & SUTZ, 2010). It means that learning by studying is the process through which one can acquire knowledge and skills by means of formal processes of studying at school, especially in higher education.

- **Learning by Solving Problems**

This is the process of acquiring knowledge by systematically using advanced knowledge for solving problems (AROCENA & SUTZ, 2010). In other words, learning by solving is related to acquiring knowledge through which one is able to solve and fix problems. The learning by solving problems is also related to obtaining the so-called knowledge demand, i.e., a sort of knowledge that comes up to answer relevant questions, by mean of search, in a given context.

Thus, regarding the less developed economies, without investment capabilities, it is deeply difficult to produce endogenous knowledge to deal with the trends in technologies and production which come abroad. (AROCENA & SUTZ, 2010) Therefore, endogenous generation of knowledge (which comes by a learning process) is a necessary complement to the success of knowledge imports, particularly when knowledge in the making is imported.

In the following section, I will go through the issue of science, technology and society. Therefore, I present first an approach on culture in social sciences, regarding some features and idiosyncrasies that can be found in any country – cultures, behaviours, beliefs, natural resources, and history – which are some of factors that influence the NIS.

4 SCIENCE, TECHNOLOGY AND SOCIETY

4.1 Introduction

In the chapter above, I stressed on the importance of investing in science and NIS building as a means to develop a country and increase the economy, taking into account the contextual features. In this token, I present first an approach about culture that I consider important to understand such features.

4.2 Culture in Social Sciences

Although this work is not necessarily guided in the field of culture, I made a brief foray into the theoretical assumptions of culture in social sciences to get a sense of how societies can structure their systems of innovation, over time. In this sense, taking into account the traditional knowledge, and the historical process whereby Angola experienced, I believe that the main cultural facilitators in any country's innovation are its education system and its education training policies and programs. This means that there can be substantial variation between the countries and/or states on the length of time spent in different targets and the amount of emphasis on other brand new subjects.

Over time, many scholars have been working to understand the impact of national culture on societies and institutions. But before anything else, it is important to ensure the etymology of the word "culture". In the point of view of Cush (1999), it comes from the mother of the romance languages – "Latin", derived from the verb *colere*, which in its original meaning, in France of the XIII century, was related to agro-pastoral era. This design is feasible from the modern anthropology studies. These studies showed that humans, since the earlier civilizations, shared and replayed knowledge to generations to generations that differed from region to region.

The notion of culture is intrinsically related to the study of social sciences, because, with the passage of time, these studies support the concept of cultural differences between peoples, as can be seen among Africans, especially the Angolan people. In

this token, culture is seen as manners and daily actions of each society or country or even ethnicity. In the case of Angola, as pointed out earlier, there are various ethnic groups that preserve and communicate through their languages that identify them greatly, although the official state language is Portuguese. The same author who has endorsed the above, reinforces the culture "as a complex whole which includes knowledge, belief, art, morals, law, customs and other capabilities and habits acquired by man as a member of society" (CUCHE, 1999, p. 35).

For a better understanding, many authors have brought broader considerations and definitions about culture. Therefore, Motta (1997) emphasises that culture is an anthropological and sociological concept that holds multiple definitions. For some, culture is the way in which a community meets its material and psycho-social needs. Implicit in this idea, is the notion of environment as a source of survival and growth. For others, culture is the adaptation per se. It is the means through which a community defines its profile due to the need for adaptation to the environment (MOTTA, 1997).

This approach reinforces the idea that human beings are essentially cultural beings, because through human beings we have all the mechanisms and assumptions to understand the world and all things that are around us. Of course, these human beings will be able to trace methodologies to develop their skills (catching up) through scientific knowledge, suiting their needs, challenges and changes in the national and international levels.

From this perspective, in the words of Laraia (1997, p. 27), "to understand the world and human behavior itself, one must take into consideration the different worldviews and value systems." In this token, there is the need to understand and analyze the different social, cultural, and historical forms which are constituted in various societies. Also, one must consider its various levels of economic development and their capacity to produce and use knowledge for their own progress (VELHO, 2011).

In the words of Lea Velho (2011) Moreover, various countries have different views on how to develop a knowledge-based society due in part to the stories, traditions, institutional structures, cultural values, and styles of government of each.

Da Matta (1997) defines culture as a word that expresses precisely a style, a manner and a way of doing things. For Hofstede (2003) culture is a collective mental programming that will distinguish the members of one group from another.

In turn, Geertz (1989) refers Max Weber in which a person is tied to webs of meaning which he himself wove. Moreover, he takes culture to be those webs, therefore, not as an experimental science in search of laws, but as an interpretative science, looking for meaning.

In this vein, Levi-Strauss (1974), argues that the entire culture can be considered as a set of symbolic systems in which frontline put up the language, the marriage rules, economic relations, art, science and religion. Faced with these huge amounts of concepts, it is important to note that the definition of culture is already a manifestation of that culture that defines it. However, although there are differences in several aspects (most meanings converge at some points) listed by Dias (2003, p 22-23.) as it follows:

1. it is transmitted by social inheritance and is not by biological;
2. it comprises the whole of human creations;
3. it is unique to human societies;
4. it interferes with the way a person sees the world, how he perceives things;
5. it is an adaptive mechanism, responsible for the survival of human communities;

In this same light, from the previously mentioned aspects, the author points out that "we can identify some basic elements in the formation of any culture. Although they may have different contents, are common to them as a whole: beliefs, values, norms, sanctions, symbols, language and technology " (DIAS, 2003, p. 23). Moreover, Fleury (1992, p. 18) highlights the extent and importance of the symbolic universe, a recurring feature in the definitions saying, "It enables members of a group to have a consensual way of apprehending the reality, integrating the meanings, enabling communication."

Thereby, given this exposure, one can realize that it is through symbols that a person finds meaning. Moreover, there are those that guide their lives, which can be corroborated by Turner (1999) in which person, without symbols or culture, would be lost and the world as we know it would collapse. In this token, symbols and norms/rules may seem as an obligation, especially in a modern world, where the information revolution is always generating new systems of symbols. In addition, one cannot escape from a world full of signs. However, without such systems of symbols, no one could be able to create new relationships, nor build and live in the structures of modern life.

Moreover, such symbolic relationships become important for any study that addresses the theme of culture, especially for this study that tries to discuss about the issue of science, technology, and innovation of Angola. It is important to remind that this is a new country that tries to raise up, leaving behind a culture harassed by the armed conflict that lasted for nearly thirty years. They are trying to adopt henceforth a scientific, technological and innovative culture as a way to overcome the shortcomings of social and economic development through knowledge. Since it is known that without these elements, it is almost impossible to achieve a society able to develop from multiple possibilities that take place in the interaction and knowledge and technology transfer with developed countries.

In this design, one can see that,

> For most governments, groups or individuals who fail to manage diversity and accept it as constitutive of nationality, it must be contained in the private space, in ghettos, with greater or lesser repression, because it is considered a risk to identity and the unit. However, there is no denying in the sense that plural cultures and nations always made up the differently, more or less concealed by a forced homogenization in large artificial part. (CHIAPPINI 2001, p.2)

In Africa, nations are not homogeneous, nor is modernity linear, but the scene of multiple temporalities that have never been possible to disguise at all. Culture is just an element of great importance for the common good of nations, groups, or ethnicities. These reflections, with which this study focuses, recognize that cultures are historical, relational and idiosyncratic. That is, they become different in various contexts.

It is, therefore, important to clarify that the conceptions of culture presented in this section only serve to support the perception of the cultural profile of Angola. Because, for this research, in addition, the sociological, economic, and historical perspectives were taken into account to strengthen the analysis around the subjects who participated in the process of institutionalization of National Policy of Science, Technology and Innovation of Angola and the nature of institutions across the country.

Considering these explanations upon the importance of culture in order to have a strong national system of innovation, the section that follows shows a discussion upon STI and its impacts in society.

4.3 Models of Technical Progress

As pointed out earlier, investing in science is of a paramount importance because it can be a means to avoiding conflicts, because education promotes critical thinking and technical progress in a country.

For instance, Murenzi (2015) quotes that conflicts such as the 1994 genocide in Rwanda and other countries in Africa, can be seen as a failure of critical thinking. A scientific education could have led people to question instructions to kill their neighbors solely because of their ethnic origin. He augmented, arguing that if the continent is to avoid being left behind in the global knowledge economy, African countries need to adopt a science and technology strategy, to invest in the data revolution, and increase the numbers of academics with doctorate training.

According to Longo (1989), science is the organized body of knowledge concerning the universe, involving natural, environmental, and behavioural phenomena. The generation of scientific knowledge is through research or scientific research, following a scientific methodology. For example, at the end of the Second World War, big companies placed hope and trust in the power of science and technology with a view to envision social and economic progress naturally. Right now the goal of science

was to rebuild the damage caused by wars and economic recovery, generating hope guided the good character of science and technology while keeping the image of 'linear model and triumphalist (BINOTTO 2012).

Simplistically, the following table reports the technological developments and paradigms of science since the Second World War.

Table 1: Explanatory Models of Technical Progress Since the Second World War and Its Main Features

Paradigms	**Contexts**	**Model of Technological change**	**Vectors of political choice**	**Predominant Types of Search**
Science as an engine of progress	Scientific prestige, cooperation	Linear Model	Choices related to big science	Basic Research
Science as a problem solver	industrial competitiveness	Linear Model	Choices through the establishment of priorities linked to economic growth and competitiveness	Applied Research
Science as a source of strategic opportunity	Competitiveness in the context of economic and financial globalization	Non-linear model complex including various actors, institutions and processes	Choices related to strategic opportunities; associated with long-term needs, including the basic science	Strategic emphasis on interdisciplinary and collaborative research

Source: Adapted from Guimarães (2005, p.244)

According to Binotto (2012), over the years, this view has been changing, and now science is no longer seen simply as a source of problem-solving, but also as a process that seeks to understand the conflicts it generates, plus new challenges that are presented along with the development of societies.

The main purpose of science becomes the vector of growth and improvement of the people and the consequent development of societies, because *en el orden de las cosas, a medida que la ciencia revela y explota las leyes universales, la vida mejorará. En los terminus empleados por Bacon, la meta de la ciencia no es otra*

que ésta: que la vida humana esté dotada de nuevos descubrimientos y facultades (Ginzberg, 1965, p 13).

Incurring this ideal, societies have been encouraged to establish partnerships, and enhance mechanisms to undertake transfers of scientific and technological knowledge, because men realized that the world is in a steady socioeconomic and cultural interconnection through information technologies. Thus, "*Acoplando este pensamiento con la doctrina de la perfectibilidad humana, muchos hombres llegaron a la conclusión de que lós câmbios que se producen constituyen progresso* (Ginzberg, 1965, p. 13).

Therefore, the system of Science, Technology, and Innovation of Angola faces with concrete actions to foster basic and applied research to be generated in R&D institutions, colleges and universities. The problem is that it is not done in a ubiquitous manner, and it has been a back set to empower the industry, business, and other institutions of society.

According to Longo (2004, p. 2), "Science and Technology traveled, throughout history, paths to different principles until they become virtually inseparable and central factor in the rapid progress of humanity." This shows that the paths taken by scholars about the basic and applied research initially had the essential goal of bringing a general explanatory knowledge of an area of science. On the other hand, the applied research was understood as one that will reduce the degree of empiricism of practical activity.

In this light, here one can realize the one-dimensional image representing the dynamic version of the post-war, called "linear model", where basic research will lead to applied research and development, and then to production or operations, the main factor for product innovation or process.
In the view of Longo,

> The average citizen of the world today, albeit moderately educated, have incorporated into their culture the notion that the generation of modern technology depends increasingly on scientific knowledge. Some even to exaggeration to believe that technology is the term used to express applied

> science, which in fact is not correct, because many successful technologies are still generated by empiricism and intuition. (LONGO, 2004, p.2)

However, despite this linear model that prevails in some academic circles labours, the truth is that nowadays, more and more technologies are generated from scientific knowledge. Current expressions such as high-tech or advanced technology and cutting-edge technology, pointed to express the intensive use of scientific and technology knowledge, are at the frontier of science, and on the threshold of the unknown in its particular field. (LONGO, 2004)

Clearly, from the earliest times, human beings have always sought to improve their way of life, perfecting the instruments that amplified their muscle strength or broadened their skills. In sub-Saharan Africa, the Bantu already had in their technological background, stone tools and irons designed to facilitate the handling of their current day-to-day activities. Historical accounts of the development of art in Africa are related to nomadism of those people in search of better living conditions and livelihoods. To Silva (1992, p.188), "When the pre-Bantu came with their canoes through the forest, through Lake Chad to the north of Chaba, they had not yet worked iron. They were few – a few hundred –, and must have quickly crossed the jungle. Their knowledge of metal would only come much later, by the same route, and brought by their descendants who had remained in Chad, or outside". Their successors, the called proto-Bantu, had to adapt themselves to the adverse weather conditions**.**

According to Silva (1992):

> The proto-Bantu had to move to a very different environment from that to which they had been accustomed. They had to change planting to seeding; roots, pods and nuts to cereals. Of a renewed emphasis on pastoralism [...] it is assumed that proto-Bantu who lived northwest of the jungles of Zaire had a noun to a verb and mallet for the act of forging. This could be in evidence already practicing metallurgy (p.189).

In view of several specialized anthropologists in Africa, the Bantu comprised several groups including: Ovimbundu, Bakongo, Lunda Cokwe, Mbundu, Ovimbundu, Ambo and some other small sub-groups, which have extended through Africa from the equator. They brought with them their skills to bear any difficulties they could find.

This is all to say that despite having won most of the African territory, the Europeans, especially the Portuguese, were already aware that the conquest of those territories would not be so easy because the Bakongo and other Bantu peoples had already mastered metallurgy techniques, transforming iron into tools of war. This is a process that happens in all societies, whose objective is improving their lives. Such processes are commonly called *revolution* by some scholars.

As a result of the Industrial Revolution, the introduction of the machine, somewhat, has led not only to getting the job done in much larger scale and speed, but also to the replacement of man in direct physical work. The machine has become the central element of the technical production process. The shift from artisanal manufacture to the factory resulted in profound changes, especially with the devaluation of the manual skill of the craftsman. Moreover, it promoted the destruction of social relations of production hitherto existing and break with tradition. (LONGO, 2004 p.5)

In contrast to the idea of the linear model, is the process of the Industrial Revolution in the earlier eighteenth and nineteenth centuries. People who tinkered were investors, but then as these people got more education, the emphasis on state-of-the-art to a minimum amount of people prevailed. In this perspective, the Industrial Revolution was caused by men with little or no systematic education in science and/or technology. That is, there was a practical symbiosis between scientists and the architects of the industrial and technological revolutionary processes.

> In fact, over the years, science has been endeavouring to respond to the questions initially represented by the phenomena of nature. It had to gradually to explain the questions arising from the machines, processes, and products created by human kind. Only in the late nineteenth century technology began to make significant use of science, especially when the chemical industry and the uses of electricity relied on scientific discoveries. Since then, increasingly, machines, processes, and products began to emerge from advances in scientific knowledge, inverting chronologically, the connection between the science and technology chain. (LONGO, 2004 p.6)

The truth is that over the years, many questions have arisen from some situations around the needs to improve the performance of industrial machines due to the economic demands imposed. There was, therefore, a need for systematic application in industries in response to the challenges imposed at that time. In this context, "science shall supply the technology not only specific findings, but also with the

increasingly widespread use of the scientific method of investigation, laboratory techniques and their certainty of the importance of research in solving problems of the productive sector" (LONGO, 2004 p.6).

It should be noted that societies are always faced with the need to improve the living conditions of their populations, and innovate to overcome the challenges over time. Although they had no advanced technologies, they always had in mind the need to overcome and even the need to conquer other places and peoples, whether through marketing or their belligerent manner. For Freeman (2008), the division of labour in manufacturing facilitated the use of new machinery and the accumulation of specialized skills on the part of workers. The opening of markets and reducing barriers to trade within and between countries have allowed industrial producers compete, broaden their markets and obtaining economies of scale for their products, giving them the possibility of a greater division of labour.

In the next section, I present a discussion around the importance of diffusion of R&D in order to have successive results in the development of technologies and the consequent growth of national economies.

4.4 Research, Innovation, and Diffusion of Science and Technology

Knowledge has always been essential in promoting the development of societies. Thus, according to the new political and economic trends, countries are forced to improve policies in order to produce more pragmatic and/or applied knowledge. This is all to say that any policy must take into account the critical role of knowledge upon economic, and political fields around the world. Although the jump of Asian Tigers and, more recently, the rapid growth of China and India revealed advances often based on copying and imitation, (Arbix, 2010), they have enhanced their activities on learning.

To even have a capacity of imitation and copying, it is necessary to have a policy to promote investment and pragmatic knowledge in facing the realities and challenges at the national and international levels. It is the idea that emphasizes the importance

of science and technology and their functions in modern societies to promote capacities of catching up for the effective sustainable development. Albuquerque (1997) points out that all countries that have made successful catching up process (Germany, USA, Japan, Canada, etc.) have increased such processes by copying, imitation and transfer of technology from more advanced centers.

According to Castells, what should be understood about the relationship between technology and society, is that the role of the state is breaking, promoting, and leading the technological innovation. This understanding is a decisive factor in the overall process, as it expresses and organizes dominant social forces in a certain space and time. Largely, technology expresses the ability of a company to boost its technological field through social institutions, including the State. The historical process in which this development of productive forces occurs, indicates the characteristics of the technology and its entanglements with social relations (CASTELLS, 2011, p. 49).

In this token, we need to pay a special attention on R&D because of the paramount role to empower the peripheral countries in order to achieve substantial levels of development. In other words, their actions must be proactive with regard to innovative systems in favour of a sustained economic development in science and technology. According to Mowery (2005, p. 21), "the initial conditions under which the innovation appears and is refined to its economic exploitation exert a powerful influence on the kinds of knowledge required for this operation, the types of knowledge it generates and the evolutionary path followed by technology." This ideal implies development of processes for catching up as a consequence of an absorbent capacity of knowledge and technologies developed in other countries (Albuquerque, 1997). That is, it is necessary to establish public policies and actions that facilitate the reduction of economic and technological gaps between the center of the developing countries and the others who are on the periphery of scientific and technological development. This can be accomplished with the creation of new paradigms.

To Albuquerque (1997, p. 224), "establishing a new paradigm, technological trajectories will be established primarily from incremental innovation. And it creates a

huge set of technological opportunities." At this moment, the process of catching up becomes more apparent in the culture of scientific and technological research in peripheral countries. Also empowerment would play an important role on these peripheral countries, which concentrate their strategies in diffusion from the incentive to fund scientific and technological innovations.

The argument I have attempted to substantiate in this chapter is a discussion upon theories and scholars' point of view that brought me a substantial mindset about the challenges to improve NIS of Angola and any other developing country. Successful development of such a country depends on the strategies they adopt. Innovation in technologies is indeed needed, but to succeed, it is extremely important to invest in diffusion.

Thus, for the successful diffusion of new technologies, adaptation efforts are important. Throughout a diffusion process, technologies are improved. Thereby, the diffusion process (ALBUQUERQUE, 1997) only becomes active and successive, theoretically, from the viewpoint of agents who adopt innovations. In other words, innovations do not diffuse without the effort of those who adopt innovations.

Thus, to strengthen these approaches, I will present in the following section, an approach through the university as a sub-System of NIS, and interactions between universities and other institutions.

4.5 Higher Education & Scientific Research

4.5.1 Conceptions of the Universities

As addressed throughout this work, education and information have been the linchpins of knowledge institutions for several centuries. Santelices (2010) says that they were born as separate institutions for students and professors, which got together with the objective of education and learning.

Currently, societies are requiring a sort of development in which all actors must be

included. One of those actors is the university that has a wider academic understanding, immerging in a sort of research-based university. For Mowery & Sampat (2005), the research university plays an important role as a source of fundamental knowledge and, occasionally, relevant industrial technology in modern knowledge based-economy.

For Dominguez (2013) the university was only created in the 12th and 13th centuries. In addition, there was production and dissemination of knowledge in Plato's Academy, the Lyceum of Aristotle, in the Garden of Epicurus, in the Library of Alexandria, in Hippocrates' medical schools. Moreover, it happened in the courts of Magnum Greek and the Roman Empire, which was the center not only of production but also of legal practice.

In the late Middle-Ages, the picture changes with the creation of universities, which were governed by the church. The church at this time dictated how universities operated and the knowledge production complied and aligned with the structure of the Christendom (DOMINGUEZ, 2013). **T**he board below shows a historical overview of the concept of university within their needs over time. The objective is to understand the mission of the university, its history, and the core role universities have played throughout history.

Table 2: TYPES OF UNIVERSITY CONCEPTIONS

Medieval University - Medieval Era	- They taught the knowledge related to time, including theology, law, medicine and philosophy. - The universities were regarded as institutions of Christendom because were supported in the figure of God and therefore theology occupied a prominent place in science.
Napoleonic University - XVIII century	- University geared to meet societal demands – the know-how; - Creation of professions with strong influence in society; - Division of university targets: a. Faculties - bestowed licenses to perform work with legitimacy in society; b. Schools - training of qualified teaching professionals, dedicated to the research and creation of knowledge. c. Institutes - mainly dedicated to the study and research and eventually to teaching. These institutes later became Polytechnics who are dedicated in training experts in specific fields with

	professional bias.
German University - XIX century	- Foundation of the University of Berlin - 1810, resulting from the movement of university reforms; - University as a corporation in the service of science - Wilhelm von Humboldt - whose mission is to seek and convey the truth through science as science is per se the essence of the university; - Research is the paramount task of the university.
American University - Postwar, 1950.	- Allocation of science and technology as an essential component of university work; - Greater demand on the university, on technical experts well prepared to meet the challenges of constant technological development and the solution of societal needs.

Source: Prepared by the author, adapted from intakes Santelices, 2010.

It is important to note over time, the universities' conceptions took form through the contextual situational demands (economic, social, geographical, religious, and political, including the wars). In Medieval times, Christianity had a great impact on society. However, being the factor of many strains, "*el advenimiento de la Reforma provocó la division de las universidades europeas en cotólicas y protestantes, generando la consecuente ruptura de la unidad religiosa y la formación de universidades de distintos credos* (SANTELICES, 2010, p. 50). Prior to creation of universities, there were also very important monastic schools which were charged with the training of the clergy. There were, as well, the craft guilds which also generated technical knowledge according to the needs of the time (Dominguez, 2013).

> They took care of technical education, and diversity was huge: notaries, jewelers, sculptors, carpenters and masons and all manner of artisans whose techniques were transmitted by oral tradition and with the help of experience. This group is called the associate mechanical arts, which covered a range of technical disciplines and practices such as: the production of wool, craft farmer, manufacturing weapons, seamanship, crafts related to the theater and medicine. There were also workshops on architecture, which encompassed engineering, civil engineering, and was associated with a multitude of professions related to the art of construction and decoration of buildings, religious and civil. The university has come to integrate this landscape much later, when it started to take care of three formations: Theology, also covering Philosophy, Medicine and Law. That was an education in which humanism-Christianism prevailed (Dominguez, 2013).

After this Medieval period, there are universities of the Renaissance and the Modern era. These had a more humanistic nature, but faced trends and competition of

academies of science, such as those in Florence, France, and the Royal Society of London.

In turn, inspired by Cardinal Newman, Britain introduced a model of university based on a paradigm of personality. More than focusing on the transmission of knowledge, he was interested in the formation of character and personality, in the perspective that, according to contemporary concepts, might be described as liberal education. Cardinal Newman was the great inspirer of the movement that originated this perception of university at Oxford University in England in the nineteenth century (Caraça et al, 1998). The revolutionary process around the university is irreversible as the needs and interests of the actors are at the daylight.

Strictly, Wilhelm von Humboldt in the nineteenth century, revolutionized the concept of university, suggesting that teaching should be linked to research (resulting in the establishment of the University of Berlin), based on spiritual freedom, essential foundation which enables a free search for truth as an indispensable part of university life.

> Thus, the dichotomy between teaching and research was disappearing, and science becomes a reality of universities. So much so that many universities now follow the Humboldtian model. Already in the 20th and 21st centuries the system gains a lot of scale. Along arise laboratories and independent research institutes that play a very important role in the research and production of knowledge arise. Noteworthy is the Royal Institution, founded in 1799, in London, the first public research laboratory, relying on it first employed scientist staff which still exists until today. Have large private corporations, the best known, emerged from the mid-20th century (Dominguez, 2013).

However, the twentieth century is strongly marked by the rise and impact of American universities whose curriculum has attracted students from around the world, including Europe, the cradle of the above countersigned revolutions. In the mid 1960's, the U.S. scientific system clearly took the global lead in most fields of science. According to the statistics report of the Nobel Prize history, the best indicator is the flow of students from Europe for postgraduate courses in the U.S., reversing the prevailing landscape before the war (NELSON, 2006).

Mowery and Sampat (2005) point out that American universities in the nineteenth century contained a centralizing administrative problem. That is, the decisions did not

meet the administrative, scientific and technological and social realities. This brought paradigm changes, specifically on the threshold of the twentieth century. In addition, it led them to adopt a profile of entrepreneurial universities with their research aimed to resolve and remedy the problems and socio-economic demands, at the expense of what was still practiced in Europe.

American universities started to invest in a large scale in R&D, promoting a scenario of accelerated development in all areas, more specifically in the "hard sciences." As already pointed out earlier, Vannevar Bush, then director of the Scientific Research and Development Office, was responsible for massive efforts in R&D investment in the United States. In his document submitted to the Federal Government, *Science, the Endless Frontier*, in reference to the development of the country's post-war, presented three proposals (Mowery and Sampat 2005, p. 212) that would be the hallmark of the scientific and technological development in the USA:

1. The U.S. government should not let wane its skills for military R&D, achieved during the war, but continue to maintain the level and composition of adequate funding to preserve this ability.
2. The U.S. government had to enforce a significant public support for medical research. With this proposal, there is the famous National Institutes of Health, the main exponent of the substantial federal resources.
3. It was necessary for the U.S. government to assume responsibility for the funding of basic research in universities in a broader sense.

Thus, it becomes easy, recognizing the strategic importance that the U.S. represents the political, economic, scientific, and technological trajectory globally. Because science occupies a prominent position in decisions of all kinds, hence there is a substantial investment in universities and R&D.

Therefore, it should be noted that we live currently a scenario of profound economic and social changes in the global context. This, in turn, has resulted in changes and paradigm shifts in regard to the values and missions of universities, taking into account the challenges of social development. That is, both in the developed and in

the developing countries, the main emphasis is now on how universities may serve industry through direct flows of information from ongoing research (Brundenius, 2009).

It is true that in the context of developing countries, the challenges are huge, and universities should play a crucial role to enhance the creation of technical capabilities that, in turn, foster the economic and social development of societies. This role of universities effectively stems through their preparations to develop research and actions inherent to local realities in which they are located.

All this information creates the idea of building feasible interactions between universities and other actors in developing countries. The experience of the USA in the post-war era, does not necessarily have to be implemented in Angola or wherever. My point is around the necessity of building a system that works according to the needs of that country after the civil war that destroyed almost all infrastructures. Nevertheless, the government must assume the responsibility as a whole of enforcing a significant public support, funding basic research in universities in a broad sense. In addition, it must create policies to bring together all actors in order to focus on the main needs and targets of the development.

In this token, higher educations institutions (universities, institutes) play a paramount role in terms of, first, educating and training, and second, in terms of creating methods, and undertaking scientific and innovative activities that can be useful to foster the technological development and increase the economy.

However, this is only possible when the role of universities becomes effective within a robust university system, integrated to a National System of Science, Technology, and Innovation. The performance of a System of Innovation is (VEIGA, 2009) closely dependent on the intensity and effectiveness of interactions between key players involved in the generation and diffusion of knowledge and its effective users. In other words, to bring innovations, including science-based innovations to the market, organizational learning, industrial networks, as well as employee participation and competence-building are more important than ever (Brundenius, 2009).

Under the auspices of the university conceptions, I present below a discussion about missions of the university, taking into account the challenges of linking universities to society, industrial innovation, and economic development. Therefore, it is important to bring up the traditional understanding of the main missions of the university, such as *Teaching and Research*.

4.5.2 The Education Mission

As shown in **Table 4**, regardless of the views of each period, the university has undergone several transformations, forcing itself to break down paradigms to insert into the society.

Seen from instrumental and economical point of views, the education Mission is the training of graduates, masters, and doctors demanded by society, expressing this need through the requests of the labour market (CARAÇA *at all*, 1998). This is an initial perspective of the English school whose primary function is the formation of coherent personalities and people that meet the demands of society and the demands of the labour market. As pointed out by Caraça *at all* (1998), the requirements are not limited to the acquisition of technical knowledge, but also including other types of skills, creativity, leadership, teamwork, and the skills that are more relevant for their settings.

4.5.3 The Mission Research

In a Humboldtian perspective, to have an effective research, the university needs to provide a freedom of spirit among students and teachers. In this sense, this paradigm revolutionized the modern university, creating new paradigms around the mission of the university as a whole in society. It strengthens (CARACA, 1996) the role of research, placing the function of creation and the advancement of knowledge in the core of university mission.

4.5.4 The Third Mission - Mission Connected to Society

Despite the revolutions around the university paradigms, universities over a long time remained under isolation. They were cloistered in their physical structures, fuelling intellectual dilettantism, moving away from the reality of the societies in which they were allocated (SANTOS, 2004).

However, there is still a misunderstanding of the role of the university as one of the sectors of society that promotes and forms capabilities to meet and serve the society. Moreover, one cannot overlook the crucial role of the university in Science, Technology, and National Innovation Systems. This problem, as has been discussed throughout this study, is due to the lack of knowledge of the importance of support STI initiatives and the role of some politicians and even some within university circles. In other words, the problem comes out because of the lack of established framework conditions for knowledge-based structure GLENDA at all, 2012).

Thus, this mission is considered the Third Mission of the University, which evokes a strong relationship between the university and the society in which it operates (UNESCO, 2007). This must stand as the university committed to developing the comprehensive development of the society in which it is allocated. It should also have a position itself as an entrepreneurial university, whose idea is reflected in the academic entrepreneurship in order to capitalize on the knowledge, because *is the heart of a new mission for the university, linking universities more tightly to users of knowledge and Establishing the university to an economic actor in its own right* (Etzkowitz, 2004, p. 66

As Caraça *at all* (1998) points out, the current university has to bear with a multitude of requests and requirements. In particular, I highlight the role of research in university activities, essential to differentiate the university from other entities, emerging in an increasingly knowledge-intensive economy. The identity of the university necessarily depends upon maintaining its dual role as creator and disseminator of knowledge institution.

Thus, in the view of Santos (2004):

I. We live in an information society. The management, the quality and speed of information are essential to economic competitiveness. Dependent on hand labour very knowledgeable, information technology and communication have the characteristic of not only contribute to increased productivity, but also to be incubators of new services where education takes pride of place.

II. The knowledge-based economy requires more human capital as a condition of creative use of information, increased efficiency in the service economy and also as a condition of employment, since the higher the human capital, the greater is its ability to transfer skills and cognitive abilities in constant recycling processes that the new economy requires.

III. To survive, universities have to be at the service of these two key ideas - information society and knowledge-based economy - and this must themselves be transformed from within by means of information and communication technologies and new types of management and relationship between knowledge workers and between them and the users or consumers.

To this end, we have to take into account the pillars of broad political-educational project of the university since its inception in the middle age, considering the rise of knowledge as a center for excellence. In addition, one must consider the scientific spirit of the University of Berlin, the postulates of the University of Bologna and the revolution in the service of science, technology and innovation in Postwar.

This process, over time, has suffered all kinds of difficulties. First, the struggles of political forces, thus weakening the real role of the university in society. Secondly, the insensitivity and arrogance (SANTOS, 2004) that revealed in the defense of privileges and socially unjust corporate interests. Third, the inefficiency, sometimes, in the use of available resources. Finally, the apathy, cynicism and individualism that many teachers showed as if the institution did not matter to them.

4.5.6 The Interaction Between Universities and Other Institutions

Some countries of sub-Saharan Africa, such as South Africa, Nigeria, and Uganda, have been increasing policies aiming at creating conditions to boost the economic and welfare. Such a policies have been done accomplished through the promotion of scientific and technological knowledge, even though some of these policies seem so weak to that end.

In doing so, the interaction between universities (or Institutes of Higher Education), communities and other institutions is the core of policies, if those policies are to promote development. According to Glenda (2012), this interaction should be typically with suppliers and users. The networks of cooperation and capacity to use knowledge from external partners such as universities, public research institutes, and technology centers must become a strategic priority for African countries. However, difficulties are varied and multiple, because the debate still lingers in some political and academic circles. There is also a large lack of understanding in investing in science and technology training in order to create such interactions.

According to Schwartzman (2002), there are two reasons for this:

1. There are many people (scientists and researchers) living and working in these countries, without greater participation in decision-making. In being so, they would have to act primarily as lobbyists in defense of their world views and professional interests.
2. There are attempts to constrain researchers and their institutions under policies and strict government ideologies, thus, choking freedom of inquiry and expression of scientists and researchers, as happened in totalitarian regimes in Russia and Germany.

To provide solutions to this relational crisis, Glenda advocates the following:

> Interactions with universities has benefits to enhance innovation and firm competitiveness. Firms which Interact with universities reported Considerably larger proportions of total turnover from innovating goods and services than those which Cooperate with other partners than universities

> and the firms that do not Cooperate at all. They also reported slightly higher levels of success in entering new markets or increasing their share in the market and higher levels of success in improving the quality of their goods or services and capacity for production or services. (GLENDA, 2012, p.521)

The race for inventions and improvements of existing technologies have been the driving force behind the creation of synergies between universities, industries, and companies. This race facilitated, first, the creation of financing in R&D. Second, it promoted the approximation agreements between engineers and economists linked to universities, industries and business. These now have a direct action on the market, identifying gaps and opportunities for improvement of the products. This is to say that "innovation has being forged during the twentieth century, both from existing technological knowledge as Science. And, in some celebrated cases, technological innovations appeared before the scientific theories that explain the performance or its picture." (Mowery, Rosenberg, 2005, p.19).

In the early twentieth century, the world economy was already geared towards the advent of globalization. Specifically, the countries at the core of science and technology such as USA, Germany, and England have enabled transfers of knowledge and advanced technologies. The European multi-nationals, specifically Germany, have played a leading role in the industrial market due to their early advanced technologies of chemical, electrical, and electronic industries and internal combustion engines.

As stated earlier, knowledge drives economic, social, and industrial development. In doing so, universities, and institutions of R&D are considered important sources for learning and innovation in developed and developing economies. As happened in Brazil[12], for instance, the CAPES (Coordination for the Improvement of Higher Education Personnel) and CNPq (National Council for Scientific and Technological Development) were created in the earliest second half of the twentieth century to boost the economy through education. Both of these two institutions had in its core

12 In countries like Brazil, with incipient industry, low level of entrepreneurship, investment, and innovation, the tropicalized version of the linear model contributed much to the isolation of the university and the academic community, hampering the business environment. It means that new companies benefited only from the knowledge generated in universities and scientific research centers. For example, there were no sufficient public policies to return the funding for the fruition of such knowledge. It is known that the generated knowledge needs encouragement to increase technological innovation in different spheres of society, creating added value (ARBIX, 2010, P. 17).

mission enhancing scientific and technological research, promoting a symbiosis with the national productive sector across the country. Also they are committed to recover and train human capital and strengthen R&D institutions on the ground.

However, their actions had some limitations. Its strategy represented a turning point in the history of S&T in Brazil[13]. The two entities, however, were based on prevailing ideas supported by the linear model as the basis for generation of innovation (ARBIX, 2010, p.17)."

The problem was accentuated with the development of policies around which there were distortions created by the linear model in the relationship between universities and companies. Clearly, today, one can already perceive a short different scenario with the deployment of business incubators in major universities and scientific research centers, such as SEBRAEs (Brazilian Service of Support for Micro and Small Enterprises) providing a culture of entrepreneurship from the academic field to the market and vice versa. Young students from fields of engineering, business administration, economics, educationalists, have been the clear target of these actions. Therefore, they assume positions as knowledge workers and feed their ambitions to become independent in the productive sector.

> Entrepreneurship in these conditions takes prominent place, as is manifested as a mediator, translator, interpreter or performer traffic between the new knowledge and its ownership and/or marketing by other companies, not necessarily the same as they were derived. Innovation and technological change emerge as major emulators that models the performance of economies. "(Arbix 2012, p.173)

As an example, the Asian tigers justify their economic booms that are grounded in these scientific, technological and innovative strategies, and research and development (R&D). Brazil “has increased its expenditure on R&D, around 1.1% of

13 In Brazil, although some institutional efforts were introduced in the 1950s with the setting up of the National Research Council, it was only in the late 1960s that an explicit policy for science and technology began to take off. Nevertheless this policy concentrated in organizing a post-graduation and research system primarily at public universities. But these policies were much influenced by a broader import substitution industrialization policy which only in a small number of cases addressed internal technological capability building. In fact, the Brazilian production subsystems with high internal technological development are precisely those where the technological policy has been the core of the industrial policy: petroleum and gas, aeronautics, bio-fuels, most of the agro industrial subsystems, some industrial inputs (raw-materials) such as mineral ores, and paper and cellulose. Then, the decision to create state-owned enterprises in some of these sectors represented, in fact, implicit technological policies insofar as these firms gradually built their own R&D labs (BRICS, 2010).

GDP in 2008. But China, since 2005, has occupied the third position in the ranking of this investment with a growth rate of 18% per year over 2000 and 2005" (Arbix 2010, p.175).

In short, the bulk of NIS is increasing the relationship between universities and other actors – firms, industries, creating funding for research, credit lines and scholarships, considering the local resources.

4.6 Conclusion

The chapter has gone through NIS approaches which have been built to achieve effective results in R&D in correlation with a strong relationship with all sectors. One of the challenges is related to the creation of mechanisms or policies in order to strengthen a NIS in less developed countries.

In the following sections, I will go through the challenges to strengthen the National Innovations System of Angola. In this vein, I will as well go through issues of contextual National Innovation Systems building, taking into account the sociological, economic and cultural views as a way to give greater sustainability to enhance actions in Angola. The objective is to understand Angola, as any other African country, regarding its own idiosyncrasies that can be found in these aspects – cultures, behaviours, beliefs, natural resources, and history.

PART III: CHALLENGES IN ANGOLA

5 NATIONAL INNOVATION SYSTEM (NIS) AND THE CHALLENGES OF DEVELOPMENT IN ANGOLA

5.1 Introduction

As pointed out earlier, Africa has many problems which plague indeed its population over many times. It puts the mainland out of the overall competitiveness in terms of innovations and R&D. In a more globally competitive environment, an innovation system that can tackle a growing number of complex historical and socio-economic problems and enable technological convergence is fundamental to enhancing the socio-economic state of Africa (DOERN, 2007).

The medieval and contemporary stories are illustrative of actions perpetrated by various peoples in searching better living conditions. In the meantime, these peoples saw themselves obliged to invade, plunder, enslave, and even decimate entire populations to raise their survival skills. In this scenario, the strongest overlapping group performed their civilizing practices at the expense of the weaker or vanquished people, forcing them to follow and conform to the standards and requirements. This is what the story says, as we know, the main role is played by conquest, subjugation, and murder, to steal and violence (Marx, 2013).

But history has also shown that the weaker and/or subdued, even in their meager forces, always seek to create outputs and subterfuge to escape the impositions perpetrated by their "enemies". Varied examples can be found in the annals of any subjugated nation state which were inexorably creating mechanisms to achieve their freedom and independence. Angola experienced the same sort of problems to survive, as pointed out earlier.

This indicates that, since the beginning, homo sapiens, in their tireless quest for survival, struggled with the need to invent, innovate and develop their skills (technical, economic, and social). They undertook such activities because of the

constant environmental changes and seasons that forced them to be prepared to brave the issues resulting from these processes. In a Schumpeterian perspective, the residence of individuals or institutions in adverse contexts, require the development of selective capabilities and systematization of their actions to confront such local phenomena.

Thereby, from this approach, the following question is posed:

"In light of the view of the OECD and TRIAD (U.S., Europe and Japan) countries, is it possible to devise a System of Innovation for Africa?"

There have been several attempts to conceptualize the National Innovation System, taking into account the objectives of promoting the development of economies and consequently improving the living conditions of populations.

According to Björn & Lundvall (2003), the history and development of the concept of innovation indicates that it may be useful to analyze the less developed economies because, in general, the basis of this concept is a historical strategic development of catching up on the production system of developed countries.

As stressed earlier, self-assessments are of paramount importance in building a National Innovation System in Angola and broader in Africa. Following up on these approaches, some contextual operations relating to these issues would allow Angola and Africa to develop evidence-based strategies for such success.

5.2 Contextual NIS Strengthening in Angola – Challenges

Across this study, I have been stressing on NIS, considering the differences between developing and developed countries. Of course developed countries have their strengths and weakness related to their behavior, size and long history in R&D. Therefore, this success is the result of huge investments in many fields, such as: a great connections between actors of the NIS; a number of scientific publications and patents produced by authors and inventors, universities and industry; huge efforts on

new production technologies, materials, energy, environment, health, and automobiles industry.

Angola has its own behavior due to its idiosyncrasies, which derive from a set of specific issues. On one hand, there are its own languages, cultures, beliefs, and thoughts. On the other hand, there is the ancient colonization, the struggle for independence, civil war, and diseases. Of course, Angola must seize all sorts of opportunities and could better use it to achieve development and welfare for its population.

5.3 NIS Approaches for Africa

Throughout human history, the strongest people imposed their rules and lifestyles over the weak and defeated. During the colonial period, specifically the mid-nineteenth century, after the Berlin Conference, Africa was the target of a massive imposition of customary habits of the great European metropolises. The goal was to create confusion in order to carry their exploratory interests (SILVA, 1992).

The truth is that Africa, before the colonial era, had its local organization among nation-states in which each ethnic group foreshadowed socio-political rules, their beliefs, rituals, and traditional institutions.

With the development of the colonial process, the African people were weakening their traditional structures, and their identities were mixed and divided socially and geographically. This process continued until the decolonization of countries formed from the partition of Africa between the European colonial powers, resulting in long disagreements, civil and ethnic wars, and abundance of endemic diseases. In other words, the colonial process was extremely cruel, resulting in institutional backlogs across the mainland. Families, clans, and kingdoms were divided. Traditional paradigms, rules, faiths, and behaviours based on African gross roots, were either confused (SILVA, 1992).

Nevertheless, by consequence, thinking of a National Innovation System for African countries adjusted or fit to specific molds of the TRIAD and/or OECD, requires a more refined exercise of adaptations. In other words, we need to build a strong mindset in order to develop a local and contextual System of Science Technology and Innovation which suits the targets of development, taking into account the realities of any country.

Without discounting the idea-based economic development, Björn & Lundvall (2003) believe that the concept of a National Innovation System, in the first instance, may be useful as an analytical tool and as a promotional tool for the welfare of African countries. This is because this concept is dependent on OECD realities. At the same time, they recognize the need to adapt and develop a concept that fits to African realities, given its long history. The adaptation of the TRIAD Innovation System is a very challenging issue for scholars, pan-Africanists, and local policy makers, taking into account the specific challenges related to combat poverty and endemic diseases that plague a large number of populations in much of the continent.

However, there have been several ideas for discussion and construction of innovation systems in Africa, as Björn and Lundvall (2003, p. 25) point out below:

- The role of nation states
- Pre-requisites to build educational systems
- Building social capital and good governance
- Finding ways to use the systems of local knowledge
- Finding strategies for proper insertion into the world economy

As pointed out above, ideas would play an important role in the sense of strengthening the National Innovation which considers the local development targets on education, economy, and rebuilding the Angolan industry. Of course, through learning, one will be able to trace methodologies to develop skills. Thereby, it will allow him suiting his needs, challenges, and changes in the national and international levels.

Thus, Jamison (2003) notes a conceptual approach regarding the systematization of science, technology and innovation. These points are, first – what to do with economic growth? And second – what to do with the social and environmental well-being?

The truth is that in the midst of these approaches there has been misunderstanding related to the implementation of policies for Science, Technology and Innovation as primarily part of the industrial and economic policy. This relegates other areas to a simple sphere of "political welfare" disagreement.

Regarding these issues, the document of National Policy of Science, Technology and Innovation of Angola (PNCTI), states the following:

> Currently, we are witnessing the fragmentation of the National System of Science, Technology and Innovation (NSSTI), which results in a weak relationship between the actors and the low profitability of the resources available, despite legal and isolated initiatives to pursue and increase scientific, technological innovation production, and the consequent integration of knowledge and technology transfer in the productive sector. Also, there is a significant lack to increase an interaction among “possible” (sic) actors of the NSSTI and society in general (PNCTI, Decreto Presidencial. Nº 201/11, de 20 de Julho).

These are some of the results of misunderstanding the systematization of Science, Technology and Innovation program in Angola. The current organization of Science, Technology, and Innovation, including the funding of research activities associated with the lack of essential documents establishing guidelines, principles, rules and procedures and evaluation procedures, has not allowed to harmonize sectorial programs. Because each of the actors that pursues scientific and technological innovation works in isolation. This situation puts the country in a weak position. Considering that the Angola depends indeed on oil production, there is no force to deal with the power and commands of multinational companies. Hence, the government is unable to create new opportunities to develop its economy, revitalize its industry, and even safeguard its culture and identity.

Taking into account this landscape, Jamison (2003) brings to the table, a discussion around the Innovation Policy in order to build a solid national system of innovation, considering three approaches: economic, sociological, and cultural.

5.3.1 Economic Approach

From an economic perspective, scientific and technological changes are seen as the key factors of economic competitiveness and business success. This perspective evokes only the importance that is given to technological development as a means of leveraging business and its affirmation in the competitive market process.

In our contemporary world, technology is seen primarily as a source of market innovations and new products. It provided the formation of new areas of expertise, such as technology management and industrial innovation as well as new theories and concepts of evolutionary economy, innovation systems, technological dynamics, and knowledge economy. As Jamison argues, what is at stake is not whether science and technology meet particular social or human needs, but if science and technology help to solve any social pressure, environmental, or human problems (JAMISON, 2003)

Given this situation, how can an innovation policy be designed, taking into account the different nuances in diverse environments? The table below tries to explain the different approaches.

Table 3: What is Innovation Policy?

	Economic Approaches	**Sociological Approaches**
What is it ?	Commercialization	Construction (social)
How is it analysed?	Technological Trajectories Innovation Systems	Networks of actors Contextual tensions
What is studied?	Businnes Strategies Learnings processes	Life Laboratory Mediation/construction
Methods used?	Surveys Economic modeling	Case studies Narratives
What needs to be improved?	Competitivity Policy instruments	Public participation Accountability procedure
Which is based on?	Instrumental rationality	Communicative rationality

Source: JAMISON (2003, p.64)

One can deduce that in a simplistic economic view, the meaning given to technological change is essentially commercial, and the processes of technological

change are embedded in wider processes of economic development or capital accumulation or, more simply, income generation activities (JAMISON, 2003).

5.3.2 Sociological Approach

Jamison (2003) pointed out that there have been many social studies of science and technology whose sociological view accentuates the importance of understanding the technological changes with the focus on the actors and their actions in relation to technological development. In the perspective of Latour, Jamison (2003) features these actors as translators, and their actions are seen mainly related to particular projects of hybridization in which humans and non-humans build a reality. The issue here is that technological change is a kind of lever or vehicle for broader social change and for effective success. In this vein, technological actors must build networks both with inanimate objects that most interest them, and with others (JAMISON, 2003).

5.3.3 Cultural Approach

I addressed earlier that in Africa, before the colonial era, local organizations existed among nation-states in which each ethnic group had its socio-political rules regulated by their beliefs, rituals, and traditional institutions.

Because of difficulties concerning environments and seasonal weather, Africans became excellent hunters and gatherers. They also developed their techniques for agricultural production and iron exploitation (SILVA, 1992).

As a result of the Industrial Revolution, however, work was conducted on a much larger scale and with greater speed as machines took over the physical work previously employed by person. The machine became the central element of the technical production process. The shift from artisanal to factory production resulted in profound changes, especially with the devaluation of the manual skill of the craftsman and the destruction of traditional social relations of production. (LONGO, 2004).

However, what is at the core of this discussion are the consequences of the process of technological change occurring inexorably, directly or indirectly in almost all modern societies. One of the crucial points of debate is around innovation in the field of genetic engineering. Because it is perceived that these innovations have led to the establishment of alliances between foreign companies with similar interests (JAMISON, 2003), threatening the local cultural and idiosyncratic structures such as religious beliefs, rites, customs and interpersonal relationships.

In my view, it does not mean that the technological changes of various kinds should not happen. The truth is that there must be a pragmatic and systematic language to understand the various nuances that make societies, lest they run the risk of deploying global and imposing innovative systems that risk being non- productive. It can result in major setbacks for the development of these societies.

5.4 Conclusion

According to the PNCTI of Angola, culture is considered a complex issue, which includes knowledge, beliefs, art, morals, laws, customs, and all other habits and skills acquired by a person as a member of society. Despite the huge potential of culture as a source of national unity, Angola is not as strong as it should be to support itself and strengthen frameworks and infrastructure for research and cultural dissemination.

The objective of all of these approaches is to think about Angola in terms of strengthening a National Innovation System which covers all Angolan challenges such as STI, and socio-economic growth, taking into account its idiosyncrasies. Even though this is a big challenge, policies around education play a core role in accurately understanding of this issue. Because through science connected with strong policies, countries should be able to progress in order to diminish the abundance of problems that plague the world.

Hence, it is important to point out that Angola is a country which did rise from a colonial period which plagued its cultures and identities. Moreover, after the

independence, Angola immerged in a civil war that destroyed the majority of its infrastructures and institutions. Considering these approaches, the next section is a contextual overview which shows its own specific characteristics and difficulties.

PART IV: ANGOLA: CONTEXTUAL OVERVIEW

6 FOUNDATIONS OF THE NATIONAL INNOVATION SYSTEM OF ANGOLA

6.1 The Colonial Period and the Independences of Portuguese Colonies From 1885-1975

Between1885 to 1975, Angola was subdued by Portugal. Through an agreement among other European countries, Portugal was able to design the actual boundaries of Angola.

As pointed out earlier, Angola is potentially prosperous from its natural resources, but suffered indeed under the slavery perpetrated by Portugal. However, in the early years of the colonization, there was an endemic warfare between the Portuguese rules and the various African traditions. Thus, a systematic campaign for freedom was undertaken by the African students who had education in Europe and America. In the earliest 1970s, all African Portuguese colonies began to reach their independence.

Portuguese Guinea (Guinea Bissau) was the first, in September 1974. Portuguese East Africa followed in June 1975, getting a new name “Mozambique”. The Republic of Cape Verde was established in July. And Angola became independent in November 1975 (http://www.historyworld.net) Accessed in 01/26/2015.

The quest for freedom of expression and the possibility of managing its own resources has been substantial as Angolans endeavour to perpetuate their idiosyncrasies and identity in spite of globalization.
As illustrated by Santos (2001),

> The Angolan liberation struggle in the twentieth century should be focused, with its own specificity, as intrinsically linked to the evolution of resistance caused by the expansion of the world capitalist system. In this perspective, reducing this fight to a purely political dimension means limit it to the achievement of independence, the struggles for political power and belittle

> its fingertips. The Angolan national liberation struggle has, at its base, a rich content. Its building is, first and foremost, a matter of cultural identity, essential and permanent institutions to build their own element, based on the recognition of differences, and to develop a social, national and popular project based in dispute. (p. 3)

However, the struggles of Angolans are made with the purpose of perpetuation of African values. These values are defined by cultural traits that underlie the native language, rituals, idiosyncratic acts, dance, music, art and technique of each African nation.

According to Mourão (1996), the consolidation of the nation, as a project, became the target with several consequences from a scientific and technological and cultural-historical view, depending on the specific experiences of each country.

Hence, it is necessary to know the cultural idiosyncrasies of Angolans, with all differences throughout the country. We talk about these idiosyncrasies which had the purpose of abolishing outright colonial ideals that only subdued the indigenous. As stated by Nito Alves, "One day in Angola, scanners street citizens [...] not only blacks but also whites and mestizos, racism will disappear." (Nito Alves, in Matthew, 2007, p. 162).

The colonial process carried out in Angola resulted in cultural and intellectual reduction of Angolans perpetrated by the Portuguese, leading them to a spirit of defeat and feelings of worthlessness. But it is important to take into account that this process had its obstacles, as a proportion, albeit small, of Angolans still managed to do actions that inhibited in certain parameters, the colonization process of devastating exploitation.

As illustrated by the author below:

> Although Angola has adopted ad hoc the Portuguese as official language, Angolan diligently maintained their cultural idiosyncrasies within national languages (native), the management practices of the common good, in the rites of passage and local religious beliefs. (SANTOS, 2001, p. 4)

In this ideal, from the point of view of identity, among others, the Angolans maintained especially the nomenclature of their African ethnic groups, respectively,

Umbundo, Kimbundo, Lunda–Tuchokwe, Ovakwanyama, Vangangela, Ambundu, Nganguela - Tchinganje, Ovandonga, Nhaneca-Humbe, Ovahelelo, Ovambo.

Figure 1: MAP GROUPS OF ANGOLA ethnolinguistic

Source: In Institute of Geodesy and Cartography of Angola Map of Angola ethnolinguistic (adapted), apud Fernandes, J.; Ntondo, Z. (2002:57). Angola: Peoples and Languages, Luanda: Editorial Nzila.[14]

It is worth stating that these ethnic groups carry on their ancient heritages the great features called Bantu ethnolinguistic trunk. According to Silva (1992, p. 183), Bantu means "people" or "men." Is the plural of munto, "the man". The term exists in almost all Bantu languages. And is the oldest, with its meaning.

Many of the cultural characteristics of these ethnic groups are defined by Silva:

> It seems that food producers were those who spoke the proto-Bantu. They had words for palm oil, vegetable, fig, bean, olive, mushroom, guinea hen, goat, dog. And perhaps to steer, although the term also meant "buffalo". They had names for bush and scrub, but not for meadow or pasture (SILVA, 1992, p. 186).

14 http://www.triplov.com/letras/americo_correia_oliveira/literatura_angolana/anexo3.htm. Access: 27.11.2013.

Among these populations, one could see markedly a technological activity of iron and ceramics and they structured their own molds of organizational training. However, this profile would suffer, of course, a drastic change in European colonial process. The process of colonization of Africa was complete before the end of the First World War, when virtually the entire continent had reorganized and divided by European powers (REIS, 1999).

In this process:

> The Portuguese colonial regime incarnated the encounter between different African social formations and the nascent Portuguese and European capitalism. The late nineteenth and early twentieth century marked a period of articulation of these non-capitalist formations with domination of European capitalism. Artificially, and according to interests of Portuguese, German and British bourgeoisie in the region, it constitutes a geographic, political, economic and social space called Angola. (SANTOS, 2001, p.10)

However, this process would not hold for long, because soon after, during the 1960s, a large part of the occupied territories became independent. The desire to deploy a neo-colonial regime apparently proved a failure, not due to the industrialization of Angola, but basically because of decolonization itself (FERREIRA, 1985). Of course, in a broader view, the new capitalism dynamic system was crucial to end the colonialism across Africa.

In this process, Angola became independent, precisely in 11/11/1975. Such independence, geographically, promoted Angola to a prominent position in Southern Africa, economically and militarily[15]. This is because the engine of Angola's economy is the liquid gold – oil, producing nearly 900,000 barrels a day. Angola is the second

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15 Angola is the 7th largest country in Africa with a population of over 24 million and is located at the southern Africa. There are three components of Angolan military: the Army, navy and air force and all of these have a combined manpower in excess of 100,000 divided into 87,000 active front-line personnel and 30,000 active reserve personnel. It has 140 tanks, 980 armored fighting vehicles, 298 towed-artilhery, 270 total number of aircraft, 98 helicopters with, 15 attack helicopters, 82 fighters/ interceptors. Country's naval strength is boosted with 30 coastal defense crafts and 2 mine warfare and with a defense budget of over $4 billions (www.answersafrica.com).
By 2013 rankings, Angola's defense expenditure ranked second in Africa after top defense spender Algeria. However, Angola is now the top defense spender in Sub-Saharan Africa after surpassing South Africa in the 2013 rankings. An analysis of recent statements made by top Angolan military commanders and government officials suggest that Angola's defense spending is also being driven by its new commitment to support United Nations peacekeeping operations across Africa. In the past decade, the FAA has successfully intervened militarily to restore security IN SADEC region mainly in neighbors Republic of Congo, Democratic Republic of Congo (DRC) and Guinea Bissau to end the steady chaotic military coups and armed rebellions (http://www.defenceweb.co.za).

largest oil producer in sub-Saharan Africa where crude oil accounts for 90 percent of total exports; more than 80 percent of government revenues and 42 percent of the country's GDP (HENRY, 2014).

South Africa (AISA, 2012) has economic and military power disproportionately superior than all other African countries, but Angola has stood out among the other countries in the region due to the puissance of its economic growth, size and experience of its armed forces and the experience acquired after the victory in the civil war and some stability operations in neighboring countries.

> Even though it may seem paradoxical, the struggle for the construction of the Angolan nation replaces the country in its true context, in Southern Africa. No more it comes to choosing between Portuguese colonialism or neo-colonialism and national liberation as a political achievement, but from a greater global integration and regional integration (SANTOS, 2001, p. 21).

This process will rigorously promote the Angolan citizens an idea of keep growing through education. In this scenario, after 1975, Brazil was the first country to recognize Angola as an independent, free and sovereign of Portuguese colonial interference. This recognition enabled the implementation of bilateral relations between the two countries in education, bringing to Brazil students to attending Secondary level, Higher and Postgraduate institutions. This is important because due to the civil war, the institutions were destroyed and as a result, there is no sufficient professional staff to manage the institutions across the country. Brazil since independence, has helped Angola taking into account their common history and language. After the process of independence Angola created 18 provinces that make up the territory today (See Figure 2).

Figura 2: GEOGRAFIC MAP OF ANGOLA

Source: Embaixada de Angola[16]

As illustrated by figure 2, Angola is situated in the southwest of the continent, on the western coast, in the southern region, between latitudes 4° 22' and 24° 05'. It comprises 18 provinces, 163 municipalities and 547 communes and 1,271 villages. It is bordered on the north by the Republic of Congo and the Democratic Republic of Congo, the east with the Democratic Republics of Congo and Zambia, to the South by the Republic of Namibia and west by the Atlantic Ocean a length of 1,650km. [...] The territorial extension of Angola is approximately 1,246,700 km2, with an estimated population of 16,037,000, which provides a low population density in the order of 12,86 inhabitants per km2 (OLIVEIRA, 2010 p. 23).

16http://www.embaixadadeangola.com.br/v2/index.php?option=com_content&view=article&id=58&Itemid=69. **Accessed: 27/11/2013.**

6.2 General Economic Situation in Angola – Main economic indicators

The years that followed the proclamation of independence in 1975 were of defense and territorial integrity of Angola. This Country experienced a civil war that lasted 27 years. Not only such a war destroyed much of the industrial infrastructure, it lost as well a lot of valuable time for socio-economic development of the country.

Thus, in 2002, Angola reached peace, after an agreement between the main parties such as Popular Movement for Liberation of Angola or Movimento Popular de Libertação de Angola (MPLA) and National Union for Total Independence of Angola or União Nacional para a Independência Total de Angola (UNITA). In doing so, this country has experienced a fast growth in the social and economic field.

This growth is mainly sustained by the oil sector, but it is important to note that we observed a higher rate of growth for non-oil sector, from 2007. This ratio has remained and, somehow, is indicative of commitment to diversifying the economy taken previously by the Angolan government.

Table 4: Global growth of the Angolan economy (%)

	2004	2005	2006	2007	2008	2009	1st Sem. 2010
Growth Rates (%)							
GDP	11,2	20,6	19,5	23,30	13,80	2,41	4,30
Oil GDP	13,1	26,0	21,2	20,40	12,30	-5,10	7,10
Non-oil GDP	9,0	14,1	17,2	25,40	15,0	8,31	2,0
Diamonds	-	-	-	2,69	-8,19	4,60	-5,30
Construction	-	-	-	37,10	25,60	23,80	-18,41

Source: Ministry of Planning, National Plan 2011-2012

The Extractive Industries, manufacturing and construction materials are the three main areas which divide the Angolan industry. The first involves the extraction of oil, natural gas, diamonds, and marble, while the second covers metallurgy, metal working, electrical, electronic, transportation, construction materials, chemical, rubber, wood and furniture, paper, glass and ceramics, textiles, clothing, leather,

food, fisheries, beverages, coffee, sugar and tobacco. The latter is the industry of construction materials such as cement and ceramics.[17]

Manufacturing was also hit by war and the exodus of the Portuguese which occurred in 1975. During the next two years, most of this industry was fully or partially nationalized and production fell 3/4, despite the partial recovery seen since 1977 (MIND, 2014).

Therefore, Angola is experiencing a massive rebuilding of its physical infrastructure and human capital process. Although this growth has not been uniform for all sectors of national life, data indicate that the observed growth in the extractive industry (oil and minerals) can help to create conditions to foster growth in lagging sectors (PNCTI, 2011). In this token, Gross Domestic Product has continued to grow despite the fluctuation of oil prices and the global economic recession observed in 2009 and with particular emphasis in the mid-2014 to date – 2015. Oil production accounts for over 50% of GDP, constituting 90% of export incomes. Therefore, due to the instability of the oil market across the world, the Government is hardly striving to find different paths to diversify its economy. Other important components of GDP have been obtained from non-oil sectors such as banking, agriculture, fishery and forestry.

Table 5: Main Economics Indicators (2012)

NOMINAL GDP	**USD 114,8 Billion**
GDP REAL GROWTH	**6,8%**
GDP "per capita"	**USD 5.681**
GDP PPP	**USD 126,21 Billion**
GDP PPP "per capita"	**USD 6.244**
Inflation	**9,6%**
International Reserves	**U$D 33,41 Billion**

Source: Adapted from Brasil globalnet. http://www.brasilglobalnet.gov.br. *Accessed in 18/11/2014*

17 Embaixada de Angola em Portugal. Accessed in 04/15/2015.

The Angolan economy is overwhelmingly dependent on oil revenue. In recent years, the oil industry and the high international prices of their products fuelled the rise in the rate of growth of the country. Increased oil production supported an average growth of over 15% per year from 2004 to 2007. Between 2008 and 2011, the Angolan economy recorded smaller, but equally significant growth rates, bearing in mind that the demand and International oil prices experienced some shrinkage, especially in 2009/2010. In 2011, the growth of Angola's economy was 3.9% and in 2012 8.4%. In Africa, Angola was the country that had the fifth highest real growth of the economy in 2012. The latest IMF estimated for Angola a real growth of 6.2% in 2013 and 7.3% in 2014. (BRAZIL GLOBAL NET, 2014).

Although having submitted such growth, the country still remains dependent on foreign markets to strengthen its economy. Because of this vulnerability to oil markets and extreme dependence on crude oil, the Angolan government is working hard to (MINFIN, 2014) diversify the economy by creating tax bonds to strengthen the productive sector (industries, companies, stores). Each Ministry is involved to give their account in the sense of implementing the Angolan government programs.

During the civil war, firewood was (even today) collected and used for cooking and construction, augmenting deforestation across the country (REDE ANGOLA, 2014) As a result, it has contributed to the so-called global warming, shortage of rainwater, and desertification. Moreover, as a result, respiratory diseases across the country have been overwhelmingly increasing (REDE ANGOLA, 2014.

The focus on science, technology and innovation is a key to supporting the growth and plays a key role in promoting sustainable development. This support should focus above all in the areas described below as critical to boosting the economy with regard to the environment, management and responsible use of natural resources.

Areas such as Education and Training, Higher Education, Scientific Innovation and Technological Development, Agriculture and Fisheries, Telecommunications and Information Technology, Oil, Gas and Mineral Resources, Health, Water, Energy and Environmental Resources were identified by national experts and by the United Nations as of great importance to the national economy.

For instance, supported by a large and powerful rivers that cross the country, Angola has a huge problem concerning to hydro-Electricity[18]. In this vein, from 2012, the Ministry of Energy and Water Affairs has been working in order to create legislation to regulate the renewable energy sector. The idea behind it was to deploy renewable sources to enable the expansion of electricity to homes in need and to ensure that citizens pay a fair price for energy (smallhydroworld.org, 2013. Accessed in 2015).

6.3 Current Situation of Science, Technology and Innovation in Angola (STI)

The recently-established Policy of Science, Technology, and Innovation of Angola, (PNCTI) *in Portuguese,* released important information about the situation of science, technology, and innovation. Thus, there is a lack of coordination between the various actors of research and scientific, technological development, and innovation, as well as the isolated initiatives and endeavours to a National System of Science, Technology, and Innovation (SNCTI) building. It has been harming the implementation and development of best R&D's practice. It has caused, consequently, bad results, which are mainly characterized by immediacy and not sufficiently integrated actions toward a sustainable development.

Data show that the poorest countries are the most vulnerable to the effects of climate change and all sorts of diseases. Hence, in building innovation systems in Angola, policies (MYTELKA, 2003) must be directed towards ensuring the presence of critical factors and building a number of new competencies. Nevertheless, it requires an uptake of different competencies and capabilities among actors that will enable the change of this landscape in this country.

Meeting the challenges of a national innovation system building in Angola requires an understanding of what Joseph Schumpeter (1997) postulates as the importance of

18 The national electrification rate was 26.2 per cent, with 13.7 million people not having access to electricity programme, which has set a target of increasing production to 7,000 MW enabling an annual per capita consumption of 4,000 kWh by 2016 – an eightfold increase in current consumption. The medium-term goal is to develop capacity of 4,646 MW by 2017. There are also bottlenecks in the transmission and distribution networks that need to be overcome (www.smallhydrworld.org. Accessed in 2015).

interaction for learning and innovation and its systemic properties of the process in order to foster a sustainable development.

As mentioned earlier, the National Policy of Science, Technology, and Innovation of Angola (PNCTI), is an over-arching document that is an official statute approved by the Angolan Government in 2011.

The objectives of this statute are organized according to three main axes:

1. **Organization and Development of the National System of Science, Technology and Innovation** which is based on four essential components:

    - highly qualified human capital,
    - institutions with the means and conditions required for the performance of research, development and innovation,
    - networks and exchange processes, national, regional, and international, maximizing the access to knowledge and;
    - a legal and organizational framework to promote the achievement of results.

2. **Contribution of Science, Technology, and Innovation for Sustainable Development** which has the aim of:

    - raising the scientific level of culture of the Angolan citizen;
    - contributing through which Science Technology and Innovation (STI) able to foster the development on social, cultural and environmental issues across the country;
    - incorporating the scientific and technological knowledge and innovation capacity, to support economic and business development and;
    - using the science, technology and innovation aiming at supporting the country's governance;

3. **Funding of the National System of Science Technology and Innovation (NIS)** which plays a core role in boosting the scientific and technological development, impacting on socio-economic development.

Therefore, building these three legal instruments are essential to have decisively significant improvements in all sectors – Public & Private. Hence, it will enable a feasible environment to create, strengthening, and networking knowledge institutions such as universities, R&D organizations and enterprises in producing manufactured goods. It will, as well, enable the creation of productive companies in agriculture, and strong industries as a whole.

The Ministry of Science and Technology (MINCT) was created under the Presidential Decree N0 70/70 of 2009, aiming at preparing, conducting, executing, and controlling the executive's policy in promoting the development of science, technology, and innovation. One of the assumptions of the Angolan government is based in promoting the human capital training to reach excellence, quality and innovation, scientific and technological development (PNCTI, 2011).

In 1997 the Ministry of Science and Technology was created to rule the policy of STI in the country. In this vein, the Angolan government has reinforced its commitment to the creation of conditions to put Angola in the pathway of scientific and technological development.

Over the following years, more recently, the Angolan Government had in its targets some activities which fit the foundation of STI legislation base, such as the creation of Internet Community Centers, the Portal of Knowledge, and the Scientific Researcher Career. In doing so, they collected subsidies to support the Government targets of registration of a sort of innovative activities across the country. All this has contributed to a marked increase national awareness about the importance of STI in order to develop the country and build a knowledge-based society.

Nevertheless, it’s possible to see a breakdown of the National System of Science, Technology, and Innovation (SNCTI), resulting in a weak and feeble line among its actors. This has led to a poor use of local resources, although there are some

individual and/or collective with the aim of increasing scientific research and technological innovation actions (PNCTI, 2011). These actions have equally inhibited the promotion of integration of knowledge and technology transfer between Angola, Africa, and overseas.

Currently, among the institutions, called Scientific Research and Technological Development Centers, just two (2) are overseen by the Ministry of Science and Technology such as Centro Nacional de Investigação científica (CNIC) and Centro Tecnológico Nacional (CTN). The others are scattered across the country and some of them are overseen by some other Universities and Ministries.

Taking into account the systematization of Science Technology and Innovation of Angola, I noticed that there is an ongoing development/approval of a statute called *General Regulations of R&D Institutions*, in order to re-evaluate all those Institutions (MINCIT, 2013).

According to this issue, the Angolan Government has currently in its projects the multimedia libraries building for the communities across the country. This Project aims at the social and digital inclusion of society, especially the youth, because this segment of the population easily joins the information and communication technologies.

So far it has been observed that the levels of the STI budget fall far short of what is recommended in the developing communities (SADEC) – 1% OF GDP – and it has not been possible to monitor the funds for scientific research and technological development. Nor has it obtained the overwhelming majority of members of the National System of Science, Technology, and Innovation, which is data for the development of indicators for STI (PNCTI, 2011). In short, all this has not resulted in optimizing the use of available resources and means to assess the impact of investments and the performance of R&D institutions, universities and its professionals.

Thereby, taking into account the above approaches, in the next section, I present an overall state of Higher Education in Angola, and its position in Africa.

6.4.5 The University in Angola

University plays a paramount importance over the times. It plays a core role in developing skills as a strategic tool for economic development and sustainable development[19] of any society. Therefore, after the civil war, Angola has had hard time to solve its problems in a systematic and coherent way. As a result, the table 8 shows a picture of what is current nowadays in country. The UNDP (2007) presented a report with the following indicators related to the state of Angola in the Postwar as it follows bellow.

Table 6: Indicators – State of Angola in the Post War, 2013.

INDICATORS – State of Angola in the Post War	
Human Development Index (HDI)	**0.446**
Life Expectancy	**50 Years Old**
Adult Literacy Rate	**67%**
Gross enrolment Rate	**26%**

Source: Adapted from UNDP, 2013 and INE, 2011.

The above indicators show an overall picture of what Angola is facing in terms of education, welfare and life expectancy. By this token, as the Angolan population is extremely young, meaning that 48% are younger; only 2.4% are more than 65 years, and the life expectancy is around 50 years old. In addition, the percentage of illiterates throughout the country is 34%. More than half of Angola's population has only completed primary school, less than a quarter have lower secondary education, and 4% completed higher education (INE, 2011).

As pointed earlier, for instance, life expectancy is one of the many problems Angolan people face since Angola got the independence in 1975. After it, the country

19 The knowledge of sustainable development comes from the understanding of the human being and its predecessors. This means the ability to make sustainable development to ensure that it meets the needs of the present without compromising the ability of future generations to deal with their own needs. In tis vein, the concept of sustainable development does imply limits – not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities. But technology and social organization can be both managed and improved to make way for a new era of economic growth (47/187 BRUNDTLAND COMMISSION REPORT, 1997. Accessed in 11/24/2014).

emerged in civil war that destroyed institutions, infrastructure and public health service. However, it is experiencing some improvements.

This is one of the biggest problems in Angola because, according to Kunietama (2014), this country has already been confronted with the difficulty in integrating these human resources into the labor market. As a result, the majority of youth works in the informal economy.

> Angola is one of the largest economies in sub-Saharan Africa, and is considered an economy with lower middle-income. Angola still faces the enormous challenge of development. The Human Development Report 2013 (United Nations Development Programme - UNDP, 2013) shows that the country maintained its position in the Human Development Index, over the previous year. Angola holds the 148th position in 187 countries, entering in the ranking of countries with a low level of human development, despite being only seven away from the middle of places of Human Development Index (KUNIETAMA, 2014).

The fluctuations of the world economy and other imbalances that result from the process of globalization, and internal issues are some of the factors that promote such indicators. Despite various efforts, Angola remains the country that has the lowest rates in terms of scientific and technological performance. Thus, it is clear that the University is the center of creation and dissemination and catalyzes the development of a scientific society. However, it does not work synchronized with government's targets and public and private companies.

Overall, the development of higher education in Africa, in general, is characterized into three main stages: Colonial Higher Education, Higher Education, and Post-Independence Current System of Higher Education. This is to say that Higher Education in Angola and in other African territories was based specifically on the scholastic model, in which scientific research was insignificant. In other words, there was no significant attention to basic and applied research as it was in the metropolis. Soon after independence, African countries had not been able to consolidate and develop the universities and scientific research inherent to them for various reasons. Among these reasons are: lack of experience of governance, lack of well-trained staff, brain drain, lack of investment, and that associated with the outbreak of civil wars in some regions of the African continent (TETA, 2011).

This is a problem that most African countries face today – recovery and improvement of the higher education institutions, because they are far from the universities of scientific and academic enhancement. Although there is no strict and directly proportional relationship between economic, technological growth, and the ranking of top universities, it is important to understand that universities play an important key role for the development of countries. They can also promote scientific and technological research in order to guarantee sustainable development in several areas.

Given the anomalies that occur in the implementations of policies for scientific and technological development in Angola, it is important to note that there is not actually a symbiosis among government, universities, firms, and all actors. The feeling of uncertainty in the economic sphere is quite apparent. Firms and government seem to be exogenous to the process of knowledge production. In this case, there is no exchange of accurate information to give leverage to the development of the country.

Despite some government efforts, there are still difficulties to collect and systematize data on the science that is practiced in Africa. Thereby, according to the Forum on Higher Education, Research, and Knowledge (Scientific Committee for Africa) held in Dakar in 2002, the following problems were identified taking into account the scientific research in Africa:

- Few research results
- Inadequate policies to support research
- Lack of funding
- Lack of infrastructure for research
- Lack of training in research level
- Lack of access to scientific journals
- Lack of access to information and communication technologies
- Lack of oriented researches

In addition to the reasons mentioned above, another problem is the lack of a networking among professors, students, and institutions in order to operate on the same page. According to the annals of the Ministry of Higher Education, Science,

and Technology of Angola, there is a drive to increase the indicators of scientific research and technological development in the country, guiding the creation of more universities and research centers. For this purpose, reforms were undertaken in the sub-system of Higher Education when the Angolan Government recently created seven new Public Universities (Decree 07/09), seeing a major input in the academic and investigative scenario. The creation of new universities had place from expansion of Angolan University – Universidade Agostinho Neto – UAN. In 2008, with the creation of those universities, other Angolan provinces were provided with courses in the humanities and social sciences, and to a lesser degree, with courses in engineering because the lack of infrastructures across the country.

Beyond the problems which were pointed out earlier, after the period of the liberation of Angola, followed by the independence in 1975, the Angolan government has been covered by the government of Cuba on secondary and higher education and public health. Currently, after a long period of civil war, Angola has benefited from Cuban teachers who are scattered throughout Angola to bolster and sustain the seven new universities created recently. This means that the number of professors and highly prepared technicians is too minimal to solve the lack of mastery of modern science, technology, and innovation in order to put the country on the road to development.

Some of the reasons which put Angola outside these rankings and in the lowest positions in education are:

- Low visibility of research outcomes for policymakers
- Lack of convergence between the academic agenda and the policy-making agenda
- Reduced feedback which discourage researchers' participation
- Insulated research centers across the country
- Weak infrastructure of universities across the country

All of this information shows that what distinguishes — and continues to handicap — Angola and other African countries is its lack of mastery of modern science and technology. Without advanced competency in these areas, nations cannot harness

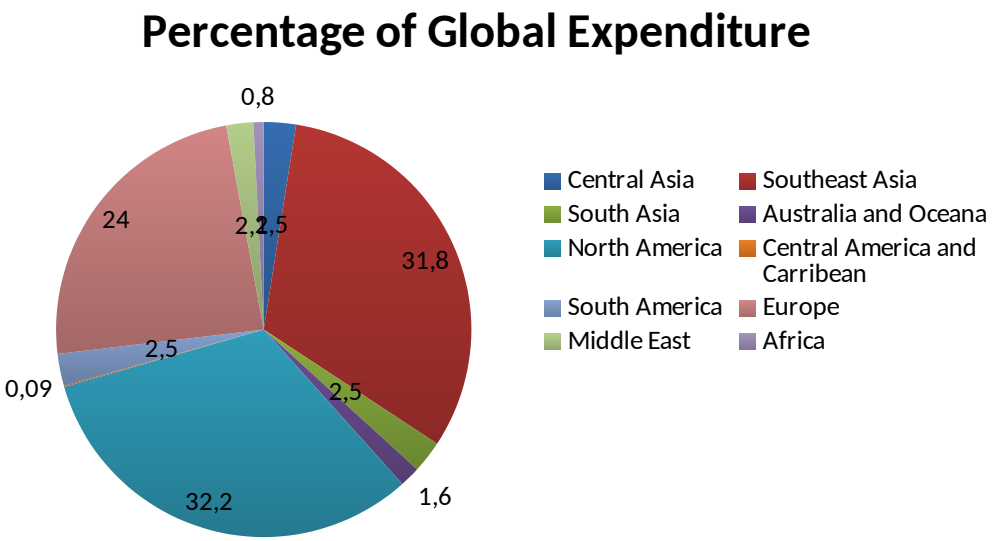
the full power of scientific research and technological tools to solve the many health, energy, and development challenges confronting them (KHUMBAH, FOOTE, 2014). The System of Education is currently incipient, requiring improvements on its institutional structures and training in order to reach high education levels. Because, according to the two ranking tables, Angola does not appear in any position.

Having high-level capabilities are necessary to create policies which promote investment and pragmatic knowledge in facing the realities and challenges at the national and international levels. This is in order to emphasize the importance of R&D and their functions in modern societies, to promote capacities for an effective development, and to diminish the plethora of diseases which plague Angola.

This effectively illustrates the best way to leverage sustainable development and economic growth based on the production of systematic-pragmatic R&D knowledge. This is an essential condition in order to develop and assess the education and R&D activities, given the concerns of the country in terms of boosting the local industry and welfare.

Thus, knowing that Science is the cornerstone of the development, we can see below the Global R&D expenditures, by region, in 2011.

Pie Chart 1: Percentage of Global Expenditure in U$ billion: 2011



Sources: National Science Foundation, National Center for Science and Engineering Statistics, estimates (August 2013). Based on main Science and Technology Indicators of OECD data (2013/1); *Accessed in February 19th, 2015*.

According to the pie chart, Africa appears in the last position after Central America and the Caribbean. This puts it below the development targets of UNESCO adopted by heads of state at an African Union summit in 2007 for African countries.

North America, the Southeast Asia, and Europe, together invested more than 80% on science, technology, and innovation until 2011. Regarding the global economic and financial crises that has plagued several countries, even so, in 2013 the percentage of GDP Expenditure in R&D in OECD countries rose by 3.2% in real terms from 2012 through 2014. This recent growth has been driven by a strong increase in R&D performed by universities, government and businesses, while R&D expenditures in government institutions in Africa are estimated to have fallen.

On the other hand, in the last five years, some African countries such as South Africa, Uganda, and Malawi have invested more than 1% of their Gross Domestic Product (GDP) on R&D, putting them on a considerable path of development. South Africa comes out on the forefront of the significative efforts in R&D Expenditure, with a Gross Expenditure on R&D (GERD) around 1.5% of GDP by 2014 (http://unctad.org. accessed in 02/23/2015).

As I pointed out earlier, the Angolan Government set up seven new public universities in 2008. The challenge of these new institutions is identifying local problems and possibilities in order to enhance developmental research – I mean Development Research which is focused on relevant, useful and important questions. If there are no questions, there can be no research (http://www.etu.org.za, accessed in 12/05/2014) – which is relevant to them. By doing that, the benefits could be enormous to communities, provincial governments and, of course, the country. “To promote developmental research, however, African universities may need to re-examine the way they assess and reward research, and ensure that their rules and regulations in no way discourage academics from embarking on developmental research or disadvantages them. They equally need to establish closer links with the community, review their approach to teaching and learning and provide experiential learning opportunities to their students through short attachments” (MOHAMEDBHAI, 2014).

For example, Angola comes from a long civil war which plagued its people profoundly in several forms. These universities, as important centers of knowledge, have the challenge of exploring childhood intellectual development, examining urban programs, understanding the problems associated with soil devastation in the South of Angola, or examining the water of ponds which were poisoned by bombs.

Networking among government, companies, and universities are crucial to reach high levels of knowledge exchange in Angola. As Mia Couto (2013) says, is clear that more technical staff do not solve itself the misery of a nation. If a country does not have strategies aimed at producing profound solutions, then all this investment will not produce the desired difference.

Thus, in the following chapters, I present the state of the national system of science, technology and innovation through interviews, the perception of agents involved.

PART V: ANGOLA – INTERVIEWS

7 STATE OF THE NATIONAL SYSTEM OF SCIENCE, TECHNOLOGY AND INNOVATION THROUGH INTERVIEWS; PERCEPTION OF AGENTS INVOLVED

7.1 Introduction

To understand many of the dialogues between the respondents and the results of research undertaken in some institutions, one has to go back to the history of Portuguese colonialism in Angola, which started in 1482, with trade, evangelizing missions and military expeditions. Reached the independence, Angola relied its economy mainly in two natural resources – Oil and diamond. Therefore, after the civil war, in 2002, the Angolan economy was majorly dependent, primarily on oil exploitation. It boosted the macro-economic performance above the regional and global average with the exportation of these goods.

As indicated in **Part III** of this study, despite efforts by various governments, Africa remains the continent that has the lowest rates in terms of scientific and technological performance. In this vein, one can notice the steps of Higher Education in Africa into three main stages: The Colonial Higher Education, Higher Education and Post Independence Current System of Higher Education (TETA, 2010).

Thus, the system of Higher Education in Angola, as in other African territories was based specifically on the scholastic model[20], in which scientific research was

20 Scholasticism model is a method of critical thought which had a huge domain in teaching by the academics. Moreover, it is a Medieval school of philosophy (or, perhaps more accurately, a method of learning) taught by the academics of medieval universities and cathedrals in the period from the 12th to 16th Century. It combined Logic, Metaphysics and semantics into one discipline, and is generally recognised to have developed our understanding of Logic significantly.
The term "scholastic" is derived from the Latin word "scholasticus" and the Greek "scholastikos" (meaning literally "devoting one's leisure to learning" or "scholar") and the Greek "scholeion" (meaning "school"). The term "schoolmen" is also commonly used to describe scholastics.
Scholasticism is best known for its application in medieval Christian theology, especially in attempts to reconcile the philosophy of the ancient classical philosophers (particularly Aristotle) with Christian theology. However, in the High Scholastic period of the 14th Century, it moved beyond theology, and had applications in many other fields of study including Epistemology, Philosophy of Science, philosophy of nature, psychology and even economic theory.

insignificant. In other words, this model did not allow the natives to develop capabilities of critical thinking. In my opinion, it is not conducive to supporting innovation because it is based on rote memory (namely memorizing facts and arithmetic such as x + y = z) versus critical thinking. However, to move to a knowledge-based economy, universities and the educational institutions, under strong policies, must create possibilities to enhance and use human resources capabilities. They are the center of creation, innovation, dissemination, and catalyzing socio-economic development of a society. According to Nico Cloete (2015), internationally, there is growing consensus among national policy-makers and other central socio-economic actors that the university is a driver of economic growth and development. This has to do with the role of the university in producing a highly skilled and competent labor force, as well as in producing new knowledge.

Thereby, to get these skills, some steps must be taken into consideration such as gaining a much better research-based understanding of the characteristics of research universities, as stressed earlier. Also knowing that too many things were destroyed (social, economic settings, and infrastructure), simultaneously a task force must be enhanced to build infrastructures and an academic environment to support emerging research universities across the country. It is because, soon after independence, this African country was not able to consolidate and develop a system of universities as well. In other words, there was only one university across the country.

This is a set of problems that most African countries have been experiencing nowadays on creating and improving R&D and higher education institutions. Thus, considering these approaches, in general Angola is significantly below compared to other developing countries and OECD[21] in terms of education and innovation.

Essentially, Scholasticism is a tool and method for learning which places emphasis on dialectical reasoning (the exchange of argument, or thesis, and counter argument, or antithesis, in pursuit of a conclusion, or synthesis), directed at answering questions or resolving contradictions. In medieval Europe, dialectics (or logic) was one of the three original liberal arts (the "trivium"), in addition to rhetoric and grammar (MASTIN, 2008).

21 Here, the differences between developing countries and OECD countries in terms of education and innovation stems from the average level in terms of innovative workplaces when compared to other sectors of the economy. For instance in Europe, similarly to the 69% average across sectors in 2005, 70% of graduates into the education sector considered that they were employed in highly innovative workplaces (excluding Portugal). The proportion of highly innovative workplaces in education was similar to that across sectors in most individual countries, being above in three countries and below only in Portugal and Czech Repubic (OECD, 2014).

Some of the research institutes (see on Appendix) of Angola are connected directly to the Ministerial Departments, devoted to the research in the areas overseen by those agencies. For example, some of them have been called upon to solve various problems in the field of public health in the country, directing their actions in the fight against HIV and endemic diseases that plague the country. In addition, I noticed that there are few actions within private companies whose activity focuses simply on the handling and maintenance of equipment to achieve their business goals.

As mentioned earlier, these institutions face the difficulties that other R&D institutions in Angola face, due to the lack of capabilities and a national innovation system. For this purpose, the Angolan government recently approved the National Science, Technology, and Innovation Policy or Política Nacional de Ciência, Tecnologia e Inovação de Angola (PNCTI) in order to boost scientific research and technological innovation across the country. However, the actions aiming at strengthening innovation are at a very early stage, because the scientific reality is still very incipient.

Overall, I took the opportunity to remind the reader that the National Policy on STI has the main objective of putting together all national actors – Universities, R&D's Institutions, Public and Private Sectors – looking at boosting the development of Angola. Thereby, in the next chapters I relied on Lundvall's *et all (2009)* different perspectives of narrow and broader definition around NIS. First, is the narrow perspective which aims at mapping indicators of national specialization and performance with respect to innovation, research, and development efforts on science and technology organizations. The broader approach takes into consideration social institutions, macro-economic regulation, financial systems, education, communication infrastructures, and market conditions as far as these have had an impact on the learning and competence-building process.

Therefore, African societies have their own characteristics that shape their idiosyncrasies and collectivist identities. Kuada (2003, p. 115) cites Hofsted, arguing that Collectivist societies are characterised by the willingness of all individuals contribute to collective gains. This motivation to contribute is inherent in the cultural values and norms of society. The concept of social solidarity is employed by some

scholars to describe this phenomenon, carrying the understanding that personal relationships and trust among in-group members underpin people's behaviour.

This is a core point for any society or organization to succeed effectively. But, as pointed out earlier, the cultural approach on NIS is of paramount importance to make it successful. In other words, as mentioned earlier, there must be a pragmatic and systematic language to understand the various nuances that make the Angolan society, lest it runs the risk of deploying global rules and imposing innovative systems that risk being non- productive, resulting in major setbacks for the development of this society.

The idea is to alert developing countries to enhance alliances between other countries and multinational companies with similar interests, lest it threaten the local cultural and idiosyncratic structures such as religious beliefs, rites, customs, interpersonal relationships, and traditional knowledge. Several countries have different views on how to develop a knowledge-based society due in part to the stories, traditions, institutional structures, cultural values, and styles of government of each (VELHO, 2011).

That is all to say that Angola has its own characteristics, and rather than forcing the way NIS is understood and built in developed countries, as a developing country, one must take into account its features in order to ease contextual NIS building. Whereas some emergency strategies bubble up from all corners of the world to find a resolution of the plethora of problems in Africa, especially in Angola, policy-makers have to be knowledgeable and strong so that they will be able to find the best pathway of NIS building.

7.1.1 Conclusion

To summarize, it is fair to remind readers that during the 27 years of war, Angola had only one university, directing its activities exclusively in the areas of education and literacy. During this period, the Angolan government invested heavily on the importation of war materials to strengthen the army. Even though the civil war ended

thirteen years ago, in 2002, various R&D institutions and some SMEs undertake their activities isolated, because of the results of the war, and the weak connectivity among them.

Whereas this work is based on qualitative research, the answers of the respondents brought a large volume of data, which enabled me to undertake this work profoundly. The interview process was accomplished through the use of a recorder, with the recordings being transcribed. The interviews were made, following the thematic categorizations (it is in the next chapter) that enabled the analysis of data.

A pragmatic perspective, had taken into account the geographical layout of the interviewees as they, until the time of the interview, were displaced in distant areas of the country. Some live in Benguela Province in further south of Angola. Most live scattered by the large city of Luanda, distributed in its various ministerial and/or university sectors.

Finally, to give support to the proposal of this thesis, beyond the interviews, I also took into account the location of some scientific research institutions in the provinces of Huambo, Luanda, and Benguela. Thus, the **Chapter 10.2** is the presentation and discussion of the result analysis of the interviews. And in **PART V** are the presentation and discussions about the institutions. Finally, **Chapter 12** is assigned to conclusions and recommendations.

7.2 DISCUSSION – PRESENTATION AND RESULT ANALYSIS OF THE INTERVIEWS

7.2.1 Introduction

As aforementioned in **PART I**, I conducted interviews with the National Authorising Officers of the Ministry of Science and Technology, as well with the Rectors of two Universities of Angola. They were part of the working group that drafted the governing instruments of the National Policy on Science, Technology and Innovation for the Angolan government in 2011.

I undertook seven interviews, taking into account sixteen themes. Such interviews are related explicitly to the institutionalization of the National Policy on STI, the challenges of scientific and technological development, and the difficulties involved in implementing a national system of science, technology and innovation in Angola. The questions were selected from the theoretical framework by means of the following categories, which draw from the work of the so called DUI – *learning by doing* (ARROW, 1962), *learning by using* (ROSEMBERG, 1982), and *learning by interaction* (LUNDVALL, 1988) materialized on institutions – firms, R&D institutes, universities or government agencies.

1. **Origin and Background**
2. **Design or Planning and Implementation of the National Policy of STI of Angola**
3. **Role of intergovernmental bodies in the design and implementation of the National Policy of Angola**
4. **Levels of scientific research in Angola**
5. **Technological Change and Industrial Development Strategy as promoters of the National Economy**
6. **Role of Universities in National System of Science, Technology, and Innovation**

The interview was open and semi-structured, but focused on issues of limitations of scientific and technological development of Angola. The interview guide served mainly as a conversation starter. To analyse the results, I relied on the notion of a national, regional, and provincial system of innovation as a strategic alignment combined with talented, well-trained researchers conducting activities within an innovative yet efficient environment that motivates them (BEINTEMA, 2014).

The main objective here is to explore the background and characteristics of the interviewees as it follows below:

Table 7: Origin and Background

ORIGIN AND BACKGROUND				
Suject Respondents	**Origin**	**Training**	**Training country**	**Activities**
Gm	Angolan	Geologist; PhD in environmental sciences in the field of geology	Angola, Germany, Spain and Holland	Professor at Universidade Agostinho Neto-UAN; National Director at the Ministry of CTI
Ar	Angolan	Agronomist; MSc and PhD at the University of Havana	Cuba	Professor at UAN; National Director at the Ministry of CTI
Dn	Angolan	Biologist; Ph.D. in Biology, with differentiation of post doctoral also in Biology	Rússia and Portugal	Professor at UAN National Director at the Ministry of CTI
Al	Angolan	Biologist; Masters and PhD in Biological Sciences	United Kingdon; Brasil	Professor at UAN National Director at the Ministry of CTI
Rm	Angolan	Chemistry; Master of Science in Chemistry	Angola	Professor at UAN Executive Director at the Ministry of CTI
Af	Angolan	Physician; Masters and PhD	Brazil; Cuba	Professor at Universidade Katiavala Buila-UKB; Rector at UKB.
Rs	Angolan	Chemistry; PhD in Chemistry	Germany; Cuba	National Director at the Ministry of CTI; Professor at UAN

Source: done by the author.

According to the table 10, it is possible to deduce the characteristic profile of each interviewee, from their origins and their academic and professional lives. During and after the period of struggle for the liberation of Angola, ending with independence in 1975, the Angolan government established partnerships with the governments of Cuba and Eastern European countries in the field of secondary and higher education.

Thus, thousands of youth (PNCTI, 2011) were sent to these countries in order to attend courses in different specialties, including war-engineering courses (tanks, guns management and so on). **Gm**, **Ar**, **Dn**, **Al**, **Rm**, **Af** and **Rs** are some of those youths who were sent to these countries.

Referring to Castells (2011), societies are organized in structured processes historically determined by production relationship, experience and power. As countries become more powerful or more influential, a spotlight will reveal how internal forces organize and strengthen the nation. The turmoil during the process of technical training of Angolans, which has already been mentioned throughout this work, was a reality. Families were forced to give up and leave their children going to the front lines (to be soldiers) and others were sent to various countries, with greater importance in socialist countries, to train in various specialties, including war-related specialties. It occurred because the party MPLA[22] in the government was created under the socialist principles.

However, as in every revolution, some were inevitably forced to stay at the "*first corner"***.** In other words, during the struggle for independence and during the civil war, many young people became martyrs in the ranks of combat. Others continued to be soldiers until the end of hostilities. Today, some of the survivors are part of the decisions and destiny of the country, thanks to the training received abroad.

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22 Peoples's Movement for the Liberation of Angola or Movimento Popular de Libertação de Angola (in Posturguese) MPLA was formed in 1956 during the struggle against Portuguese imperialism when it was forced into exile. It formed a government in exile in the early 1960s while also conducting a guerrilla war against the Portuguese. The military dictatorship in Portugal ended in 1974, and Angola gained independence the following year. The MPLA became the sole legal party and immediately had to fight a civil war against guerrilla groups supported by the United States and South Africa. The MPLA gained support of Cuban troops, and in 1976 it formed a socialist peoples's republic of Angola, guided by Marxism-Leninist ideology. From 1977 until 1992 the party became known as the MPLA-Workers'Party (MPLA-PT) (Partido do Trabalho). In 1979 the MPLA's founding president, Agostinho Neto died and José Eduardo dos Santos, who had become foreign minister at independence, became president of Angola. As the civil war lingered on in the 1989s, Dos Santos and the MPLA gradually took a less hard-line Marxist-Leninist approach, introducing some market reforms into the essentially planned economy and legalizing private property. Dos Santos was reelected president in September 1985. In 1990 the party committed itself to democratic socialism and in 1992 won the presidential and parliamentary elections. In the presidential contest Dos Santos obtained 49.5 percent of the vote. Jonas Savimbi as leader of the main opposition guerrilla movement – National Union for the Total Independece of Angola – UNITA – participated in the election but refused to accept the result. Although a peace treaty was signed in 1994 and a government of national unity including opposition figures set up in 1997, the civil war continued intermittently until 2002 when Savimbi died in fighting and his movement's armed wing disbanded (DOCHERTY & LAMB, p. 270).

> ***[Gm]*** *... / I'm a geologist with a degree in geology; I have a PhD in environmental sciences in the field of geology. ... also I had education in many countries such as Germany, Spain, Angola and Holland. /... Currently, I am the Director of National Development and Technological Innovation's office here at the Ministry of Science and Technology; and I am Professor at the Department of Geology in hydrology, management of water resource.*

Respondents have a substantial technical profile and high academic level and bring with them scientific and technological culture enhancement gained over the period of training in foreign countries. In this case, besides being part of the staff of the Ministry of Science and Technology, they are also encouraged to join the faculty of local universities and scientific research institutions and productive sectors. This is due to the substantial lack of well prepared teachers and technicians to support the plans envisaged in the National Policy Document.

> ***[Al]*** *... / Degree in Biological Sciences, with a molecular biology specialty, with a Doctoral Degree acquired at the university of Brasilia in Brazil. Also, I'm Coordinator of the Founding Committee of the National Fund for Scientific and Technological Development at the Ministry of Science and Technology; And Professor of General Genetics and Population Genetics chairs at the Department of Biology, at the Faculty of Science of University Agostinho Neto chairs.*
>
> ***[Dn]*** *... / PhD in Biology with differentiation of Post Doctoral also in Biology. Countries of Education are: Doctorate in Russia, Academy of Sciences in Russia and Post-Doctorate at University of Lisbon which is also called Classical University. I hold the position of Director of National Scientific Research Office, since June 2009, and I am a Professor at the Faculty of Sciences at Agostinho Neto University. In this case I am director of the Ministry of Science and Technology.*

Given this scenario, the country is facing a shortage of PhD's and teachers in all domestic universities. This situation creates an even more dramatic lack of technical capacity and resources for the development and training of new staff in order to continue the development of the country. It is also possible to infer from the context that respondents feel compelled to meet the demand for professionals in all spheres of society. They divide their time between teaching and ministerial bureaucratic activities.

> **[Ar]** */ ... I'm a Professor at the Faculty of Agricultural Sciences, have the rank of Associate Professor. And right now I'm on commission at the Ministry of Science, Technology and Innovation as General Director of the National Centre for Scientific Research*.
>
> **[Af]** *"/ ... So I graduated in medicine at Agostinho Neto University, and obtained a doctorate in physiological sciences from the Federal University of*

> *Espirito Santo in Brazil. I'm Currently Rector of the University Katiavala Buila ".*
>
> **[Rm.]** *"/ ... I have Bachelor's and Master in Chemistry at the Agostinho Neto University in Angola. I am also a Researcher and Executive Director at Ministry of Science, Technology. "*

It is confirmed here, again, the basic characteristics shared by the respondents: components of a thinking elite, very knowledgeable, with foreign experience, whose participation in the process of structuring PNCTI of Angola was extremely technical and of political substance. Beyond their high level technical capabilities which allowed them being useful on drafting the document, they are more politically astute, working effectively as policy makers as, say, professors providing advice to the government.

As already addressed throughout this work, the system of Higher Education in Angola and African territories is based specifically on a scholastic model, in which scientific research was insubstantial. Some Angolan scholars agreed that after independence, in 1975, the country has not been able to consolidate and develop the universities and scientific research for several reasons, among which: lack of experience in governance, lack of well-trained staff, brain drain, and lack of investment in education, all of which are associated with the outbreak of the civil war that lasted 27 years. These issues become clear as we hear what the respondents had to say.

7.2.2 The Lack of Experiences in Good Governance

While the concept of governance is an ongoing subject of debate, the challenge for governments is clear: how will they put in place the processes, frameworks, and capabilities to manage resources, information and data so that it meets the growing and complex needs and expectations of the population. It can be seen more broadly as the capacity to establish and sustain institutions organized according to rules (FYE & MUNROE, 2015).

Although there is an overall discussion about the governance among too many scholars, in general this is also defined as the capacity to establish and sustain

workable relations between individual actors in order to promote collective goals (CHAZAN, 1992). In this vein, good governance must rely on a process of organizing and managing legitimate tools. This is a sine-qua-non to provide law and order, protect fundamental human rights, and provide welfare and sustainable development of a country.

The problems generated by political, social, and economic instability and the prevalence of ethnic, communal, and religious crises overall have been a backset for most countries in Africa. In the World Bank view, the problems rely on the matter of good governance with its characteristics such as: **Effectiveness and Efficiency, Transparency, Consensus oriented, Responsiveness** and so on (UNESCAP, 2015).

Firstly, **Effectiveness and Efficiency,** are shown as processes whereas institutions produce results that meet the needs of society while making the best use of the resources at their disposal. Secondly, **Transparency** means that decisions made and their enforcement are done in a manner that follows rules and regulations. It also means that information is freely available and directly accessible to those who will be affected by such decisions and their enforcement. Finally, the **Consensus oriented** means that all actors must be included in decisions that guide the society**.** In this sense, good governance requires mediation of the different interests in society to reach a broad consensus on what is in the best interest of the whole community and how this can be achieved. It also requires a broad and long-term perspective on what is needed for sustainable development and how to achieve the goals of such development.

Therefore, the World Bank (2000) defines governance as the institutional capability of public organizations which produce goods needed by the population as a whole. In this perspective, good governance creates the goal of working in a transparent, impartial, and accountable way, including its economic policies and regulatory framework (KERANDI, 2008).

More strictly in sub-Saharan Africa, the above pillars are not yet a reality at all – some African policy-makers, scholars, and institutions still remain far from this

understanding compared to some other developing and developed Countries. It is important to make sure that I do not intend to apply here a model of governance to molds of the Paris Commune[23] or another reality. Let me here refer to the difficulties that most peripheral countries face in implementing their projects for the welfare of their populations and political stability.

In this case, we have as reference OECD countries, whose actions are based on political stability and consequent welfare of their populations, which involves food safety, sanitation, quality education, etc. I am concerned with these elements as crucial to the formation of a conscious and capable human capital that addresses the institutions and persons in adverse situations and solve their own internal problems.

Thus, for Angola this is a big challenge because the moments of colonization and the outbreak of civil war did not permit Angolans to have education and increase human resources quickly enough to sustain the institutions and redesign the destiny of the country. In other words, because the civil war that began shortly after independence, Angola was too busy focusing on the civil war, including training soldiers and so on. As a result, it did not allow them to spend a feasible time in building up institutions for good governance such as a robust legal system, health care system, and higher level of education.

7.2.3 Lack of Well-Prepared Human Resources

As mentioned, good governance influences the creation of policies that encourage the training of staff in the country. Because Angola still suffers from a governance quality, thus directly proportional, it suffers from a lack of highly qualified staff.

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23 The Paris Commune had a great effect on the world in the 120 years that followed, with the rise and fall of communism. Short-lived, it quickly developed a reputation as being the model for a fairer system of government, that could and should be applied elsewhere. Essentially, the idea was is stressed on government uprising by the people for the people. It established the principles under which the city would operate. This included a separation between church and state, abolishing night work in Paris bakeries, return of pawned items to workers so they could resume work, and the rights of employees to take over the running of an enterprise that had been abandoned by its owner, among others (FRANCE THIS WAY, 2015).
In addition, according to Riggins, one of the outstanding accomplishments of the Paris Commune, which so impressed Marx, was that all the servants of the new state were paid no more than the average wages of working people. The Commune was not a "special force" serving the interests of a small class against the majority but was a "general force" serving the vast majority against their oppressors (RIGGINS, 2014).

As a result, Angola currently has benefited from Cuban professors – an agreement between the two countries. These professors are scattered throughout Angola to support and sustain the six new universities created recently, as the numbers of teachers and technicians in Angola are unable to close these gaps in the field of human resources.

7.2.4 The Escape – Brain- Drain – and the Return of the Brains – Brain Pool

With regard to brain-drain[24], it is noted that in the period that corresponds to the proclamation of independence and the start of the civil war, Angola has suffered a significant drop in the number of technicians and teachers with a high level of preparation. They were forced to take refuge in neighboring countries and overseas where they were availed, given their technical skills.

> ***[Gm]*** *[...] I would highlight here for example the issue of brain drain. We need to call brains, skilled people, into the country. This is something that I highlight, taking into account the experiences I had abroad. How do they have articulated the entire system to the level of its policies in ways that can have a great attraction for brains those who are outside the country, I mean those who live already in and those who were educated abroad and even foreign technicians. That was a question that I should give particular attention at the policy level, one of the issues and, by the way, is one of the issues that Angola will have much to work because there are many very well-prepared technicians in Diaspora, where they acquired many experiences during many years. All this because of those years of conflict* (civil war) */ ... during this process, many of them went out of Angola and others generations were very well acculturated, studying in good Universities. This will be the big challenge. For me this is one of the major issues that I consider very important, having much background to develop considering the current context. There are others meaning issues in terms of helping this country to foster STI policies that are also important, but this for me ... this is what I see as a big challenge.*

Effectively, **Gm** brings great concern that must be followed and embraced by the countries on the periphery of economic development. Angola is no exception to this concern. As discussed throughout this study, there is a huge difficulty in some

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24 Brain drain can be described as the process in which a country loses its most educated and talented workers to other countries through migration. This trend is considered a problem, because the most highly skilled and competent individuals leave the country, and contribute their expertise to the economy of other countries. The country they leave can suffer economic hardships because those who remain don't have the 'know-how' to make a difference. It can also be defined as the loss of the academic and technological labor force through the moving of human capital to more favorable geographic, economic, or professional environments. More often than not, the movement occurs from developing countries to developed countries or areas (FRANCIS, 2015).

political circles in understanding the importance of investment in strengthening the technical and human capabilities through quality training. However, it is often only in speech. In other words, it is clear some of them do not see the importance of reaching high levels of development through high levels of education. Of course, the investment in this field is very high. However the results of these investments are exponentially very positive.

Thus, the issue of brain-drain across the country, as I have stressed, is related to various situations. First, these include the lack of basic living conditions for technicians who were educated abroad. In other words, Angola does not have feasible housing, steady electrical energy, water treatment, or social services as other countries do abroad. Secondly, there is the concern that the government will not create the technical and structural conditions (infrastructures, environment, and communication) to attract highly skilled technicians who are abroad. This is one of the points recommended in the National Policy of Angola in which the attraction of Angolan and foreign technicians abroad is crucial to meet the desideratum of development (PNCTI, 2011). To this end, it is urgent to create feasible conditions to attract them.

These efforts are also clearly emphasized in American trajectory, when the government, industrial companies, and universities sent their technicians to hone their knowledge in Britain and Germany in the first half of the nineteenth century MOWERY, 2005) because those countries already had substantial progress in science and technology in the field of chemical and steel industries. In the subsequent years, with the return of its scientists and engineers, the U.S. surpassed old England in terms of productivity.

Also Kim (2005) highlights the systematic attempts of successive Korean governments to repatriate Korean scientists and engineers living abroad. One of the major actions was the creation, in 1966, of the first institute of public R&D, otherwise known as the Institute of Science and Technology of Korea.

> The government sought to forcefully repatriate scientists and experienced engineers, providing them a highly attractive set of benefits – which pointed to an abandonment of the administrative culture of Korea, where the literati

> bureaucrats always exerted his authority over the technician. In 1966, eighteen scientists and engineers were hired as founding members of the Institute of Science and Technology of Korea; in 1975, reached 68. The total number of permanent returnees reached 276 in 1980. The repatriation's program conducted by the State was very successful, because few researchers came back to developed countries (Kim, 2005, p. 111).

In this token, several initiatives should be taken into consideration for the promotion of science, technology and innovation and effective materialization of the National System of Science, Technology and Innovation in Angola in line (a creative imitation) with the successful practices of the Triad countries or OECD. The Brain-Drain, according to the literature, has been caused by two situations. The first is the brain-drain, as already discussed above, due to the political, economic and social instability, i.e., they are forced to take refuge in neighboring countries or other continents and are often persecuted for their political and/or technical positions. The second situation is related to young students who do not come back home after being sent abroad to study for a time.

Foremost among these, is the so-called Brain Pool through which the government provided grants to R&D institutes and public universities to recruit scientists and engineers abroad to work on specific research projects for a period of six months two years (Kim, 2005). These technicians must be nationals and foreigners, as it happened in USA at the end of nineteen and early twenty century when the government sent many Americans to attend courses in England and Germany (MOWERY, 2005).

7.2.5 Conclusion

This phenomenon (Brain-drain) occurs given the lack of working and infrastructure conditions so that technicians could develop their professions and skills. Also, they are struggling with the lack of habitability in their countries because in returning, they would be forced to, once again, live in their parental home, sometimes in conditions none too wholesome. Thus, these brains are mostly absorbed by the companies where they had education, being forced to raise family and establishing a strong and effective link with the host country. However, according to UNESCO (2007), the number of young students from developing countries who migrate to developed

countries has increased significantly because they are looking for the best courses at the best universities. Within this growth raised another big phenomenon, "the international mobility of students," whose subject is of paramount importance to be discussed on further studies.

7.3 THE INSTITUTIONALIZATION of PNCTI OF ANGOLA – CHALLENGES

7.3.1 Introduction

On the issue of implementation of the National Policy of Angola (PNCTI), there are various challenges presented in the statements of the interviewees. As already mentioned, the lack of investment in scientific research in Angola is one of its major constraints that endures over the years, and hinders a sustainable development.

7.3.2 Experience Overseas

The international experience of the interviewees brought important information to corroborate the importance of investment in technical training. That was the main factor in the institutionalization of National Policy of Angola. To give support to this question, the interviewees gave arguments, keeping in mind the following question:

How does your theoretical training and experience in foreign contries contribute to your performance in the PNCTI drafting?

Below are excerpts of the interviews which clearly show such importance.

> **[Gm]** *[...] This was big, I tell you the diagnosis, which, for example, we undertook. it was really the basis of what was the local experience as a professor; local experience, as person who worked in several areas outside university. And it was very well what we could learn out there (*out of Angola*) where we were able to compare all of these experiences. It was possible to see how they are organized out there; all the success they have out there, the level of R&D Institutions and the experiences we had here. This symbiosis almost made us play a role that was what I consider a job we were doing actively. These experiences contributed greatly, from the standpoint of all: How are organized systems in these countries; the difficulties that these countries have; how they can overcome these*

> *difficulties; what are the difficulties that we have with our living. So these two contents, these two realities played a very dominant role in my participation in this dossier.*
>
> **[Dan]** *Well my ... let's say ..., my participation in the process of drafting the National Policy on Science, Technology and Innovation, clearly had ... let's say in specific terms, an investment, a source of inspiration in my route [...] on my route mainly as a researcher. Being researcher, willingly or not, I had the opportunity to live in conditions, lets say, that allowed the accumulation of experiences on the functioning of the management of science itself in countries like Russia, in countries like Portugal, in countries such as South Africa and in countries such as Angola ... In any of these countries, my scientific initiative comes from Russia, but then already PhD, I had the chance to join a research's teams for almost four years at the University of Lisbon, and in 2003, I returned to Angola where I joined, beyond national teams, mainly teams from the National Institute of Investigation and Research. Also I joined regional teams made by researchers in South Africa and Namibia, and sometimes by researchers from Germany, Norway.*

Gm and **Dn** are insistent in stating that their training outside, but also inside the country, contributed significantly to the drafting of the National Policy of Science, Technology and Innovation of Angola (PNCTI). It is fair to notice that the PNCTI of Angola is accompanied by other two guiding documents. First – the Coordinating Mechanism of National System of Science, Technology and Innovation or Mecanismo de Coordenação do Sistema Nacional de Ciência, Tecnologia e Inovação (MCSNCTI). This document aims at backing up and improving the coordination and articulation of National System of Innovation or Sistema Nacional de Ciência, Tecnologia e Inovação (SNCTI) of Angola through which all actors should work at the same mindset, optimizing the use of human and material resources available for STI. In addition, it aims, for example, at improving the welfare of the population, accessing new technologies, the incorporation of improvements on bio-technology, and the monitoring of bio-security, bio-ethics, and ethics in research (PNCTI, 2011).

Second – is the National Strategy for Science, Technology and Innovation or Estratégia Nacional de Ciência, Tecnologia e Inovação (ENCTI). This document aims to establish the ways and means in order to reach the government's targets in short and medium terms, in accordance to the vision and mission of the National STI Policy.

> ***[Dn]*** *... / Well… When I came back home, I had wonderful experiences with some other scientists from other realities. It allowed me somehow to have any contact with different experiences and different approaches of*

> *management, conduction of policies on science, technology innovation. But clearly, only this was not enough. It was, perhaps, more basically assertively in order to know the problems, for example, the needs which the Angolan scientists have faced; deficiencies; gaps. Of course, knowing these realities, perhaps, was more easy to know where we should pay more attention to be improved. At least, lets say, maybe we will try to do what has not been provided to me as a researcher of course, with the proper research in terms of literature. I personally went through, I was directing my efforts in trying to understand how to overcome the constraints that I myself lived and what other colleagues have lived, based on the experience of countries that I have already quoted …/which is the case of Russia, the case of Portugal, South Africa, the case of Namibia, somehow, Germany as well*. All of it allowed me to be more usefull in drafting the PNCTI.

Without experiences in different countries, the difficulties (to understand more clearly the country's challenges and mechanisms for creating the vision of developing patent) would be even greater. **Dn** insists in stating that the different experiences taken abroad gave him a better insight into how STI in these countries function, so that in the course of history, they will serve as parameters to avoid the same constraints they experienced in the past. For skill building is the center for the creation, absorption, and use of knowledge for innovation and, thus, to update (CHAMINADE at al, 2009).

> ***[Ar]*** *[...] I must say I was lucky to have a very strong scientific Education. First, in my graduation I was very strong in the subjects of science, math, physics, chemistry, biochemistry and, already very early as student in the first year, I was selected as a participant in student scientific forums. After I finished my degree with high average, which earned me the right to post free graduation paid by the authorities of the country where I lived. And then, during the training, I was always stuck in the labs somehow in initiation's teams as one of the best and preferred students, sometimes, when teachers were absent. And then already in post graduation, I have been working many years in laboratories, where my research was purely laboratory, whose theme has to do with "determination of cyanide, nutritional quality of certain food produced in Angola, etc., etc.. and even cyanide and its relationship to human health. "These questions gave me enough theoretical and practical basis when passed to the dean of the college of agricultural sciences, later Vice-Chancellor, it served me to some extent, to interact predominant factor with greater firmness and security when dealing with partners who were academic and scientific field. This and all attached to outer experiences, contact with other latitudes and publications [...] also I made publications, participated in international conferences and even as a student, for example, I left Cuba I went to Brazil to do research in other research centers, all of this, more preparation, self preparation, permanent resilience, helped me to participate in the process of institutionalization of PNCTI more easily.*
>
> ***[Af]*** *... / Many contributions. I believe… in a positive way because in our training abroad and throughout our personal training, I had contact with the instruments of operationalization of research policies. During my personal training in the management of scientific affairs at the University Agostinho Neto, I was benefited by a teaching program in Cuba that gave me a diploma of research science and technology management in Pinar Del Rio University.*

Ar and **Af** exhibit characteristic profiles of similar experiences in terms of skills acquired during their training outside the country. The technical and intellectual skills of these two subjects are also extended to academic knowledge management. That is, **Af** is currently Rector at one of the newly Angolan Universities, and **Ar** was, over four years, Vice Rector of another recently created University in Angola. Now he is a Director at the National Centre of Scientific Research ou Centro Nacional de Investigação Científica (CNIC) located in Luanda.

The practice of good governance is essential to achieve effective results in the formation of well-trained human resources to meet the challenges that are at the fore of development actions of the Angolan government. In other words, the training they had abroad allowed them to recognize and understand the need to draw a PNCTI that fits the Angolan reality and targets of development. It means that knowledge about good governance and good management tends to be more innovative than others, regardless the stage of development (Jensen *et al*., 2007).

> ***[Al]*** *[...] The experience, especially outside the country with the participation in international events, some formations in European countries and African countries, my involvement in regional programs such as plant genetic resources of SADEC[25] gave me a very large contribution in what is the preparation of such document. Also it gave me many other opportunities to work on my own in finding self-motivational ways, providing the necessary tools to undertake the work.*

Again, it appears that the interviewees are highly educated. Thereby, this meeting of different cultures acquired abroad was of great importance because the subjects brought these capacities into the National Policy of Science, Technology, and Innovation of Angola (PNCTI) drafting. They brought varied visions to the process which enabled the reading of various documents related to the Policies for Science, Technology, and Innovation of various countries and the consequent structuring of PNCTI of Angola. It is important to remind the reader that this group had, as well, useful support from scholars and other different departments across the country with many inputs related to Angolan reality and idiosyncrasies.

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25 SADEC – Southern African Development Community – is a community based on democratic principles and equitable and sustainable development, aiming at achieving socioeconomic development, peace stability, security, and growth. Also it has the objective at alleviating the poverty, enhancing the standard and quality of life of the peoples of Southern Africa, and supporting the socially disadvantaged through Regional integration.

Therefore, it is worth remembering that every person is essentially a cultural being. Through culture, this person carries all the mechanisms and assumptions to understand the world and all things that are around him. In doing so, he will be able to trace methodologies for developing perception skills (catching-up) through the production of scientific knowledge suiting his needs and challenges in the national and international levels (LUNDVALL at all, 2009).

Consequently, the education that participants received abroad facilitated these multifaceted visions, so that they were able to draft a National Policy of Science, Technology and Innovation of Angola (PNCTI). It was drew up on various, specific and overall experiences such as the TRIAD (U.S., Europe and Japan), OECD, and National Systems of Developing countries. That is, the high profile of the subjects led them to realize the benefits of a National System of Science, Technology and Innovation Policy that follows the example of TRIAD and/or OECD countries. It does not necessarily mean that less developed countries have to adopt the exact SNCTI policies of the OECD countries. As mentioned earlier, those countries have also had their difficulties to manage their National Innovation System (NIS) building. They also suffer from various systemic local problems, not just in developing countries as it can be seen on Table 11.

Table 8: Systemic Problems in Developing Countries

Component	**Mature Innovation Systems (developed countries)**	**Emerging Innovation Systems (Developing Countries)**
Purpose of the System	Knowledge Creation	Absorption of exiting knowledge
Stage of development of the system	Mature; well-developed	Emerging; System construction
Systemic problems (related to the components of the system) capacity problems	Lack of research and technological capabilities and a close interaction with customers in the manner of using and interacting (FUI); Lack of research facilities on a large scale for advanced basic science;	Lack of capacity engineering and design (CTI, technology absorption); Gaps in management capacity (intermediate stage of development the SI); Lack of learning organizations and the lack of sophisticated customers (WAS); Absence of technical centers

Network problems	Lack of a strong network among firms; Weak network of university-industry research.	Weak link between Transnational Corporations - indigenous companies; Weak links with customers; Connect with rural communities and local needs (universities of development); Provision insufficient qualified from universities to companies human capital; Lack of bridge organizations
Institutional Problems	Intellectual Property Rights (IPRs); Governance	linking formal and informal institutions; Regulations conducive to business innovation; Social inclusion; Corruption ; Intellectual Property Rights (IPRs); Provision of reliable

Source: Adapted from CHAMINADE *at al*, 2009.

As shown on the table, although there are some similarities among developing and developed countries in terms of lack of research funding, developing countries have more problems such as extreme poverty, lack of formal institutions, high levels of corruption, and difficulties with governance. All of these issues hinder the development of a NIS properly.

As endorsed throughout this work, Björn & Lundvall (2003, p.25) believe that the concept of a national innovation system, in the first instance, may be useful as an analytical and promotional tool for the welfare of African countries. At the same time, this concept recognizes the need to adapt and develop a concept that fits in African realities.

This is enshrined in the Mission of the National Policy of Science, Technology, and Innovation of Angola:

> The National Policy on Science, Technology and Innovation (PNCTI) is the central instrument for in a sustained manner and in line with the fundamental interests of the people, the State and organizations contribute to the implementation of the National System of Science, Technology and

> Innovation to be a reference on the African continent, converging to international best practices and recognized for the quality of the produced results and the impact that the processes of technology transfer, and associated knowledge leverage the economic and social development, the resolution of structural problems of economics, management and efficient use of natural resources, and maintain the security and sovereignty of the Angolan State (PNCTI 2011, p.33).

Here one can note a very ambitious and challenging project to overcome the lack of human capital to sustain and continue what is enshrined in the mission. Given the specific challenges related to a major combat to eradicate poverty and endemic diseases, technicians highly prepared are needed. In addition, this project is necessary to the development of general institutions, schools, universities, scientific research, and production companies. After all, while we understand the diversity of developing countries (and the difficulty of comparing different countries or even identifying general characteristics of developing *versus* developed countries), it is plausible to claim that the innovation systems in developing countries face different challenges than innovation systems in developed countries (CHAMINADE at al, 2009).

> ***[AI]*** *... / what is intended, in general, is to create mechanisms that facilitate the eradication of poverty, hunger and endemic diseases that still plague our country. If we do not take it into consideration, anything I do, all these effort shall not be worth it. Thereby, it is impossible to have a National System of Science, Technology and in Angola.*

From this perspective, Laraia (1997, 27) emphasizes that to understand the world and human behavior itself, one must take into consideration the different world views and value systems. For the nature of this work, the need arises to understand and analyze the different social, cultural, and historical forms in which several people are made up of the various levels of economic development where they are, and by their capabilities to develop solutions to their problems. In this token, a socio-economic and technological innovation, (SSHRC, 2013-16) fuelled by human capital, new ideas, and the productive flow of knowledge within a robust culture of innovation, are crucial.

As pointed out earlier, some intergovernmental institutions undertook a diagnosis in order to have a landscape about the current state of development in Angola. The

following chapter is related to an approach about the guidelines of UNCTAD and UNDP Angola, from a study done by these organizations in the country.

7.4 The Role of Inter-Governmental Organizations For the Implementation of the PNCTI Angola – UNCTAD and UNDP

7.4.1 Inter-Governmental Institutions

The UNCTAD (United Nations Conference on Trade and Development), created in 1964 in Geneva, Switzerland, in the context of discussions of trade liberalization, is the organ of the General Assembly of the United Nations that seeks to promote the integration of country development in the world economy.

Composed of leading experts (scientists, economists, engineers, etc), the body acts as a forum for intergovernmental deliberations, promoting an exchange of experiences. The organization also conducts research, policy analysis, and data collection for the debates of government representatives and experts. It also provides technical assistance targeted to meet the specific needs of developing countries.

UNCTAD[26] works closely with the governments of its member states and interacts with other international organizations and regional commissions, as well as governmental institutions, non-governmental organizations and the private sector, including trade associations, research institutes, and universities around the world. (Http://ois.sebrae.com.br/comunidades/unctad. Accessed 04/15/2014) The UNDP[27] (United Nations Development Programme), in turn, present in 170 countries, is a UN agency dedicated to fighting poverty and promoting policies to enhance Human Development. (See further information on footnote).

26 The UNCTAD – United Nations Conference on Trade and Development is governed by its 194 member States. This is the United Nations body responsible for dealing with development issues, particularly international trade. Its work can be summed up in three words: think, debate, and deliver.

27 UNDP – United Nations Development Programme is located in more than 170 countries and territories, helping to achieve the eradication of poverty, and the reduction of inequalities and exclusion. It aims at helping countries to develop policies, leadership skills, partnering abilities, institutional capabilities and build resilience in order to sustain development results. Also works to promote Inclusive growth, better services, environmental sustainability, good governance, and security to development progress. With a wide number of expertise in development thinking and practice. UNDP supports countries to meet their development aspirations and to bring the voices of the world's peoples into deliberations.

A collaboration of governments, private institutions, and civil societies also focus their efforts on the implementation of programs that result in the improvement and welfare of the people, protection of human rights, and equality of gender and race. Such collaboration enhances efforts towards the achievement of the Millennium Development Goals in view of the central themes: capacity building, science and technology, the modernization of the state, the strengthening its institutions, more poverty eradication and social exclusion, environmental conservation, and sustainable use of natural resources (Http://www.onu.org.br/onu-no-brasil/pnud/. *Accessed in* 04/15/2014). These institutions were called on by the Angolan government to develop a diagnosis concerning the state of development in all areas of the Angolan society, and suggesting a feasible direction in terms of governance.

Therefore, given this goal, the area of Science, Technology and Innovation was contemplated and, to this end, the interviewees answered the following question:

Knowing that the PNCTI of Angola is based on research and debates, what role the UNCTAD, UNDP and other institutions did play in the process?

> ***[Dn]*** *First, is the recognition in terms of expertise that is presented in these organisms. This is always important because they have with much experience especially on understanding about the functioning of science, Technology and Innovation ... / They are organizations with high prestige, with recognized prestige. Therefore, the participation of these bodies, and they are of great contribution in terms of expertise, also give credibility to the process. But after lifting or after undertaking a diagnosis made up by UNCTAD, lets say on the Ministry of Science technology level, we generated, at least at the staff level that the consensus was to enhance and strengthen further studies.*
>
> ***[Ar]*** *Well this institution both UNDP and UNCTAD, the United Nations agencies had the merit of having made this first study, but the study itself, not on the committee were Angolans who know the territory, Angolans who know the reality and Angolan investigating, doing science, it is not those who say they are scientists or PhDs, not ..., who at least ever published science, discuss science ... it has the merit of being the first, has its merits to have collected a set of indicators, but weak precisely the elements that I've shown. Anyway, know that human works are not perfect and therefore her for being first have all its merits, either by being first, as for giving elements that guided here. then we no longer moved, we assume their proposal as valid, with a basic working document.*

Despite recognizing the importance of these institutions, while making these diagnoses, **Ar** is imperative in saying that the absence of Angolan staff in making the diagnosis resulted in some gaps to understand local problems.

> [**Ar**] *UNCTAD has a great importance because UNCTAD, after an examination, gave some recommendations to Angola. Now we have a National Policy on Science, Technology and Innovation. And we also felt it. Thus, the Ministry of Science and Technology has been guided by something, this thing is the political coming out called PNCTI. It will define and delimit all activity of science technology and innovation in Angola ... from there arises the* ***Policy****.*
>
> **[Gm]** *Well, it's very, very much, but I would say for being a catalyst that triggered a series of questions that was an antecedent that they had to brought a number of points which were the antecedents to improve it the document. But it should be considered a basic job well done with some argument, some proper support for time because the process is dynamic. And then, there are issues that had to be placed as additional, but always based on a based diagnosis very well prepared. I think that it helped a lot, because reflections were made very well based on what existed as antecedent.*

All are unanimous that these institutions were important in reference to develop PNCTI of Angola, despite the assertion about the absence of national experts to give more accurate indicators of S&T of the country. In other words, it was the study that helped bring about the origins of the National Policy on STI of Angola, namely the need to have one.

However, the diagnosis given by these agencies was followed by valuable discussions between academics, researchers and heads of ministerial departments of the Angolan government and non-profit organizations. Promoted by the Ministry of Science and Technology of Angola, there were several meetings in which all of the above organizations came to Luanda, bringing inputs into the draft.

> **[Al]** *My opinion…, I think the study by UNCTAD came in good time because it released to the group many ideas. They were mandated to work to give information, at the time, about the state of science and technology for the most different sectors that were targeted for this evaluation of UNCTAD. Therefore UNCTAD made a very important preliminary work, and this work was later available for the committee to know what was the situation of science and technology in different sectors in order, from there, to continue with the other part of the policy document. Because even that document of UNCTAD is referenced in the policy document, it was very important because it allowed to have a basis on which the committee has worked. It is Just to say that UNCTAD made a great diagnosis on the Angolan reality of scientific and technological point of view ... It enhanced some sectors that later allowed to continue the policy document…*

> **[Af]** *Therefore, the importance was mostly in aligning policy and what contribution was the structuring and development agenda of the country by the year 2025 ... / based on the prerrogatives of the development of the country, so far in various sectors of activity of the country, we tried to draw the contributions that science and technology and innovation could contribute to all these sectors. Therefore, the contribution was part of the studies. It allow this alignment that could be done in what is the country's development agenda until 2025.*

Even though this is not a subject of this study, **Af** refers to the 2025 agenda, a program of the Angolan government that provides for the development of the country by the year 2025. This agenda is guided by the Millennium Development Goals (UNDP, 2010), whose main actions focus on reducing extreme poverty, eradication hunger. In this sense, one of the targets of the Angolan government is the creation of 8.2 million jobs, the 75 percent reduction program, and the lowering of the poverty rate, in order to eradicate hunger and extreme poverty. The Angolan development strategy for long-term aims at multiplying by nine to 10 times the Gross Domestic Product (GDP) per capita and reducing the average rate of inflation to single-digit levels (INE, 2011).

The objectives of Angola in 2025 are: to ensure national cohesion, to promote peace and tranquility, to establish equitable and sustainable economic development, to ensure fair income distribution, to create macro-economic stability, and to establish development of harmony across the country (www.angop.ao. Accessed 04/22/2014).

Table 9: Among the thematic areas, here are the particular topics included in the Millennium Development Goals

EXTREME POVERTY • Monetary Poverty • Distribution of profits	**EPLOYMENT** • Labour Productivity; • Occupation; • Labor informality
HUNGER • measurements of children • Calorie burned	**SCHOOLING** • Registration and frequency, • Literacy. • terminal efficiency
HEALTH • childhood vaccination. • maternal mortality.	**ENVIRONMENT** • Public policies, respect for forest areas, greenhouse gases and

• pre-natal care and childbirth. • contraceptive use and unmet demand. • Teen pregnancy. • incidence of HIV / AIDS. • orphanhood. • access to anti-retrovirals. • incidence, mortality and prevention of malaria and tuberculosis	substances that destroy the ozone layer. • Fisheries. • Water resources. • Protection of natural resources. • Safe water and sanitary sewer. • living conditions of the population in Musseques. **GLOBAL PARTNERSHIPS** • Foreign debt. • Access to essential medicines. • Access to information and communication technologies

Source: Adapted from UNDP, Millennium Development Goals. Angola, report 2010.

These topics are the main targets of the UNDP to help countries to reduce poverty and achieve sustainable development, which steers transformational change, promoting real improvements in people's lives. Angola has been following these principles, aiming at achieving sustainable development that tackles the connected issues of multi-dimensional poverty, inequality and exclusion and sustainability (PNCTI, 2011). In doing so, enhancing knowledge, skills, and technology capability have been the concern of the Angolan Government in finding the best ways to meet these problems.

The next section emphasizes the level of R&D in Angola in order to find a pathway to reduce some asymmetries between Angola and other countries.

7.5 LEVELS OF SCIENTIFIC RESEARCH IN ANGOLA

7.5.1 The Need to Develop Coherent Strategies

As pointed out earlier, research entails processes involving a community of scholars and researchers (DOERN, 2009). Thus, the PNCTI advises the government about the need to develop coherent strategies that use the vast natural resources, which in Angola are centred on oil and diamonds. Therefore, having recently created more than seven universities across the country, the Angolan government has had hard time in promoting projects that enable research related to the local needs in any province across the country.

Hence, it is worth mentioning the thoughts of Longo (1989), to whom science is the organized body of knowledge concerning the universe, involving the natural, environmental and behavioral phenomena. He also believes that the generation of scientific knowledge will be conducted through research or scientific research, following a scientific methodology. The lack or the weak investment in scientific research in Angola is one of its major constraints in increasing high levels of scientific research and in strengthening the National System of Science, Technology and Innovation of Angola.

To corroborate this assertion, the interviewees provide information of great relevance, referring to the level of scientific research in Angola.

> **[Gm]** *[...] Well… it is necessary to distinguish two instances: if a current moment, I would say very low level, so without fear of failure, very low. Because it has some basis for comparison. I mean very low level because, if I return before nineteen seventy five, Angola had a very high level of scientific research had highlighted the level of Africa and to the world level .... to give you some examples of Southern Angola, there was a very and recognized research on agricultural sector. And veterinary vaccines where even developed in relation of the African Continent. There were a designed sector, through which research were developed right here in Angola ...*
>
> ***[Rm]*** *[...] We had a kind of corn whose species was that was teeming in various regions of the world. Studies were made here in Angola. These are in this particular area. And we had other areas of tropical medicine itself, which formerly had very large results, ... / ... but compared to now, I will say that we are far below. This is the criteria that I use as comparison. we are very below. There is a justification of why it is low. [...] This justification is something that is also very well incorporated in a diagnosis that was made to the elaboration of national policy for science, technology and innovation in the first place. Because there is no coordination between the different actors*

> *of the national system of science technology and innovation, because for me it is not so much a lack of equipment, often because the experience we have here is equipment that exist, but they are not used or are not monetized in the dimension that should be… then there is a big handicap.*
>
> *[...] Just to say that although funding is not yet regarded as excellent, 1% is required at the level of gross domestic product almost in the African reality, there are some who say it is already 1.5% or 2%… I believe this is not the great difficulty ... the great difficulty for me is the lack of proper coordination between the different actors of the National System of Science, Technology and Innovation. Because with what they have, in terms of money and sources, the results in scientific research could be higher.*

Gm gives an Angolan reality's overview of a period which corresponds to the time of Portuguese colonization. During this period, there was a solid research in the centre of Angola undertaken by the Portuguese government, fostering the then colony to a prominent position in Africa. Such scenario was a result of a great and satisfactory production in the fields of horticulture and agriculture. Thus, with the advent of the civil war, after independence in 1975, the majority of technicians were, compelled to leave Angola, while others immigrated to Luanda. The others provinces (mainly Huambo, Benguela, Huila, etc) across the country and their own R&D institutions, were abandoned.

In doing so, as pointed out earlier, during the 27 years of civil war, the Angolan government, enhanced actions to defend their territorial integrity. They invested heavily in purchasing military technology to strengthen the national army. The majority percentage of GDP was spent on war equipment and training. Other areas such as R&D institutions across the country were left behind.

Thereby, it is for this reason that Angola is a latecomer country, because in fact, it did not have the capacity to mobilize resources and promote quality on education and research institutions. In other words, the efforts on R&D as a whole did not rise with the level of overall development in order to boost a socio-economic development for the country.

Also, **Ar** shows below the same opinion, regarding the lack of a high level scientific research in Angola. He, in short, uses the term lack of "robust investigation" due to the large socio-economic and geographic disparities in the whole of Angola. That is, the meager resources allocated for the promotion and application of research in the

country are distributed mainly in the capital. It exacerbate the problem of Angola in being a “late comer”. The civil war ended in 2002. However, the resources are overwhelmingly concentrated in the capital.

> **[Ar]** *[...] It differs greatly in some regions as in some institutions such as Lubango, Huambo and Luanda, here and there ... there is some research, but as we say, some robust research, a network of researchers do not exist yet.*

The provinces mentioned by **Ar**, such as Lubango, Huambo, and Luanda still have a certain structure (very incipient) to pursue the investigation. In the colonial period, they were covered with more robust investments for the R&D activity.

> **[Rs]** *There is not a scientific research in Angola Properly. Without a fear of making mistake, universities in this country are weak. There is not a strong culture to undertake research nor infrastructure for that end. There was in the past, not now. The war destroyed everything.*

In opposition to others respondents, **Rs** emphasises more deeply that there is not scientific research in Angola, because of lack of culture and infrastructure across the country. Because of the war, everything was destroyed.

Therefore, it is possible to notice some small actions around scientific research in these places. This reinforces **Gm**’s quote in relation to southern Angola where they undertook a robust R&D in the veterinary and agriculture fields. In other words, while there are pockets of STI happening in Angola, they operate more or less isolated, and the bulk of activity happens around Luanda.

Moreover, **Dn** highlights another major cause of these gaps in research that underpins the outbreak of the Angolan armed conflict that lasted for approximately 27 years.

> **[Dn]** *[...] In a phase of stimulation. We had scientific research, maybe. But the best moment was in the seventies, so to speak. We had the center of the central highlands of Angola or Planalto Central de Angola in Colonial time when it was taken as a reference in terms of scientific research, particularly in the agricultural field both in the field of veterinary medicine, as in agriculture. There were good results, which were used not only to the level of countries, but the level of the region. Was reached to produce vaccines, say for cattle, etc […] they had results in series. But then we had a long period of war when life became more confined to the coast and we can*

> *clearly see that the institutions that have survived have undertaken science confined to the coast. The institute for agronomic research itself, as I said, was the basis for some of the good results of the seventies. It had to move to the coast, for the lack of work conditions. Then there was a clear break during several times. There was a clear significant decrease in the indices of scientific production. Then, moreover, the National Science Technology and Innovation is clear in this regard. Then we have the guiding lines of what it should be done in terms of implementation to return to have a science that is productive, so that we can have a significant technological and scientific development. At least, if not before, at least, it should be implemented until twenty-fifth year ... two thousand and twenty-five.*

Before **Dn** shares his thoughts, it is important to emphasize the thematic areas prescribed in the Millennium Development Goals, which focus on eradicating extreme poverty and hunger; universalizing primary education, promoting equity and women's empowerment, reducing child mortality, improving maternal health, combating HIV/AIDS, malaria, and other diseases, ensuring environmental sustainability, and developing a global partnership for development (UNDP, 2010).

These thematic areas are intertwined with the objectives of the African Union who advocate the end of extreme hunger by 2025, for considering the significant importance of ensuring the quality education, training, research in science, technology, and innovation, and strengthening agriculture with a goal of ensuring food security in Africa.

> Recognizing that about 25 percent of Africa's population (about 245 million people) do not have enough food to meet their basic nutritional needs, and that between 30 and 40 percent of children under 5 years continue to suffer from chronic malnutrition, including micronutrient deficiencies; Recognizing that a large number of homes continues to face food insecurity and malnutrition due to low food availability, low income, unemployment, risk and vulnerability, inefficient access to basic services, including health, water, sanitation and education; Reaffirming the important role of education, training, research and development in the evolution of science, technology and innovation platforms in agriculture in Africa to advance the vision of an Africa with food security, ... we renew our commitment to achieve the goal the high-level meeting on the revamped to end hunger in Africa and we are committed to implementing the roadmap especially with our resources and with the assistance of our technical partners and partnership development. (Final Declaration of the meeting of heads of state held in Addis Ababa, Ethiopia, July 2013. ***http://www.institutolula.org. accessed 03/31/2014).***

Given these objectives, I understand that the challenges around scientific research are colossal, as the African situation, in particular Angola, requires investments and ubiquitous actions. The millennium goals mentioned above (table 12) are of a

paramount importance to overcome the earlier mentioned problems in agriculture, food security and poverty, education and so on.

For investments, as already discussed in the *corpus* of this work, there is still, in some political and academic circles, an ignorance regarding the importance of investing in science, technology, and innovation. This creates a delay in raising the levels of scientific and technological research and the implementation of a National System of Science, Technology and Innovation in order to contribute to the implementation process of the industrial framework. In the next section, is an approach related to a lack of investment on this field.

7.5.2 Lack of Investment on Education and R&D

As pointed out throughout this study, there are several causes of the lack of investment in science, technology, and innovation in Angola and, in general, in the peripheral countries. First, the civil wars were the most important factors for not investing. On the other hand, there is ignorance on the part of some politicians. They don't know or deny the importance of investing in education and scientific research as a driving force for economic and social development.

Of course, as noted earlier, countries in sub-Saharan Africa, such as South Africa, Nigeria, and Uganda, (GLENDA, 2012) have been increasing policies on this issue. The aim is at creating conditions for economic and social growth through the promotion of scientific and technological knowledge within the base, although in some of them, this initiative is insipient.

We can cite, as one example, the project of introducing the basic laptop in schools in Tanzania, Rwanda, Kenya, Uganda, and Burundi. According to the organization "One Laptop Per Child", which is responsible for the project in partnership with these governments, some of these countries have provided some schools with the XO computer model, distributed by such organization. (http://boasnoticias.sapo.pt / mobile / noticias.php? id = 1103. Accessed 03/24/2014).

The purpose of this project is to have children interacting with the computer at an early age in order to set up technical skills that will allow them to have contact with different realities and cultures, without moving from their towns or villages.

> As it is seen, the technology, while maintaining its core mission of ensuring the victory of the human being struggling to survive and evolve economically, began to form themselves into powerful vehicle for transformation of social behavior itself; it lead us to forget old habits, old customs in order to assume another posture demanded by new standards of living, reasoning and vision (DINIZ, 2002, p. 121).

The technology nowadays should not be ignored, even in those areas that are at a lower level than other more developed societies. In fact, currently (DINIZ, 2002) technology is celebrated "urbi et orbi" because it has already reached a level of efficiency that identifies it as the primary means to lead us to a future without the known material limitations responsible for the difficulties that preclude a more just social organization. Also without constraints of deficiencies technology allows person to observe the approach of a world where balance and spontaneous satisfaction are viable.

In this token, some issues must be taken into account, such as culture, traditional knowledge, the context, and beliefs. As discussed earlier, I assume that western knowledge must be put in line with traditional knowledge in order to solve many issues and gaps among developing and developed countries. One should take into account these nuances because ignoring this phenomenon is being unaware of what is happening now.

Thus, on the core of my discussions there is the concern of an innovative platform for research in Angola which comes with a set of feasible actions on the spot. In doing so, those young students, in their adult lives, will may have developed skills that will lead them to reflect on their own idiosyncrasies, and effectively have the capacity and skills to settle their own problems. This is because they would have structural notion of the traditional knowledge they entail. This is, not just as spectators, but effectively as co-participants in the development process of their societies in all areas, including creating and innovating.

According to consensus data, the process of transitioning to the twenty-first century will require a quantum leap in the development and operation of information technologies with corresponding ramifications for economic and social organization, environment, culture, and development of the global information infrastructure (Roffe et al 1995. viii).

Thus, developing nations should enhance efforts to get close to global development (training the population and so further), when there are still people whose lives are being indeed affected in several manners, due to the impact of these technologies.

The working group of the UN Commission for Science and Technology for Development[28] (UNCSTD), given the numerous situations that affect many peripheral countries, made the following observations (in MANSELL, Wehn, 1998, p 7.)

- There is sufficient evidence of the potential of Information and Communication Technologies in which all rulers and other stakeholders need to create new capacity to produce, access, and / or using these technologies;
- Strategies are necessary because they help create the scientific, technical, and engineering knowledge and management techniques and consistent social and economic institutions that know how to use ICT creatively to reap the potential social and economic benefits;
- Priorities must be given to policies, regulation, education, and training, assessment programs to improve the ability to produce and creatively use information technology;
- A creative, dynamic combination of government and the actions of the private productive sector of each national or regional innovation system can offer possibilities to take advantage of ICTs for all developing countries, including least developed countries;

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28 **The Commission on Science and Technology for Development (CSTD)** is a subsidiary body of the Economic and Social Council (ECOSOC). It was established in 1992 as a result of the restructuring and revitalisation of the United Nations in the economic, social and related fields.
It was established established to provide the General Assembly with high-level advice on relevant issues through analysis and appropriate policy recommendations or options in order to enable those organs to guide the future work of the United Nations, develop common policies and agree on appropriate actions (UNCTAD. Org. Accessed in 03/16/2014).

- One cannot see in the XXI century, eradication of distance between rich and poor. However, if governments and partners draw and implement national strategies for ICT, new technology and services can help reduce the gap for those who are in disadvantaged or marginalized position;
- A special attention is required for the least developed countries, and especially for the countries of sub-Saharan Africa and rural areas of countries with very low financial resources.

These points corroborate the idea of Glenda (2012), whose need for an effective interaction (so that there is a great achievement of knowledge from external partners such as universities, public research institutes and technology centers) becomes a strategic priority for these African Countries. However, these are too varied and difficult, because in some political and academic circles, the debate still lingers over weakness and the lack of importance of investing in science and technology training in order to create such interactions.

7.5.3 Challenges on Investments

As pointed out by Schwartzman (2002), researchers occupy a relatively minor place in their societies without significant participation in decision-making. Thus, they are often forced to act as lobbyists to defend their world views and professional interests. Moreover, researchers and scientists and their research institutions are taking unfeasible policies and governmental ideologies, thus stifling freedom of inquiry and expression of scientists and researchers. In the case of African countries, this is still one of the biggest issues.

As I have said throughout this work, a scientific and technological system in universal completeness, includes three processes: research, innovation, and diffusion. All of them come together for an effective materialization and successive results in the development of technologies and the consequent growth of national economies.

In other words, it may be said that without an effective investment, which consists of R&D, infrastructures, and human capital, it is impossible to materialize and embody the scientific achievements which could be produced in universities and/or in R&D institutions. Without such tools, no one is able to produce knowledge, and thus fostering socio-economic and technological innovations. This is, therefore, an emboldened set of situations in which science and technology permeate in order to have an effective materialization in the desires of modern societies. In doing so, it will be possible to achieve levels of development in all spheres of society, with the penchant of strengthening the foundations of its economies.

In the view of Velho (2011), there is a great need to understand and analyze the different social, cultural, historical, and political forms that are constituted in various societies, the various levels of development where they are, and their capabilities to produce and use knowledge for their own progress. The reality of Angola does not escape this thought. Because analyzing it deeply, other provinces are not developed as it is in Luanda. As mentioned earlier, the resources allocated to each province do not suit the need of creating infrastructure, much least the creation of R&D's institutions for various purposes, e.g., public health, and to identify and prevent potential outbreaks that affect the most recondite spots of the country .

The war caused a shift on scientific production from the interior to the provinces of the Atlantic coast (Benguela and Luanda) due to the lack of conditions to develop themselves because of the hostilities that plagued families and destroyed the infrastructure. The intellectual exercise drifted to the oblivion because technicians focused their actions to survive and feed their families.

Whereas in the postulates of Pavitt (1984), a national innovation system is a set of institutions involved in the generation, commercialization, and diffusion of new products, processes, and services. Also it is a mean to strengthen these institutions to influence on the rate and direction of change that will derive from the changes in technology. With this difficulty in which the provinces are, it is hard to establish an efficient National System of Innovation, countersigned by the above reasons, putting in "check" the financial capacity and infra-structure for research and production.

Another issue concerns the resulting lack of institutional career researchers and organizational culture in order to give value to individuals inclined to the craft of research. This problem is linked to the existence of deficient public policies to regularize and encourage careers with the Ministry of Labour, given the bureaucratic and historical issues that I pointed out earlier. Therefore, given this approach, it is recognized that the history and context make a difference when one takes into consideration how the actors interact and learn (LUNDVAL 2003). Because, as noted earlier, a national innovation system refers to a set of institutions, mechanisms, and actors that will support and determine the course of the innovations to be implemented in societies (REZENDE & VEDOVELHO, 2005). For instance, seven public universities were created across the country. Nevertheless, keeping in mind that the majority of institutions in Angola are still in the way of strengthening, some strategies such as promoting workshops among local universities, undertaking seminars for provincial governments, and get together with small and medium companies, sponsored by the central government, could be the bulk to develop the country.

On the other hand, in thinking about this issue, **AI** points out that there is little scientific research production, requiring only the creation of mechanisms that make such productions shining in a considerable acceptance plan.

> ***[AI]*** *[...] I will not use a criterion ... very accurate ... I will not need to use the slider to set the level, but I say that there is some research that happens in an elementary level, especially in academies on the way of jobs to undergraduate. And there is another extreme of works that are done by professors of the Angolan higher education institutions in the context of Postgraduate training at Masters and Doctoral level in recent years with contributions to the study of the Angolan reality, therefore, having as object of study the context of the Angolan reality. So here at this level, in association with institutions of Higher Education linked to these questions our faculty, our researchers. Some of them have been participating in international events with high quality. The problem that we have in country is the lack of reporting this sort of activities. There is no a documentation of this activities across the country to make a more precise, more accurate disclosure of all these contributions that have been undertaken by national researchers.*

AI emphasizes that there is a lack of mechanisms for documentation and dissemination of research carried out in Angola. There is a need to create interaction processes between the actors of the National System of Science, Technology, and

Innovation. Because, as previously discussed, (Glenda, 2012) interaction networks of cooperation and capacity utilization of knowledge from external partners such as universities, public research institutes, and technology centers, must become a strategic priority for the country.

This means that the knowledge generated in universities and scientific research centers does not transcend the physical boundaries of the Angolan universities. This requires public policies that excel in funding and diffusing such knowledge. So, on the brink of this issue, public policies could play an essential role, providing both guidance for Angolan policy-makers and accountability linked to the necessities of building a strong National Innovation System, which suits the targets of development. Pal (2009) is clear in saying that public policy is a course of actions or inactions chosen by public authorities to address a given problem or interrelated set of problems.

Therefore, inexorably, the knowledge generated needs encouragement to increase technological innovations in the different spheres of society, creating added value. Necessarily, as stressed earlier, scientific knowledge needs the pillar of diffusion, (so it does not occur in a scientific insulation) for the effective materialization and successive results in the development of technologies and the consequent growth of the national economy and development of Angolan society.

As pointed out earlier, for a better innovation performance, any country needs a combination of science, technology, engineering, socio-economic and political skills, an adaptive and entrepreneurial culture, nimble and agile thinkers, and flexible mechanisms which allow collaborative problem-solving (Beek, 2007). Theses strategies can allow diffusion of all sorts of production and innovation undertaken across the country. Nevertheless, knowing that (MOWERY&BRULAND, 2005) innovation is a sort of process in which socio-economic values are extracted from knowledge, creation, transformation, and diffusion of ideas and products, it requires a dynamic, systemic, and steady learning among actors.

In her work on innovation and diffusion, Bronwyn Hall (2005), in a comparison with a community of monkeys, emphasizes the following:

> Returning to the human world, it is safe to say that without diffusion, innovation would have a very incipient social or economic impact. In the study of innovation diffusion is the word commonly used to describe the process by which individuals and institutions in a society/economy adopt a technology, or replace older technology with a newer one. But the spread is not the only means by which innovation can be useful to be widespread throughout a population. It is an intrinsic part of the innovation process, such as learning, imitation, and feedback effects that arise during the propagation of a new technology to enhance the original innovation (Hall, in The Oxford Handbook of Innovations, p. 460).

The case reported by **Al** demonstrates the inverse image of a company and/or savings reported by Bronwyn Hall that invests in scientific research whose results are clearly perceived, as these produce improvements in social and economic well-being of populations. Understanding the importance of this process is to highlight the measures on funding for research and development (R&D), technology transfer, launching new products, or creating new processes. It means (Rosenberg, 1982) that diffusion of innovations is often accompanied by learning about its use in different environments, and that this in turn feeds improvements on the original innovations.

> ***[Gm.]*** *[...] We are at a very low level, and therefore there are a number of issues which, with the policy now drawn and all mechanisms that help in the implementation and monitoring of these variables itself, all of this will help consistently [...] this will require some time for us to move to moderate levels, the levels practically good and then reach a level of excellence that I already consider we had before nineteen seventy five, more or less in this comparison.*

The statements of **Gm** and **Al** are followed by the creation of the National Policy of Science, Technology, and Innovation of Angola (PNCTI) approved by the Council of Ministers of the Angolan government in 2010. It aims at establishing an effective National System of Innovation. According to the annals of the Ministry of Science and Technology of Angola (MINCT) and the Ministry of Higher Education, there is a drive to increase the indicators of scientific research and technological development in the country, guiding the creation of more universities and research centers.

That is why, as noted earlier, the sub-system of Higher Education undertook reforms even before the establishment of the PNCTI. Sponsored by the Angolan government, in 2008, they created seven new public universities under Decree 07/09, (PNCTI, 2011). In my point of view, it will foster a great boost in academic and investigative

scenario across the country. The creation of new universities was materialized from the expansion of then only Angolan University – Universidade Agostinho Neto – UAN. With the creation of those new universities, the other Angolan provinces majorly benefited with courses in the humanities and social sciences. Other subject areas such as Engineering, Health, and others that need labs and technologies, have been the “Achilles heel”.

There are other efforts, though insulated, in some government agencies to facilitate access to information by means of information technology to improve the informational listing and technical capacity of the Angolans. Teta (2010, p. 14) says that “what we are somewhat checking throughout the country is that, despite the efforts of the Government of the Republic of Angola in bringing to all populations technologies for the development and growth of world economies, the truth is that in our country these technologies are expensive and inaccessible to many people. In fact, it is worse in other provinces outside Luanda”.

This is effectively a challenging situation and also crucial for developing the catching-up skills of young students, researchers, and managers of institutions in the public and private sector in order to resolve all sort of situations in their lives. In other words, developing the skill of learning to take advantage in every moment that exists inside and outside, learning to, at any time, define what you want, learning how to make a good contract, and knowing what effectively is missed, and a knowledge of which things are not profitable (or even possible) must be done by ourselves (TETA, 2010).

From this perspective, it is appropriate to endorse the studies of Bruland (1998), who realized that the development of the Norwegian textile industry in the nineteenth century was greatly facilitated by technology transfer activities undertaken by the majority of UK suppliers in the form of training, and by increasing the supply of skilled Norwegians workers.

Other examples include, the Asian Tigers - South Korea, China and Japan. These can be taken as innovative references in social, industrial, and economic success, due to the adoption of effective policies of investment in R&D.

Korea adopted bolder policies in a short period of time under (KIM, 2005, p. 42):

1. A perspective of market mechanisms covering the demand side of the development of technologies generating the needs of technological changes in the market, such as supply-side development empowering technology of technological capability;
2. A perspective of technology flows that mainly covers three main consecutive stages in the flow of technology from abroad. The diffusion of imported technology and fostering national R&D to assimilate and improve imported technology and generate national technology ;
3. A perspective of time in which the relative impact of each of the above perspectives change as an industry progresses through time.

In addition, other very important data, beyond the above referenced, is the overseas cultural dimension of the Koreans who focused on learning the Japanese developmental experience within the assimilation of Japanese language and culture. “Both Korea and Taiwan were occupied by the Japanese, but the leaders of Taiwan came from the continent after 1940. In a different way, political leaders and Koreans technocrats in the 1960s and 1970s not only deeply dominated the Japanese language, but also acquired an important background of the culture and the social system of Japan during the Japanese occupation between 1910 to 1945” (Kim, 2005, p. 48). It is important to stress that, although Taiwan was also occupied by the Japanese, they did not focus on understanding its language and culture to the extent that Korea did.

However, the situation of Angola is not the same as stressed above. Despite the efforts of the Angolan government, there are also difficulties in collecting and systematizing data (indicators) about the stage of scientific research and R&D undertaken in Angola. In general, this is because of a lack of skilled human resources, infrastructure and information technology. Beyond these issues, another main concern is likely around the indicators of STI as shown in the next section.

7.5.4 Indicators for Science, Technology and Innovation in Africa

Indicators in Science, Technology and Innovation are of extreme importance as it is able to support the telling of the story of what happens when STI activities are undertaken" (GAULT, 2008).

Even though some African countries have drawn plans of action to provide a roadmap for the improvement of scientific and technological infrastructure through indicators, the majority of countries on the mainland do not release data about their activities, not only in the areas of Science and Technology, but in quite a few other areas as well. This is one of the challenges that I had to face during my field research.

Opposed to developing countries, developed countries (OECD, 2008) have a tradition in releasing annual indicators of activities, such as R&D performance and funding, invention, innovation, diffusion of knowledge, technologies, business performance, and the development of human resources.

Table 10: Data-Indicators on R&D Practiced in Angola In 2011/2012

Nº	Datas N Description	Number of personel / publications
1	2 PhD Professors*	-----
2	3 Master Professors*	-----
3	3 Research and Experimental Development Personnel	*2 038 people
4	3 Papers published in National Journals	68
5	5 Papers published in International Journals	91
	6 Nr. of Patent in	Group that collects indicators did not collect this information, since it

6	the Institute of IP of Angola by area and type	was collected from the right form of the institute where settle claims has no value as an indicator of CTI.
7	Patent at USPTO of Angolan companies by area	-----
8	Companies that perform R & D	There are no official data yet until this research
9	Spending on R&D measured by MCT	Was done during a data collection in 2011/2012. At this time the results are being validated by the UNESCO Institute for Statistics
10	Central Bank: Data import - transfer of technology (technological balance)	There are no data on the matter. The Ministry now created an Office to make this work, but not yet in operation.
11	Products imported / exported by technological intensity	There are no data on the matter. The Ministry now created an Office to make this work, but not yet in operation.

*2038. This is total of R&D Personnel by 2011, found in UNESCO Site.

Source: Prepared by the author, according to data collected on the Ministry of Science and Technology and UNESCO.

As noted in the table above, there is still a gap concerning the indicators for Science, Technology, and Innovation of Angola. This reality is in most African countries, given the historical issues and conflicts that have been a reality for some of these countries. I refer, first, to historical issues, in the case of the colonial period that lasted for five hundred years, in which goal was nothing more than to impose Western knowledge at the expense of knowledge of African peoples. This meant a true colonial practice of a colossal indigenous delay. In other words, colonialism, among other things, poured scorn on indigenous institutions and practices and directly and indirectly discouraged the development of indigenous knowledge, and even industries (BAFFOUR, 2012). In the same token, (WIREDU, 2005) it was not only a political imposition, but also a cultural one which affected African values, beliefs, and indigenous systems of education, projecting Western values.

Moreover, armed conflicts and civil wars, which emerged after independence of former African colonies, augmented the great concern in developing local human capital in order to promote the quality of educational institutions, the productive sector, and strengthening African nations states.

As pointed out earlier, NEPAD (New Partnership for Africa's Development), is an agency created in 2001 with a common interest in increasing the pace and impact of Africa's development. It works in partnership with the African Union (AU) endeavour to put together all African countries to work in coordination, aiming at producing an overall system of indicators to help reporting the actual landscape of STI in Africa. It is, reducing poverty, putting Africa on a sustainable development path, halting the marginalization of Africa, and empowering women (NEPAD, 2011).

The overall objective of the Initiative is to contribute to a better quality of policies in the area of science, technology and innovation at national, regional, and continental levels. In addition, its specific objective aims to support and strengthen Africa's capacity to develop and use indicators for science, technology and innovation in planning development and policies. Covering nineteen countries, including Angola, NEPAD provides strong support initially, in terms of capacity building in R&D and innovation, by funding studies to collect information from the participating countries (NEPAD, 2011).

Thus, in the workshop held in 2003 in Johannesburg (NEPAD, 2003), the congress participants agreed that some points hinder the National System of Science, Technology, and Innovation (NIS) in Africa such as: lack of information on research activities in the continent, insufficient cooperation across national borders, weak links between scientific institutions and industry, underestimation of the potential of science and technology to tackle the issues of poverty, outward mobility and loss of African scientists, low quality of science education, and spending on R&D below one percent of GDP of most African countries.

Angola, according to official information from the Ministry of Science and Technology, is also conducting work on indicators for the system of Science, Technology and Innovation, whose statistics will be published in due course (MINCT, 2014).

However, as pointed out earlier, the concerns of all interviewees above are in agreement with the reports of the Forum on Higher Education, Research, and Knowledge (Scientific Committee for Africa) held in Dakar in 2002 in which they identified among others too many problems that hinder the development of R&D in country. The inadequate policies to support research in Angola are lack of funding, and lack of infrastructure for research. These are the biggest concerns, because it hinders the increase of training in research, and it also hinders a feasible catching up to foster innovation and technology development.

On my perusal, I noticed most peripheral countries have already local policies that facilitate the import of advanced technologies. But there are gaps and weaknesses in handling these technologies, due to the weak technical capacity of professionals in different areas of knowledge. They do not have qualifications to manage efficiently the technical equipment purchased. The qualification of these skilled professionals is a *sine qua non* for effective and efficient use of the equipment to ensure a relevant and applied research. Technical training is required for the effective success of actions around research and innovation and the consequent development of economies.

As previously stated, in this context, "science shall supply the technology not only specific findings, but also with the increasingly widespread use of the scientific method of investigation, their laboratory techniques and certainty the importance of research in problem solving "(LONGO, 2004 p.6). The deficit of more qualified professionals hinders the development of research activities, technical, and scientific skills, including the empowerment to manage and handle the imported technologies.

In consequence, the stage of dependence on foreign institutions and companies that export technologies for peripheral countries is increasingly high. From this perspective, Pedro Teta, vice-Minister of ICT, advocates the following:

> This is not to say that the installation of multinationals dedicated to the activity of information and communication technologies is unfair for the Republic of Angola. On the contrary, we will end up defending their entry into the domestic market, if they are in the most appropriate approach to the Republic of Angola's interests. Indeed, drained resources of the country through the activity of these multinational allow them to spend large sums on research and development of new technological solutions. Under these conditions, the dependence of the countries where they settle tends to perpetuate itself (TETA 2010, p.17)

Although Angola imports cutting-edge technologies (ICTs, devices, and so on), it is sine qua non effectively investing in indicators. This is because indicators cover the resources devoted to research and development, patent families, technology balance of payments and international trade in R&D-intensive industries (OECD, 2008). Overall, enhancing efforts in indicators could be the key to meeting the needs of developing Angola as a whole.

Therefore, the costs of using any kind of technologies are quite high, because every imported machine or device is very expensive, and demands knowledge to be applied into production. Of course, Angola is a new country in terms of democracy, well-being and industrial development. In being so, in my point of view, a strong policy in higher education will herald a new dimension to the new universities in order to foster the building of industries to create technologies that suit the new landscape across the country.

Finally, the costs to get new technologies, and the costs to build a national information's infrastructure to have a knowledge-based and innovative society are high. However, "the costs of not doing so are likely to be much higher" (UNCSTD, in MANSELL&WEHN, 1998, p. 37).
Nevertheless, as Angola is (BAFFOUR, 2012) seeking its own renaissance and seeking to establish the terms of its development, Angolans must take historical evolution and take lessons from the past into account. In so doing, it will allow them to establish viable educational and R&D projects that address the current needs of the country, taking as example the innovation undertaken in Botswana.

Although data are likely weak in terms of industry in the country, in the next chapter, I am going to present a discussion around a technological change and industrial strategy that will foster the development of national economy in Angola.

7.6 Technologies and Industrial Strategy for the Development of a National Economy

7.6.1 The Use of Technologies and Industrial Strategies

According to the diagnosis undertaken by UNCTAD, UNDP, and the ministerial team of Angola, I intended to realize the symbiotic relationship between the use of technologies and industrial strategy for the development of economy in Angola.

Therefore, the national technological development should be a symbiotic relationship with the process of industrial development. In addition, the literature also showed that the process of technological development in developing countries is different from the OECD countries due to several factors. One of them is the difficulty of realizing and internalizing the stages adjacent to developing nations through a National System of Science, Technology and Innovation.

On this basis, the respondents bring information worthy of reflection around the symbiosis between scientific activities and development of the Angolan.

To this end, the subject relied on the following question:

DO YOU PERCEIVE A SYMBIOSIS BETWEEN SCIENTIFIC AND INDUSTRIAL DEVELOPMENT IN ANGOLA?

> ***[Gm]*** *Well ... It does not exist. I can say that without fear of making mistakes. No because when we made the diagnosis in policy itself, we saw that there is no a link between the Angolan industry and the technological development. It is an emerging industry, the same thing we used to say that before nineteen seventy-five Angola had an industry not considered to be at the level of excellence in Africa. But was considered moderate, it had legs. But there was a very clear need for growth in an exponential scale in this development within the industry. There was a need to have back the industrial sector with large industrial pols that have been created with a very large infrastructure and investments before 1975, and an increasing trend in this investment. They are all indicators that shows us somewhat that would change very moderately the development of the industry to a good development, even exponentially. This was a trend. We had all of it ... Those are indicators of what is produced on an industrial scale. After nineteen seventy-five, with all fall, there was a big gap into the R&D institutions the productive sector.*

> *We had the opportunity to draw an attention to this very important aspect, because on one hand there is much talk about development of scientific research. On the other hand it is only effective if that scientific research has some application at industrial level. It means that knowledge must come into tangible things that redound to an application.*
>
> *... This is still much because there is no coordination between the two sectors.*

Therefore, (UNESCO, 2007) innovation, science and technology are concepts that should become part of the new corporate culture of the XXI century. In this vein, companies, regardless of size, sector, and context of their productive activities, may be able to compete in the new world order – the globalization in where the world is closer through the exchange of goods, products, information, jobs, knowledge, and culture in a scope of global integration. It results from unmatched advancements and reduction in the cost of technology, communications, science, transport and industry (STEFFAN, 2004).

Today, the reality forces governments to strengthen the institutions to tackle the global competitiveness, which is increasingly fierce. Thus, industry is no exception. The Angolan industry is not engaged in the designs of scientific and technological development. It is known that from this symbiosis arises innovations that will promote the strengthening of them in the competitive and economic plan (UNESCO, 2007).

> **[Gm]** *So, we have practically a very weak industrial sector because of what I have said – the results of the war itself.*
>
> *On the other side, there are a number of policies on industry sector that would really make things change. There are clear pillars to drive better links between industry and institutions of scientific research, technological development and industry innovation. The problem is that there is no an articulation among them. But the guiding documents of PNCTI provide it. In so doing, we will have innovations that will foster the industry and consequently the economic competitiveness in Angola, SADEC's region and overall Africa.*

Gm brings forth important elements bearing on the industrial situation of Angola. There is a substantial deficit in promoting industrial development resulting, initially, in political war that plagued Angola for several years. Prior to that time, in the colonial period, the industrial sector enjoyed a prestigious expressiveness in the context of African continent. However, with the Civil War, the problem was exacerbated by the

brain-drain, lack of investment in scientific research, infrastructures, towns, and insulated provinces.

> **[Ar]** *[....] Well, to some extent, there is a delay in our industrial development. Two reasons. First, the weakness of science. Second, the lack of technicians to manage the imported technologies properly. Because unfortunately, the recent history of Angola obligated us to study more sociological, economics, historic, law, etc., etc., rather than focusing on engineering … / There were not infrastructure to offer courses in hard sciences.*
> *... With few engineers, no scientific research of course it means absence of industrial development. Even if we put much money for industrial development, it is literally difficult.*

We should strongly consider the writings of Kim (1980), in which technological change has been the major determinant to foster the national development. And it is clear that (LUNDVAL, 2008; MOWERY, 2005; NELSON, 2005) more than 50% of the economic growth of industrialized countries is due to technological changes that improve productivity or direct it to new products, processes, or industries.

Given the approaches of **Gm** and **Ar,** it is possible to estimate that there are weaknesses and shortcomings in the industrial sector and in the relation to the technologies introduced in the country. Because, besides the civil war, other correlated situational factors must be taken into account. During the armed conflict, science was distanced from school. Government eyes were focused inherently on winning the war. However, **Ar** pointes out that the process of industrialization of Angola suffered a serious stagnation due to the lack of science. It means that the government enabled exclusive courses related to the areas of education and the social and economic sciences. That is why the courses for engineering and related technologies were renegaded and postponed for so long.

> **[Dn]** *There is some symbiosis. We can find some isolated differences in the University Agostinho Neto, some companies in the oil industry, so to speak ... in mining sector as well. But this year (2013) the Ministry of Science and Technology held in April, its first advisory board and there is a clear recommendation on this point to force the proximity between business, higher education and R&D institutions,, because it is intended that the results obtained in the field of scientific research is relevant and can actually support the development of the productive sector [....] this is happening, but we were expecting to live a better situation. So from this point of view the relationship is still embryonic, we need to develop it ... / maybe there should be more contact and knowledge about the existence of scientific events calendars to share information , for example. It is a simple tool but it promotes the timely schedule of scientific events and appropriate*

> *programming which allow people to know what will happen a year from now, nine months from now, six months from now, and can move around the country. It would foster mobility's programs between provinces, from one province to another, from one academic area to another. So this is the spirit that we had not in the past. Unfortunately the world cooperation had a very restricted synonym that seemed to mean collaborating with foreign one.*

To date, the Ministry of Science and Technology is enhancing its efforts in cooperation with researchers, professors, R&D institutions, and enterprises through projects and programs as **Dn** quotes below.

> **[Dn]** *does not only mean embarrassment, but it means, in the first place, a collaboration among ourselves – teachers, researchers at an institution Angola, could found space for exchange of experience with other Angolan institutions, and of course without even hinder welcoming foreign practices. ... So we living this phase. Now we have the PNCTI, and it is now proven and expected the implementation of the Annual Plan for Science Technology and Innovation, which will be the operating instrument for the operationalization in terms of implementing the strategy. There you will find programs, projects very well defined.*

As mentioned in the **Table 13**, the Ministry of Science and Technology of Angola is sponsoring the ongoing processing of data at a national level to have a sense of science and technology innovation in Angola. According to the interviewees, the indicators to be validated, once analyzed, will clarify the state of science and technology in Angola.

> **[Rs]** *we are at a stage that can be considered good in terms of aspirations, ... / we are in a phase of working with the institutions that to ensure the funding of science to improve these aspects that are needed to evaluate and to clearly know who does the research activity. But it is a process, so let's say ... / and processes are process only when it happens in several stages, and so we believe that at the end of this term, which is two thousand twelve through two thousand seventeen we will able to do a better balance in terms of results. In fact, there is an ongoing processing of data in a national level to have a sense of science and technology innovation in Angola.*
>
> *Of course the indicators to be validated, once analyzed, will clarify about the state of science and technology in Angola. These results will be available later in a half of two years.*
>
> **[Al]** *[...] There are in some socioeconomic sectors a symbiosis, especially those Institutions whose activities depend on science and technology. we are talking about for example, the ministry of industry. Of course the Ministry Industry. Because, in addition to have a good performance in technological sphere, they must have the background on sciences, in order to develop application or development in a sort of technology. the secret is training the human resources in country.*

There is an agreement among all respondents, that there is a lack of symbiosis between industry and technological development in the country, and a lack of indicators in the light of several problems already referenced above. All of them endorse that the oil and mining companies, whose use of technology is of the highest level and quality, have a very good reputation on the international scene. This is a reality as they undertake their research in their countries of origin. They have in the base large R&D laboratories with high technical expertise, exporting only the results of their research into products. In other words, Angolans are not involved in creating more refined products with more added value.

In addition, **Af** and **Rm** say the following:

> **[Af]** *... / This is noticeable at this time as an opportunity for intervention and contribution of our research. Therefore, Angola is a developing country, it should absorb the clear-cutting technology, and it requires scientific research maturity to promote technological development. Therefore, there have been significant contributions in some areas, for example, in the telecommunications, but most likely other areas of technological development of Angola will force us to put together this new reality, and thus create that symbiosis that is needed and that is absolutely necessary.*
>
> **[Rm]** *If no, it will begin to exist. Because we already have here SPECIAL ECONOMIC ZONE. Therefore, research has to leave the lab to the economic zone, because it is there we will produce. So this symbiosis will have to exist if it does not exist. But it is going to be a reality. It is essential. Because if you do the research and we have an exclusive economic zone, they will necessarily need our investigation. The research laboratory must go toward industry to produce several products for society*

Rm refers to the Special Economic Zone – ZEE[29], whose goal is to create a sustainable economic and social base with the idea of starting and catapulting the re-industrialization of the country and boosting the domestic production of goods and services in the country and in SADEC .

> **[Gm]** *There is a lot being done to improve the situation. What we expect is a better monitoring and effective implementation of these policies. ... You have to improve this field, and there are these guiding documents. There is a trend at the ministry of industry to make strides in that direction, and effectively recognize that the industry can only be regarded with a good expression if it ally with almost scientific research. They are also trying to*

29 In this vein, the ZEE intends to contribute to the diversification of the national economy and to boost the competitiveness in the market of goods and services. It is situated outside Luanda in an area of 8,500 hectars. This is a project of the Angolan government, aiming at diversifying sources of income for the country, and the creation of a strong and competitive economy. (http://www.ecofinancas national economic groups. com / news / industry-Angolan. Accessed 04/07/2014).

> *bring a lot of ... how do I say, ... a series of incentives even at the industrial sector to universities. They now stress it, or they see it as important policies that will also have to give to universities what they have.*

Considering these arguments, the Angolan government must update their perceptions. It is no longer enough to support the fragmented science and technology systems. They must implement an integrated system of innovation, which implies new attitudes and ways of organizing and promoting greater collaboration between the public and private sectors. Geared by the Angolan government, the ZEE is supposed to attract public and private companies to develop their industrial activities. This systematic support by government is important because it can accelerate industrialization and strengthen competitiveness for better.

Af says that being a developing country, there is an absorption of cutting-edge technology, and this requires that the academy, which is the sector of scientific research and technological development, promotes and accompanies these contributions. In this vein, Kim (1980) brings significant contributions to the effective development of the industry in the least developed countries through three stages or models: **Implementation, Assimilation, and Improvement**. These stage-models were formulated as a strategy that these countries should adopt in the perspective of *when* and *how* local companies import, and must implement, assimilate, and improve foreign technology in response to changes in the competitive environment per se.

In his study on the technological and industrial development of Korea, it is mandatory for Kim Linsu to state that the main strategy of industrialization of the least developed countries during the early years of post-war was to replace importation. Thereby, following these steps, Korea reached exponential numbers in terms of socio-economic development from early the 60's until today. Thus, the three-stage models are seen in the development of the Korean industrial production, as shown:

- ***IMPLEMENTATION***

  Initially, in most cases, the creation of products and production technologies have to be imported from abroad. At this stage, production merely consists of

assembling parts and foreign components. And the major concern to local companies is the simple implementation of a manufacturing operation.

In the case of Korea, the seminal moment of his development takeoff, a few local businesses were not able to make efforts to make technological changes in products and processes due to the lack of technological capability and market incentives to promote technological change in a competitive plan .

- ***ASSIMILATION***

  As the design of products and production techniques transferred from abroad are successfully implemented in many companies. Technical skills are widespread throughout the territory or market, promoting therefore, the assimilation process.

This resulted in a competitive market, increasing process among Korean companies, because the accumulated experience in product design and production created a base, while still limited in terms of efforts to assimilate and/or to understand the imported technologies.

- ***IMPROVEMENT***

  The assimilation of foreign technology and the increased competition of the market, along with increased scientific capacity and local engineering staff, leads to a gradual improvement or refinement of imported technologies.

The process of improving products (creative imitation) and costs reduction became an important catapult in increasing the competition in the Korean national and international plan.

Table 11: Characteristics of the Three Stages

#		Implementation	Assimilation	Improvement
1	New businesses are established through	Technology transfer	Mobility of technical personnel and entrepreneur	
2	Emphasis on technical tasks	Imported Technology	Diversification of products	Enhancement to create competitiveness
3	Critical human resources	Foreign Experts	Local staff trained in supplier companies	Scientific staff and local engineers
4	Production technology	Inefficient		Relatively efficient
5	Predominant source of technological change	Transfer of foreign packages		indigenous efforts
6	Predominant form of international technology transfer.	Packaged		Packed
7	Predominant sources of external influence on technological change	Supplier and government		Customer, competitor
8	market	Location (low competition)		Local and overseas
9	Emphasis on research, development, engineering	Engineering	Development and Engineering (D&E)	Research, development and engineering (R,D&E)
10	Source components and parts supply	Mostly foreign		Mostly local
11	Key government policies	Import substitution and control of foreign investment		Promotion of import
12	Role of R & D institutions applied local	Advisory	Adaptive Development	Research and development

Source: Selected and adapted from Kim table (1980, p. 11)

Given this scenario, according to the chart above, one can notice that they undertook systematized actions in order to foster industrial development through changing technology. However, this process occurred due to the execution of government programs because, as discussed earlier, government policies are essential for the

systematization of science, technology, and innovation and the consequent technological and industrial development of the country.

In other words, government policy was a major influencer in the stage of implementation in two ways. First, the technology transfer to establish the industry occurred when the government implemented policies of import substitution and protection of the local market. Second, several government incentives programs were also as important to stimulate technological change in the industry. And multinational companies played an important role in establishing the industry as technology stakeholders, as well as technical staff, money, equipment, and component parts (Kim, 1980, p. 263).

This process, in general, gradually created a high standard of competitiveness across the country. Because with the assimilation and effective technology improvement, local production made strides toward excellence of its products in a diverse manner. In other words, diversification of products promoted a strong competitiveness and improved efforts of foreign technologies assimilation. As a result, this competition caused pressure which, in turn, reduced the costs by manufacturers in the national and international level.

In the knowledge-based society, it is essential to realize that innovation is a competitive advantage that must be developed and adopted, and it cannot be separated from science and technology. With the absence of such symbiosis, industrial development is defective in developing local capacities (research, development, and engineering) to face the challenges related to the management and maintenance of technologies.

Considering the Korean way (Kim, 1980) of aggressive investment in education in the post-civil war, Angola will have to promote the emergence of highly-qualified personnel, and an important basis for the subsequent process of Angolan industrialization. It does not mean that Angola must emulate all the steps of Korea. In my point of view, the above three stages must easily occur within, first, investing in high-level training, secondly, mapping the reality of science and technology, and

thirdly, stimulating integration among all actors (companies and SMEs, universities, R&D institutions and government and non-government institutions).

In conclusion, research has too many results when it is focused to solve problems of the population and boost the economy. According to the interviews, one of the main challenges faced by the team in the implementation of the PNCTI was a lack of accurate indicators in science, technology, innovation, R&D, industrial, and economic activities. In addition, in the light of the big challenges, the weak number of experts to support and foster R&D is one of the most indicators. Therefore, robust policies must be the government's main priority if they want to see changes.

In this sense, implementation, assimilation, and improvement must be integrated with some useful ideas such as, facilitating (ISTIC, 2012) the integration of a developmental approach into national science, technology and innovation policies, capacity building in science, technology and innovation through policy advice, and exchange of experience and best practices. In addition, they must create a problem-solving network of centres of excellence across the country, as well as supporting the exchange of students, researchers, scientists, and technologists among institutions and provinces.

In the next section, a discussion will be presented on industrial and intellectual property, knowing that this is another one of the challenges in Angola.

7.6.2 The Industrial and Intellectual Property in Angola

Across this study, I have stressed the importance of building a strong NIS which meets the desires of developing Angola. The above ideas of Implementation, Assimilation, and Improvement need policies that protect the country and/or institutions. In this token, Intellectual Property (IP) has the objective of protecting the interests of scientists-innovators (creations of the mind, such as inventions, literacy and artistic works, designs, symbols, names, and images used in commerce) and the wider public interest, aiming to foster an environment in which creativity and innovation can flourish (WIPO, 2015).

More strictly, on one hand, Intellectual Property Rights are laws that protect products and investments and allow inventors to profit financially from their creativity. These laws also provide an attractive incentive for R&D so that anyone inventor or company – can take the risk of investing the time or money necessary to create or perfect new products and put it into the community's desires. On the other hand, as set out in the Paris Convention for the Protection of Industrial Property (Article 1 – 3), Industrial Property is broadly understood as a law that covers patents to protect inventions, and industrial designs, which are aesthetic creations determining the appearance of industrial products. Industrial property also covers trademarks, service marks, layout-designs of integrated circuits, commercial names and designations, as well as geographical indications, and protection against unfair competition (WIPO, 2015).

Thus, it is important to have a strengthened knowledge about Intellectual Property Rights, taking into account some elements, such as (http://www.cipo.ic.gc.ca):

1. **Patents** cover new inventions (process, machine, manufacture, composition of matter), or any new and useful improvement to an existing invention
2. **Trademarks** may be one or a combination of words, sounds, or designs used to distinguish the goods or services of one person or organization from those of others in the marketplace
3. **Copyright** provides protection for literary, artistic, dramatic or musical works (including computer programs), and other subject-matter known as performer's performances, sound recordings, and communication signals
4. **Industrial Designs** are the visual features of shape, configuration, pattern or ornament, or any combination of these features, applied to a finished article; and
5. **Integrated Circuit Topographies** refer to the three-dimensional configurations of electronic circuits embodied in integrated circuit products or layout designs (CIPO, 2015)

Policy-makers also must understand that the IPR plays a core role to secure all sorts of production. One of them is Traditional Knowledge (TK), as pointed out earlier. In this sense, according to UNCTAD (2002), IPR aimed to record TK for the benefit of present and future generations of local communities, to promote its continued use

through recognition of its value and inter-community exchanges, and to protect it from misappropriation. In doing so, the country would be able to build national registers, set up incubators for converting innovations into viable business opportunities, and help in the diffusion of this information across different regions of the country.

Therefore, there are two legal basis covering Intellectual Property Rights (IPR) in Angola: the Industrial Property Act 1992, which covers patents, trademarks, industrial designs and utility, appellations of origin (geographical indications) and unfair competition, and the Copyright Law of 1990 (PNCTI, 2011).

The current Code of Industrial Property in Angola is still incipient in its legal structure. However, it provides the protection of industrial property rights, by the consecration of the fundamental principles in these issues, among which contains the principle which is the number one priority *the first to file*. This determines that the right belongs to those who first apply for registration, not foreseeing as a rule, the protection of a mark on the sole use of the same. That is, according to Maria Garcia (2010), in Angola, registration is constitutive of the right. It means that the failure of registration results in the absence of any right of exclusivity and the impossibility of someone defending himself before some other person, or submitting the registration of a mark confusingly similar to his own, in the territory. And one of the basic principles of industrial property, valid in Angola and elsewhere in the world, is called the Principle of Territoriality, which is explained below.

7.6.3 The Principle of Territoriality

I must mention the significance of the Principle of Territoriality and the applicability of its advantages. The action to protect intellectual property assets, globally, is very crucial in a globalized world, as multi-faceted as it is. Countries need to create safeguards and rights according to the national and international laws.

> The rights resulting from intellectual production have immaterial character, and are essentially international, cosmopolitan (...), "the production of the spirit, purpose of intellectual property law, is intended to naturally expand to all the places where civilization goes. It is divisible to the infinity, but remains always one. The author of a

> book, the inventor of an industrial process, one that produced a musical work or work of a susceptible be disclosed by no matter what art or design, certainly not worked solely for their own little world in which he lives, even for the nation to which he belongs. His desire, his hope is to see his work expanded. Its intensity is not lost, but to expand, acquire new vigor. For material things, inability or destruction, becomes, for an intellectual thing, an opportunity for strength and celebrity. "The production of spirit is a cultural well, and it is embedded with a certain universality, and it represent somehow the expression of the personality of the author (CASTELLI, 2006. http://castellicastelli.com.br. Accessed 14/05/2014).

This specificity of intellectual property assets, according to Castelli, through which can be synthesized in an essentially immaterial, tends to be supranational. It can also be intangible essence and not discoverable by the customary means and criteria. It creates the need for protection beyond the boundaries of a territory, once that intellectual property cannot face barriers and presents itself as a well being expanded beyond the territorial limits of a state which gives rise to the development of what we call international law.

It means that the Principle of Territoriality related to industrial property, does not apply to the rights of the author who is related to the registration or to the local use of these goods. But it can relate to the principle of private international law, which admits the recognition of legal status (ownership) originated abroad (extraterritoriality), as well as the application of the law of the place of protection for the enjoyment and exercise of these rights in the territory.

It means that this principle derives (CASTELLI & CASTELLI, 2006) from the Principle of Territoriality Laws, which is reaffirmed by legislations and international agreements. In addition, it must be based upon the sovereign power of states which are competent to apply in their territories according to their own laws.

Therefore, the Principle of Territoriality establishes criteria for patent protection. It states that the patent will be valid only in the country where it was granted. However, if the same invention has validity in another country, another request must be made in that other country.

As it turns out, Angola is still absent from the list of countries inscribed in agreements related to the protection rights of industrial and intellectual property. For example, Angola is not a part of the Agreement / Protocol of Madrid, and therefore can not

undertake an international registration, because the Angolan system adopted the mono-class registration through which one can only specify one class of goods or services in each registration.

In so doing, Garcia (2010) quotes there is, therefore, the need to submit multiple applications for registration, depending on the number of classes that need to be effectively covered. Nevertheless, it is important to consider that the patent plays a key role in the level of securing creation and innovation of the country and individuals. In this vein, the patent system was created to encourage and promote the dissemination of knowledge and technology transfer so that it contributes effectively to the economic development of the region in which one is involved (WIPO, 2012).

Thus, given the current political and social reality in the country, the investment of foreign companies is expensive[30]. This can be possible with a symbiosis between knowledge producers and industry. In other words, it is necessary to have an interface that promotes a rapid and effective dissemination of knowledge developed in the bodies of scientific and technological system by the private sector, accelerating the commercial development of new products and processes (VEIGA, 2009).

This symbiosis is a reality in the countries at the core center of economic development. The following WIPO 2012 Data Report, is an example.

Table 12: Patent Ranking Granted to Countries – Data from 2012

Country	Patents Granted
USA	2.200,000
Japan	1.600,000
China	875,000
South Korea	738,000
Germany	549,000

30 To submit a trademark in Angola, is more expensive than registering a mark in Portugal (Garcia, 2010. Http://www.pt.cision.com. Accessed 22/04/2014).

France	490,000
United Kingdom	459,000
Monaco	42,838
Brazil	41,453

Source: Author's construction. Adapted from anprotec.org.br. *Accessed on 07/05/2014*

The United States appears in forefront in the number of patents granted. According to studies, a patent is applied and granted for technology, it being a new product or to enhance some invention. And the number of patents is one of the factors or indicators that reflect the degree of innovation of a country. For instance, in OECD[31] patent indicators are counted according to the priority date, which is the closest to the date of invention. However, there is a time lag between the priority date and the availability of patent information OECD, 2002).

In the BRICS[32] China improves, ranking in the first position, as shown in Table 16.

Table 13: Ranking of Patents Granted to the BRICS – Data 2012

Country	Patents granted
China	875,000
Rússia	181,000
South Africa	112,000
Índia	42,991
Brasil	41,453

Source: Author's construction. Adapted from anprotec.org.br. *Accessed on 07/05/2014*

31 Patent indicators are used to map aspects of the innovative performance and technological progress of countries, regions or certain specific domains and technology fields. The use of patent statistics for monitoring developments in the field of science and technology has been expanding rapidly over the recent past. Not only have the use of patent indicators increased, but also the diversity and relevance of these indicators have progressed. The OECD has developed new and more sophisticated indicators, notably on patent families, citations, etc (OECD, 2002).

32 BRICS is an acronym for the economies of Brazil, Russia, India and China combined. The term was first prominently used in a Goldman Sachs report from 2003, which speculated that by 2050 these four economies would be wealthier than most of the current major economic powers.
The BRIC thesis posits that China and India will become the world's dominant suppliers of manufactured goods and services, respectively, while Brazil and Russia will become similarly dominant as suppliers of raw materials. They intends to have the potential to form a powerful economic bloc. South came to the team just in 2010 because the Group saw that no African countries were included once being a big continent which was embarrassing. O"verlooking Africa suggested that the continent was an economic irrelevance, good only for providing raw materials to the rest. It also cast doubt on the group's claim to speak for the emerging world. Two African countries might have been candidates, Nigeria and South Africa. But only one would keep the acronym intact. And so, in 2010, the club of BRICs became the BRICS. (http://www.investopedia.com; www.theeconomist.com. Accessed in 03/19/2015).

According to WIPO, the number of patent applications increased 9.2% in 2012 – a record in the last 18 years. Table 15 illustrates this growth. Of the 20 countries surveyed, 16 reported growth. The largest were in China (24%), New Zealand (14.3%), Mexico (9%), United States (7.8%) and Russia (6.8%). In Brazil, there was an increase about 5.1% (ANPROTEC, 2014).

As is expected, given its history, and before its current situation, Angola does not appear in these rankings. Angola is a candidate member to WIPO and also to the African Regional Intellectual Property Organization (ARIPO). To this end, the ARIPO has organized actions aimed at raising awareness of the African countries with the motto "Making the best use of Intellectual Property for the competitiveness of businesses and the development of Africa." (www.aripo.org. Accessed 05/07/2014).

The Ministry of Science, Technology, and Innovation, until the day of this study, was promoting the Angolan Fair of the Inventor/Creator, year after year across the country (It started in 2009, only in Luanda. Currently it is being promoted across the country). The objective is to catapult the youth into the science, technology, and innovation as is shown in the next section.

7.6.4 Fair of the Inventor / Angolan Creator

Despite all sorts of weaknesses in Angola, **Gm** stresses some actions related to the objectives of the National Policy of Science, Technology, and Innovation or Política Nacional de Ciência, Tecnologia e Innovação (PNCTI) of Angola. He points out that the Ministry of Science and Technology (MINCT), under the programs' implementation to foster the scientific culture, technology transfer and technology-based entrepreneurship, is developing actions aimed at introducing scientific, technological, and cultural innovation into the general population into different members of the National System of Science, Technology, and Innovation across the country.

Hence, one of those actions is the **Fair of the Inventor / Angolan Creator,** which has taken place since 2009. According to reports, this project provides many opportunities which allow the government to discover individuals with inventive talents across the country.

The Inventor's Fair, according to MINCT, aims to develop a national culture based on a creativity and innovations mindset that fosters the development of technologies in Angola. In addition, **Gm** advocates that this event is a testament to the importance that the institution attaches towards the transformation of science, technology, and innovation, meaning it is a strategic way of developing policy of the country.

Thus, the MINCT, since 2009, is enhancing the registration of inventors/creators not only in the capital Luanda, but they are now redirecting this recruitment throughout Angola. The tables and graphs below are samples of those actions.

Table 14: Sign Inventors Creators/ Angolans (2009-2013)

Inventors Creators/Angolans	180	%
Male	148	82,22
Female	32	17,78

Source: Prepared by the author according to data provided by MINCIT.

According to MINCT reports, these programs are extended to all people who have abilities in creation and innovation. They are accepting all ages and people who have all sorts of training.

With the idea of giving effect to this program, it appears that the Ministry is constantly spreading and attracting more young inventors throughout the national territory, as shown in Table 18.

Table 15: Sign Inventors Creators/ Angolans (per year)

Year	Female	Male	% fem	% male
2009	3	25	10,71	89,29
2010	2	13	13,33	86,67
2011	14	21	40,00	60,00
2012	10	38	20,83	79,17
2013	3	51	5,56	94,44

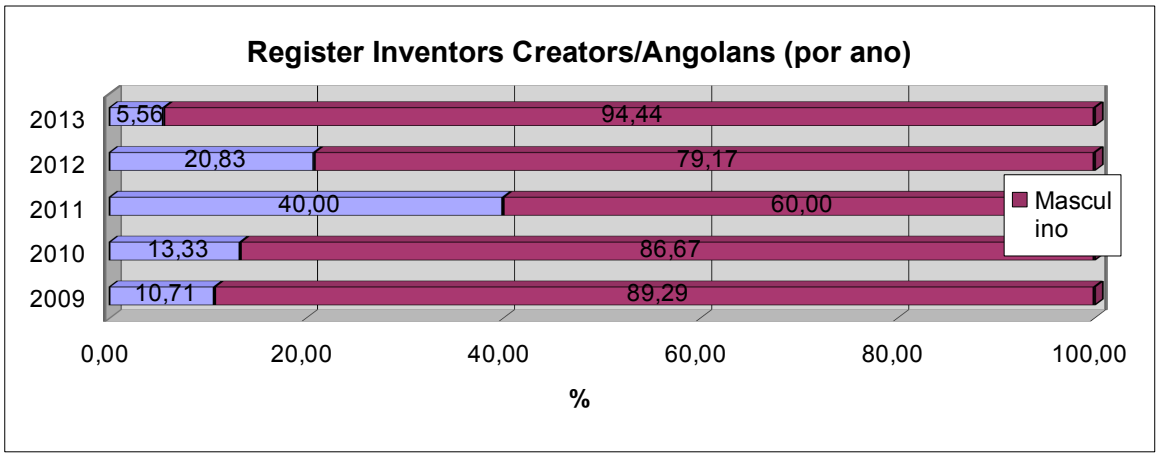
Source: Prepared by the author according to data provided by MINCIT.

It is fair to note here, the membership of females in the list of Angolan inventors/creators. The culture perpetrated by the war Kept women in the past. They were forced just to worry about their livelihood, including feeding the children, while men, at an early age, had to join the army on the frontlines.

Therefore, after the civil war, most of this combatents did not have the opportunity to go to school even in their younger years. As a result, many of them are trying to go to school in order to get a certificate that enables them to enter into the job market. The war resulted in great frustrations, and brought social problems such as unprecedented disintegration of the nuclear family.

However, the numbers presented in Table 18 show a picture of a recent past, but are also, on the other hand, a picture of progress for females.

Graphic 1



Source: Prepared by the author according to data provided by MINCIT.

Another point is the level of education that most inventors/creators hold, as indicated on Table 19.

Table 16: Education Level of Inventors / Creators Angolans – % (2013)

Attend High School	60	33,33
Higher Education	20	11,11
Basic Education	20	11,11
Others*	80	44,44

** Inventors who have concluded already Secondary or*

High Education
Source: Prepared by the author according to data provided by MINCT.

Upon an analysis of the people participating in the inventor forum, I found that there is an increase in the number and the quality of people. First, some of them came to Luanda with the intention of participating in the forum at their own expenses. Secondly, there is an increase in the number of women, even though it seems to be too far from the Angolan reality. Thus, these trends are very important because it shows what I have been stressing throughout this study: enhancing investments in education and diffusion is of paramount importance to reach development in science, technology and innovation.

Table 20 shows the number of inventors/creators distributed in different areas in which they have developed their research. In Graph 16, it shows the percentages.

Table 17: Application Area of the Creators / Inventors Angolans in 2013

		%
Eletronics and Information and Comunication Technologies	60	33,33
Mechanics	20	11,11
Art, Biology e Medicine	100	55,56

Source: Prepared by the author according to data provided by MINCIT.

In turn, Table 21 shows the geographical location of the inventors/creators in Luanda and in other provinces of the country, followed by the percentages shown in Graph 1. Because of it, the number must increase more than is shown here, a result of the new strategy going to all provinces.

Table 18: Distribution of Inventors / Creators Provinces (2013)

		%
Luanda	83	46,11
Benguela, Lunda-Sul, Cabinda Namibe Huambo, Uije, Kwanza Norte e Cunene	97	53,89

Source: Prepared by the author according to data provided by MINCT.

According to the Ministry, this forum is only for Angolans and/or people living in Angola, with the aim of boosting self-esteem and promoting scientific culture across the country.

As already mentioned above, the Fair of the Angolan Inventor/Creator is followed then by the best placed awards. In addition, the winners represent the country at similar international events with particular reference to the International Fair of Ideas, Inventions and New Products held annually in Nuremberg, in the Federal Republic of Germany, and in the International Fair of the Inventor in Switzerland - Geneva (MINCIT 2013).

Table 22 shows the medals won by Angolan inventors in Nuremberg between 2009 and 2012.

Table 19:Total of Medals Won in Nuremberg – Germany (2009 – 2012)

Total	28	%
Gold	4	14,29
Silver	10	35,71
Bronze	14	50,00

Source: Prepared by the author according to data provided by MINCIT.

It is important to make clear that this percentage is a comparison between 2009 and 2012, and it is internal. In other words, this study did not focus on a comparison between Angolans and other countries.

Finally, in 2013, the numbers remained at the same level in gaining medals, with a slight improvement in the silver medal, as shown in Table 23.

Table 20: Total of Medals Won in Nuremberg in 2013

Total	8	%
Gold	1	12,50
Silver	4	50,00
Bronze	3	37,50

Source: Prepared by the author according to data provided by MINCIT.

According to the tables and graphs, there is a considerable accession of young people to the list of Angolan inventors/creators. However, they are struggling with poverty and lack of technical and safe conditions to develop their R&D’s projects in the country.

Hence, developing a National System of Science, Technology, and Innovation which contemplates and funds researchers, inventors, and their projects according to their sort of work, is crucial. Policy-makers must understand the importance of putting the country on the best pathway of development through R&D. Everybody knows that any war produces many problems such as diseases, and orphaned and maimed children.

Even though policy-makers from The Ministry of Science and Technology encourage them to keep going down this pathway, these inventors work in non-safe and unhealthy conditions. However, they seek to develop their projects in inadequate conditions. To overcome this landscape, even though firms and governments have shown to identify and energize innovative individuals and teams, overall policy makers must notice that there are too many issues that stem from the growing problems that plague the local people. Nevertheless, these people are learning to adapt their abilities and technologies to their situations. Of course, they need support and encouragement from the government, especially while it is happening in the OECD countries.

To set up relevant strategies and policies in this regard, it is important to learn more about what happens at the intersection of people, technology, financing, policy, and institutions. The need to gather more knowledge, and a better understanding of the role that the human factor plays—along with technology and capital—in innovation, is critical. Statistically and analytically capturing this contribution and nurturing it through adequate education, training, and motivation in schools, universities, businesses, civil society, and the government itself is a challenge (DUTTA, et all, 2014).

According to the report of GII 2012, (in DUTTA et all, 2014), countries might develop their innovation capabilities and results, following an innovation transition model in four stages briefly sketched below:

> **Stage 1:** A critical level must be reached in all input areas for innovation activities to take off.

Stage 2: Innovation results increase from improvements in institutions, tertiary education, infrastructure, and market and business sophistication.

Stage 3: Input rankings improve with an innovation hysteresis effect that explains the steepness of the trend line.

Stage 4: For innovation leaders, innovation capabilities and results stabilize at a higher level.

In following these paths, the Angolan policy-makers must consider that these youth need great support to enhance their activities. These youth needs a help to become qualified personnel who are not only highly-educated in basic Science, but are also highly-trained with state-of-the-art facilities. In addition, facilitating (DOERN, 2006) collaboration between R&D performing sectors in Angola, and improving mechanisms that foster the transfer of knowledge and technology must be put in the forefront of the targets of development.

To summarize, to develop Angola socio-economically, the above points alert us to concentrate strongly on quality education. In this token, higher education plays an important role in training personnel because it helps in fostering innovation and technology development through mechanisms and solidified policies.

In this sense, in the next chapter I present a discussion around the role of universities in the National System of Innovation (NIS). Because according to Lundvall et all (2009, p. 326), “in the developed part of the world there has been increasing focus on the entrepreneurial university that is engaged in national and local problem-solving. Alternatively, the proposition is that universities should be developmental universities in order to fill up the gaps in NIS in developing countries.

7.7 The Role of Universities in The National System Of Science, Technology, And Innovation.

The challenges of having a university that meets the issues pointed out above are colossal. Many factors contribute to this picture in Angola such as lack of human capital, infrastructure. In this token, as pointed out earlier, there have been an

outbreak in terms of expansion of universities across the country. However, most of them does not correspond to the need of preparing well trained human capital. They are more focused on profits. Another important factor due to the expansion of Higher Education in Angola, according to Costa (2011), is that one can see that the number of women enrolled in higher education in the country exceeds 49%. Occasionally in some courses such as biology, medicine, and nursing, the rate is around 45%. But still we witness several withdrawals by women sharply marked by socio-economic aspects (COSTA, *in* UON, 2011), forcing them to exert a key role in household livelihoods in their early school age. In other words, to date, there are an increasing number of women in universities and institutes across the country, but the problem, first, still remains on lack of possibilities to enhance their activities. On the other hand, in some other provinces and municipalities, they have to strive to solve the household livelihoods challenges.

Hence, it is of vital importance to create a National System of Science, Technology, and Innovation, based on the mission of Policy of Science Technology and Innovation (PNCTI) in which all stakeholders have active participation to foster socio-economic and industrial development because,

> Currently, there is a fragmentation of the National System of Science, Technology and Innovation (SNCTI), which results in a weak link between the actors and the low profitability of the resources available, despite collective and individual initiatives to pursuit an increased scientific, technological and innovation production and the consequent integration of knowledge and technology transfer in the manufacturing sector, as well as a significant increase in interaction between actors SNCTI and between them and society in general (PNCTI 2011, P. 21).

For this purpose, policy-makers are crucial, because they are of fundamental importance to the role of the state. In other words, the state is one of the main elements in creating strategies involved in the process, including the realization of the University's Mission. Only then one can overcome the indicators provided by the United Nations Development Programme (UNDP), especially in the field of education, because the numbers are alarming.

From the perspective of considering the role of universities in the development of scientific and technological skills to foster industrial development, the respondents

bring the following important information regarding the profile and challenges of Angolan universities, taking into account the following question:

ONCE ANGOLA DEALS WITH VARIOUS PROBLEMS, IF YOU HAD BEEN CONSULTED ABOUT THE CREATION OF THE 7 NEW UNIVERSITIES, WHAT WOULD YOU SAY ABOUT THE UNIVERSITIES ROLES IN EACH REGION THEY ARE SETTLED?

> **[Gm]** *Well .. I would say so .... today the program of expansion and extension at university level has been done taking into account the development of the areas where these universities were created, right? ... It is already more or less done.*
>
> *It is valid to ensure the independence and neutrality of these institutions that will, first, give them opportunity to develop their activities freely, but within these guidelines, it would be another.*
>
> *Because on the contrary, if we had to try to take out the autonomy of the university as it is proposed, it would kill the mission of the university. We don't still see much today. They have to meet, the major challenges and bring solutions. Within institutions I would create a series of well defined areas that were leverage and strengthen the relationship between the productive sector and the university itself, creating mechanisms ... It doesn't mean create by creating universities, but have a university-level management of large challenges that we have now, not the university of past centuries, but the modern university.*
>
> **[Rs]** *In my point of view what the university needs to do? We must investigate. Of course in the beginning it is necessary to create a support for them to start working, the rest it has to investigate. If it does not begin to attract the industry to solve the problems, it is not a university. In so doing, university will be able to face the challenges and bring solutions where it is located.*

There is in the **Gm** speech, a concern about current universities in various parts of the world, most especially in peripheral countries. However, while he pontificates and exalts the creation of new Angolan universities, he is giving warning to the type of management and attention to be given to them. One of the points is the need to create structural, financial conditions to exercise their humboldtian freedom to promote the teaching function of the investigative university, and not forgetting the social role that it should play in the place where it is located.

But for this to occur, to university must be given the appropriate conditions, financial and institutional. Contrary to the "educational capitalism belief", the deficiencies in the performance of social responsibility of the university do not occur due to an excess of autonomy, but rather, the lack thereof and appropriate funding (SANTOS & FILHO, 2008).

Knowing that other Angolan provinces still suffer from lack of effective means (infrastructure, professors, etc) to sustain the purposes of these new universities and, therefore, meet the local demands of development, **Gm** raises issues that must be taken into account, such as… [**Gm]** "*they should be a means of leveraging the development of the regions where they" are*. It does not mean leveraging to single-sector level, but the multi-sectorial level seeking all sectors that are growing, taking into account the characteristics of the regions and their own challenges.

> **[Rm]** *The University must be based on PNCTI. I think it would change this landscape if we enhance R&D in universities across the country. And then yes these seven new universities and others to open would be very close to the excellence. The rest would be just open to open, if these criteria were not well defined and monitored.*

This is one of the pillars of the Third Mission of the University, as discussed earlier, whose focus is to act synergistically with society - in this case, in view of Santos (2004), the social responsibility of the university must be assumed by the Angolan university, accepting to be permeable to social demands, especially those coming from social groups that do not have power to enforce. It also must act synergistically with the market and industry, allowing it to assume a position of an entrepreneurial and developmental university. That is, according to the tripod education-research-innovation perspective of neo-Humboldtian university, it should be ready to (DOMINGUEZ, (2013) meet certain vocations of each academic Angolan region.

As **Al** points out,

> *Regarding Angola, with the creation of new academic areas, seems that this role can be done with a higher incidence among some regions that had not before institutions of higher education. So it seems that there is or was opened a great opportunity to teach individuals previously underprivileged regions in terms of what was the presence of universities. University must be seen as a institution able to provide extension services in these same locations. The locations where university was absent, must play an important role, creating disciplines in accordance to the difficulties where they are now located. Because we still see too many people migrating to the main regions such as Luanda and Benguela. The demand in higher education is huge. I'm sure these universities across the country are going to create capabilities to the local youth.*

Here is an understanding of the role of these universities in places that they are now located. Knowing that the social structures and institutions suffered serious destruction due to the civil war, the implementation of the National System of Science, Technology, and Innovation is a *sine qua non* to foster a holistic development across the country. In this aspect, as **AI** points out further, universities should work lined with the principles which guide the innovation in order to get all actors working in a same mindset.

> **[AI]** *The universities, institutions of higher education, beyond the capacity they have, or beyond the corporate purpose of training in our modern world is enabled or has a responsibility also to the extent i.e., to show the local community that the application of knowledge or technology brings benefits. Therefore, the task of training is important because it put into the market technicians with a certain rather large scientific ability. But then you also need to convince people, those people who have failed.*

> **[Rs]** *That people do not have a certain capability or even companies have certain technology to hire this people. In addiction, catching up an innovative capacity, applying scientific knowledge can bring benefits to socioeconomic, cultural and even environmental spheres of the community. This is a modern way universities in Angola could get through, going into the communities.*

Here one realizes the key role universities must play, covering all sectors of society. It includes industry, not forgetting the tripod “education-research-innovation” and the scientific culture, which is a *sine qua non* to put Angola into the pathway of development.

By the way, there was in the USA in the post-war period, a synergy of efforts between universities and the productive sector to meet demand and address the needs of U.S. society. According to Freeman & Soete (2008), “the new style innovations of the industries have been characterized by the presence of professional R&D departments within the firm; the employment of qualified scientists as well as engineers with scientific training in both research techniques in other functions of the firm; by contacts with universities and other centers of fundamental research; and acceptance of technical change based on science as a way of corporate life” (2008, p. 36).

Given this perspective, the synergistic aspect, a characteristic of the Third Mission of the University, plays a crucial role in developing skills in socio-cognitive, administrative, and technical aspects. In this vein, strategies in which human capital

is able to contribute to a knowledge-based economic development, must be put in the forefront of Angolan actions. Because they (human capital) can be able to perform regular activities more efficiently than the average worker; and second, they are more competent when they are led to explore new technological opportunities in the economy (BRUNDENIUS at all, 1996).

Dn states the following points,

> **[Dn]** *Of course, this is generic that each university must be inserted in the middle of where it was created, say where it was born. The university must provide the society in which it operates services. This is the first aspect. But to provide this service, the first direct service is to train men, women, people, let's just say, training Human Resources. But there are other services that come and only come from the integration of activities in an efficient and effective scientific activity, resulting in better use of resources invested in this activity. And the activities have to be clearly appropriate, they must be effectively scientific activity to foster science, technology and innovation across the country. Angola needs it to boost other sectors such as our industry, agriculture and so.*

Dn comes out stressing the core importance which universities play in a community and the linkage they must have with other sectors to spur local socio-economic development. In other words, the new seven universities must be research universities, taking into account the characteristics and local challenges where they are located. In other words, the national innovation systems policy-makers must consider that research universities must be a sort of catapult to foster development. In so doing, some important actions must be put into the forefront of their strategies such as (MOWERY&SAMPAT, 2005) a creation of science parks, located nearby research campuses, support for business incubators and public seed capital funds, and the organization of other forms of bridging institutions that are believed to link universities to industrial innovation.

As pointed out earlier, the achievement of peace in 2002 was the biggest gain of the Angolan people after a period of 41 years of permanent wars, i.e., from 1961 to 2002, despite the legacy of slavery and colonization. Hence, within 2002 it was possible to expand higher education across the country. (TETA, 2009).

For several years, it was possible to witness the neglect around higher education specifically in developing countries. In this light, Brundenius (2009) states the World

Bank and many other donors not only neglected universities, they even discouraged developing countries from investing in higher education. Thereby, it is important here to make a reference about the emergence of building a strong higher education in Angola as it follows below.

> The emergence of higher education occurs as a result of political and social upheavals that hit the Portuguese African territories in the 60s of XX century. In this period there is a growing pressure of population in Angola who aspire for independence of his country as a prerequisite to the right to education at all levels, on the one hand, and the growing colonial student population who complained workarounds instead of being obligated to finish their education in mainland Portugal, on the other hand (TETA, p. 30, 2009).

As pointed out earlier, until 2008, there was only one university, the so-called Universidade Agostinho Neto. According to their reports, of the total number that is dedicated to research activities (framed and not covered by the Scientific Researcher Career) only about 5% have an academic doctoral degree.

The Angolan university has the challenge of developing human resources and building capacity, taking into account the above information**.** **DN** presents the reasons that make the existence of the new universities in the new reality of the Angolan context. This is because before the above information, university must deliberately adopt the profile of Development's University which interacts with different groups of society, including industrial (Brundenius 2009).
From this perspective, the Third Mission of the University plays a crucial role, whose ideal is guided in University Extension (Brundenius 2009), consisting of the commitment of the university at improving the living conditions of those who are renegades to social and economic inequality.

> **[Dn]** *If this marriage of right use of resources, in this case, with the application of funds allocated to science in purely scientific activities, of course, the component terms of highly qualified scientific capital necessarily will have a significant scientific production. This means publishing their work, disseminate relevant results that pass through scientific validation processes in entrusted forums. In addiction, we will be able to create technologies that could be transferred to the productive sector. This is still a big problem to be solved in Angola*.

Once more, **Dn** highlights establishing feasible links between university research and society, which is the main idea of third mission. This is the challenge in building

Angolan universities focused on solving regional and local problems through feasible curricula. I am conscious of the fact that it is a long-running process, however to overcome the dramatic problems that hinder the development of Angola, the third mission is of paramount importance. In other words, Angola needs to develop and nurture a version of university that is suitable to its own circumstances, and to deal truthfully with the above circumstances.

Therefore, third mission of universities is a philosophy that puts a higher education institution in link with a community. Thereby, Angolan policy-makers must provide the possibilities to address such a challenge in a way that research and teaching missions are connected to the main objectives of universities to transform and solve national development needs.

In an era in which the knowledge-based economy is a significant well of globalization, Caraça *at all* (1998) states that universities have contributed significantly in making decisions by society in general. It means contributions of the third mission of universities are considered important and relevant, as they bring into focus the importance of capability- building that will act as an innovative impact on the organizational structure of the institutions. In doing so, it will foster a creation of appropriate conditions to develop the national industry across the country. To Brundenius (2009), the first-time hiring of a graduate with an engineering background has a significant positive impact on the propensity to introduce a new product and that the hiring of a graduate with a management-training background has a significant impact upon the frequency of organizational change. In doing so, it will facilitate the creation of competitive abilities among Angolan universities with the aim to innovate, develop technologies, and register patents, as **Dn** points out below,

> **[Dn]** We *will have many patents, and many of them will clearly serve to be applied in the production of products. They will be used as services for our society. If we have no university, we have no institution of higher education; no scientific research and development's agency that works properly to support evaluation processes. we won't have, in my opinion, the modus operandi of these institutions. In this point we are so far below rather than other countries.*

I have already mentioned patents cover new inventions or any new and useful improvement to an existing invention. **Dn** points out that it is not happening in

Angola. The Angolan university mission is still in the stage of structuring their beacons and infrastructure. Thereby, regarding this landscape, policy-makers must concentrate their efforts in investing heavily in university research in order to stimulate (MOWERY&SAMPAT, 2005) the creation of regional clusters of innovative firms around universities across the country.

As mentioned earlier, Angolan government enhanced reforms around the sub-system of Higher Education in 2008. Thereby, the Ministry of Higher Education created seven new public universities under Decree 07/09, 2008, showing a glimpse of improvement in the academic and research scenario. The creation of those new universities was materialized from expansion of then only Angolan University – Universidade Agostinho Neto – UAN – **Region I** as it follows below:

1 – Kimpa Vita University – Region II
2 – José Eduardo dos Santos University – Region V
3 – Lweji Nkonda University – Region III
4 – 11 de Novembro University – Region IV
5 – Katiavala Buila University – Region VII
6 – Mandume Ya Ndemufayo University – Region VI
7 – Cuito Cuanavale University – Region VIII

According to the map of Angola, each university composes one region, as it is above. Moreover, all of them are governmental. With the creation of new universities, the other Angolan provinces were provided with several courses in medical sciences, humanities, and social sciences, and in a small proportion (due to the lack of professors in engineering) some courses in engineering. In addition, those universities were plagued with an insufficient infrastructure and not feasible materials to support courses that require equipment (Machines, supercomputers, etc).

There are some models of higher education of which the North American Model and the European Unified Model (Bologna Process) (SANTOS&FILHO, 2008). However, I advocate the idea of a model of higher education compatible with the Angolan context. It does not mean they have to agree with any of these higher education schemes. In other words, the idea is to create a development university (Brundenius

2009) which is open and can interact with different groups in society and the productive sector, including industries. The main objective is to contribute to the socio-economic development, and at the same time, safeguarding the autonomy of education and R&D activity.

Across the tripod *education-research-innovation,* which is the feature of neo-Humboldtian university, it is worth noting the outbreak (the boom) of private universities in developing countries and/or peripherals countries. Universities in developing countries are particularly vulnerable to the trends of privatization of higher education. It may threaten the quality of training and the internationalization, and undermine the ability to mobilize university systems for the purpose of national development (BRUNDENIUS at al, 2009).

This phenomenon is a reality in Angola because, since the end of the civil war in 2002 until the time of this study, more than 20 private higher education institutions and universities were created specifically in Luanda, the capital.

Despite being written in the National Policy of Science, Technology, and Innovation of Angola (PNCTI) in which all actors must play a crucial role in the development of capacities for R&D, private universities are mainly geared for profit. The problem is that most of them do not strictly follow the rules of the Higher Education Bureau. They rely on the idea of any enterprise that focuses on profits rather than forming world-level technicians to boost innovation and development.

In this token, some international institutions and scholars have diligently advise the Angolan government to understand that the Angolan university must meet the challenges of building a robust science, by enhancing training (teaching) augmented with a strong R&D. In addition, they advocate that it must be undertaken taking into account the Third Mission of the University which evokes a robust relationship between it and the Angolan society.

This is to say that universities must interface with their communities where they are located. Such policies which come from this relationship can be more relevant to the targets of the economic and social development of any country. In doing so, any

country will enable to enhance the development of science, technology, and innovation and put it onto the pathway of development.

7.7.1 Funding Policies for Universities

Higher education in Angola, as I have been endorsing throughout this work, has undergone several transformations due first, to the demands of the colonizers who lived in the colony. Second, transformations happened necessarily due to the demand of the indigenous peoples who also demanded access to it. According to PNCTI,

> In the past, high education in Angola was institutionalized when they created General High Studies of Angola, integrated in the Portuguese university in August 21st, 1962 (Decree-Law No. 44530). On December 23rd, 1968 they transformed the General High Studies to University of Luanda (Decree-Law No. 48790). In 1976, shortly after the proclamation of the independence of Angola, it was transformed into University of Angola through 77-A/76 Ordinance. In 1985, the University of Angola came to be called Agostinho Neto University (UAN) in memory of the first President of Angola, and the first Rector of the University of Angola (Decreto-Lei nº 85, de 24 de Janeiro, DR nº 9, 1ª Série, 28/1/1985) (PNCTI, 2011, p. 12).

From the data available in the annals of UAN, this University graduated only 3 Angolans until 1975, and about 5000 from 1975 to 2002, when the country reached an effective peace (PNCTI, 2011). As I have mentioned earlier, the big problem today lies in the failure of professors and highly-trained technicians to face the demands of the courses and support R&D in these institutions scattered across the country, not forgetting the gaps in the productive sector. Despite these efforts, there is still a marked lack of highly qualified technicians with a PhD, especially in the field of basic sciences (Mathematics, Physics, Chemistry, Biology, Medicine, Engineering, Agriculture, Veterinary) and Portuguese language (PNCTI, 2011).

Given this scenario, **Ar** raises some concerns related to attention to be given to universities in terms of funding courses that comprise it.

> **[Ar]** *First, these new universities have to have academic and administrative freedom. Academic and scientific freedom must exist, and courses must be created in order to help the development of the region. According to the funding of these institutions should take into account the number of courses facing technologies. If there is more sociological and humanities courses, we call "courses of pencil and paper", they should have less money. When there is more engineering, there would be more sources and funded projects in*

> *their lab. So what I would say to answer you is happening in the provinces and it is important .../ it is important universities been evaluated. This assessment will allow us to know if they really need money or not. There is a funding-base, it's true. But you cannot put in the same level both an institution which offers courses of engineering and one in which needs only paper and pencil. Excuse me, but funding policies, the fate of the financial resources for Universities and Colleges should be revised.*

The National Policy of Angola (2011) points out that the current funding system of R&D associated with the reduced budget level in the Science and Technology sector (eg., 0.004% of GDP in 2008 and 2009 and 0.2% in 2010), is inefficient management. This targeted use of available resources, has caused a bottleneck in the implementation of research activities in higher education and in technological development institutions. These factors are among the reasons that contribute to the lack of success in the scientific and technological production in universities as well.

However, the concern of **Ar** relates exactly (PNCTI 2011) on the weak financial means and the lack of a system of public financing. This landscape constitutes the first constraint in addressing the key needs to optimize the use of funds for scientific research. The current organization of the Science, Technology, and Innovation in Angola includes the funding of research activities, and it is associated with the lack of a system of innovation. Today it is recommended by NPSTI, that essential documents should provide guidelines, principles, rules, and operating procedures. Harmonized sectorial of programs, collective or individual initiatives, and monitoring of research activities has been reviewed.

Thus one can read:

> So far, the levels of STI budget falls far short of the SADC recommended (1% of GDP) and has not been possible to monitor the use of funds for scientific research and technological development, nor obtain, the overwhelming most members of the National System of Science, Technology and Innovation, data for the preparation of STI indicators (PNCTI 2011, p. 11).

Given the prospect of Humboldt University, it is important to point that the essence of the university is teaching, and it must involve research. Technological innovation opens a new path. According to Dominguez (2013), we have walk a long way, we arrived fairly late, but that's no excuse. Part of the U.S. innovation also started

relatively late, and Asian too. One need to offer a diverse model able to meet certain vocations, including regional. The MIT was created to meet a development project in the region of Massachusetts. To a large extent, our problem is due to a single European legal model which establish the same framework for all institutions. We have to have various models with different vocations.

It means, for example, the university which is at Kuando Kubango Province needs to think of a project, including geopolitical location, (because this province has gone through situations of extreme structural and humanistic and social disaster during the civil war. However, she has a climate and rich soil for various crops and extraction), unlike the university *11 de Novembro* which is further north of the country, in Cabinda, because the idiosyncratic realities and local resources are disparate.

The idea here is to warn the Authorities in order to decentralize the universe of technological courses offered with greater proportion at Agostinho Neto University, that is located in Luanda the capital of Angola. From this perspective, Nelson (2006) states there are a large number of academic disciplines, such as Engineering, that are consciously and deliberately targeted to specific useful purposes. This would include research directed towards improving human nutrition through increased food supply, an explicit goal of the life sciences taught in agricultural schools.
Hence **Ar** emphasizes the importance of direct financial resources and technical courses requiring huge values because they require materials, advanced technologies, and personnel who are technically well-prepared to manage and maintain them. It does not mean that other areas do not require resources to perform their researches. Therefore, it should be noted, for example, (Nelson, 2006) in their efforts to develop organizing principles for computer architecture, computer science had to branch out to explore, in-depth, the questions of logic, language, perception, cognition, and finally, intelligence per se.

It means that the disciplinary transversality, in the era of the knowledge economy, is a prerequisite for great leaps forward in the development of universities before the key challenges of the Angolan society as the **model 2** addresses (GIBBONS, 2008). This model has the main idea of disciplinary transversality (or transdisciplinary),

whose knowledge production happens in the context of its applicability, taking into account local actors and their multiple capabilities.

In this respect, **Af** tells us that:

> **[Af]** *it is essential ... it is critical because these universities should give significant contributions, significant development to the regions in which they are inserted without excluding the perspective of this contribution is applicable to both the national context contributions and the international context. But it would be a more rational way to exploit the opportunities that the context of each region offers. Therefore, the universities may not exempt from this contribution in various areas of its operations, is to update and contextualization of teaching, whether in the production of knowledge from scientific research, is the transfer of knowledge from an interaction with the sector public, private and social sector.*

Indeed, the key entrepreneurial university (pillar of the Third Mission) is central in all surveyed approaches where universities should establish a close relationship with the other actors of the National System of Science, Technology, and Innovation (SNCTI). Therefore, I believe this is the most effective way to increase R&D and the necessary innovations (incremental, radical, cultural, and so) that will put Angola on the pathway of sustainable socio-economic and industrial development.

7.7.2 Conclusion

In conclusion, Angola still does not have in its structures, capabilities to effectively monitor, and control the challenges perpetrated by the global economic market. This landscape puts the country almost always in a lower position in the field of R&D, and knowledge transfer, including trade.

Thereby, the Angolan universities must take into account the entrepreneurship role it should play in the current period of post-war. It means to be a university which interacts synergistically with the other actors – industry, the productive sector, and national and local governments, in order to have, in fact, technological, socio-economic, and industrial development.

Therefore, as I stressed across this study, it is important to highlight that, in opposition to the principles of Vannevar Bush (Linear Model), the scientific research of a country has a strong influence on the social and technological problems arising in one country (Pavitt, 1998). It means that in planning scientific developments in universities, one must be mainstreamed with corporate and economic demand of the Angolan provinces in order to have effective and sustainable technological development.

For this reason, Angola must specialize in certain scientific areas according to its social requirements because the scientific product-mix tends to vary from province to province over the time. This variation (VELHO, 2007) can be perceived both by the number of active researchers in different areas, such as the number of new graduates by field of research, as well as the participation of each area in the national scientific production – elements that keep obviously a direct link between them.

This is a sine qua non to develop and assess the activities of education and R&D, given the concerns of each Angolan province in terms of its local socio-economic and industrial condition. Only then will the university be able to assume the key role that the emerging knowledge-based economy requires (CARAÇA *at all*, 1998). However, the Angolan government must have considerable budgets for higher education. In other words, it is, of course, starting within the base of the educational pyramid that the government can overcome the remaining technical problems that plague Angola and also in most of the African countries that are on the periphery of the development. Because, as I have pointed out earlier, for instance, the budget estimates for education of a single country like France, Germany, or Italy overcome the educational expenses of all governments in sub-Saharan Africa put together (UNESCO, 2007).

Regarding this landscape, UNESCO has been advising sub-Saharan African countries to enhance efforts to attain the Millennium Development Goal of universal primary, secondary, and tertiary education. It has released data, showing that one third of the countries in the region are about to face pressure in the coming years. So, they are called to lay down priorities in order to hire more teachers due to a rising

demand for education from an increasing school-age population. “As a result, the region will need about 2.1 million new teaching positions while filling another 2.6 million vacant positions, as many will leave the profession due to attrition from retirement or sickness” (Africa Renewal, 2014, p. 4).

The biggest challenge that I see in Angola, is that it needs a huge number of well-trained technicians to fill up the institutions and universities in the country. Nevertheless, even though we have support from Cuban professors and technicians from other parties of the world, training the human capital is the backbone to strengthen the NIS of Angola. Augmented by strong policies, it is possible to see flashes towards an effective development in Angola. In addition, investing in infrastructure, housing, and in creating good incomes could be a way to attract high level educated people abroad. Moreover, some other actions must be taken into account, such as creating the local linkages that support the change of production processes with the goal of bringing costs dawn, increasing efficiency, and strengthening the economic structure in the country.
By so doing, we will be able to put the country on the pathway of the development, and increase the economy faster.

In the next section (**PART V**), I present a survey undertaken on three institutions in Angola, aiming at strengthening the discussion around the challenges of strengthening the National Innovation System of the country, and the challenges of increasing the economy.

PART VI: ANGOLA – SURVEYS

8 CHARACTERIZATION OF THE NATIONAL INNOVATION SYSTEM (NIS) THROUGH R&D INSTITUTIONS AND ENTERPRISE

8.1 Introduction – Characterization of STI Structure and Production Dynamics

As mentioned earlier, the current state of NIS in Angola, including the lack of funding of research activities and the lack of high-level human capital has been detrimental to boosting the development of R&D institutions and hindering the development of entrepreneurial enterprises across the country. In addition, the lack of essential documents establishing guidelines, principles, rules and procedures, and evaluation procedures, has not allowed the harmonization of sectorial programs and collective initiatives on R&D (PNCTI, 2011).

In this token, R&D must be on the front line of STI policies because it plays a crucial role in promoting capacities to strengthen the NIS, reindustrialization and increase economic competitiveness. In this vein, the majority of national R&D funds must support different fields of knowledge and different institutions such as non-governmental and governmental organizations. According to Lundvall (2003), increasing funding in R&D will contribute to the creation of a basic and applied research, and it will promote sustainable development and increase economic competitiveness.

Thus, the diagnosis of the STI in Angola, published in 2008 by UNCTAD, as well as some indicators (see Table 13) released by the Ministry of Science Technology in 2010, shows a need of several actions. One of them comes from the policy-makers who must understand the importance of establishing and securing rules for R&D activity. Secondly, Angolan government must increase the rate of transfer of academic research outcomes to the productive sector, such as firms and industries, in order to increase the economy and welfare. This is because (HALL, 1996) R&D spending covers a wide range of activities such as basic research aimed at the advancement of scientific knowledge, with or without commercial objectives,

including applied research directed toward practical applications, and research directed toward the development and production of specific new products and processes. All of these activities play a crucial role in promoting such competitiveness and innovations.

This chapter analyses three case studies. One is on National Public Health. The second is on an oil refinery. The third is on a water treatment company. As mentioned earlier, it has the objective of better understanding the landscape of STI in Angola and its limitations, and the challenges in strengthening up a National Innovation System to boost the socio-economic development in Angola. Furthermore, this study ends up with a concluding view of the science, technology, and innovation landscape in Angola including recommendations to overcome all issues related to STI and NIS.

Thereby, the main objective of this section is based first on the previous discussions of NIS literature whose concept allowed me to explore the view of building a contextual NIS in Angola, considering its idiosyncrasies and /or peculiarities. Secondly, I turned to the systemic empiricism approaches which enabled me to interpret and find out why Angola has difficulties in building a strong National innovation System. By this token, in using a NIS analytical framework, I was able to consider Angola's idiosyncrasies, especially the civil war.

Taking into account the interviews conducted above, I augmented the following surveys in order to help understand the state of National Innovation System and the level of science, technology, and innovation in Angola. Furthermore, for the effect of giving greater coverage in the data, I did some traveling within Angola accompanied with a checklist related to infrastructure, human resources, operation of equipment, relations with R&D, and diffusion. The checklist allowed me to confront and get complementary data, indicators, and the diagnostics of the technologies used and the profile of technicians. The idea is that this data may be used for other studies related to the level of science and technology strategies across the country.

In doing so, I undertook visits *in situ*[33] to understand the technical profile of the actors involved in those institutions. Indeed, I relied on the perspective of the theoretical framework which draws from the work of the so called DUI – *learning by doing* (ARROW, 1962), *learning by using* (ROSEMBERG, 1982) and, *learning by interaction* (LUNDVALL, 1988) materialized on institutions – firms, R&D institutes, universities, or government agencies. In so doing, I developed an in-depth analysis to perceive the organizational layout and its planning around research, considering the following items, which enabled me to collect the information required for the study:

1. Type of Institution
2. Human resources
3. Research Career
4. Infrastructure
5. Technology
6. Diffusion
7. Technology maitenance and equipment
8. Lines of research and technological development
9. Partnerships with IES / R&D
10. Financial self-suficiency

The first organization that I assessed is the National Institute of Public Health (INSP). I chose this institution because it is dedicated to developing studies on public health, including the diagnosis of tropical diseases. Secondly, I chose the Sonangol Refinery located in Luanda because it is dedicated to refine the oil that is distributed across the country. They have high technology on display, but face difficulties on the issue of technicians and infrastructures. Finally, I chose the EJN-Soluções located in Huambo (see map. fig. 2). It is dedicated to the collection, treatment, and distribution of drinking water in some municipalities, while it develops studies on health viability of wells throughout the country.

33 Some of the visits at R&D and productive institutions were undertaken in the framework of a series of visits in tandem with the Ministry of Science Technology of Angola which I thank to permit me enhancing these discussions. In that moment I was working as a National Director at the Ministry.

8.2 NATIONAL INSTITUTE OF PUBLIC HEALTH (INSP)

8.2.1 Introduction

Basically, the system of health in Angola is structured by public institutions such as Health Post, Health Center, Health Center Reference/Municipal Hospital, General Hospital, Central Hospital, and some special services. (ANGOLA, 2003d). According to my results, there is not a strong private health system. Some private institutions function in bad conditions, offering basic treatments to their patients. On the other hand, taking into account all problems across the country, Luanda is the best spot to treat some of the more complicated health issues. Some other provinces are more stabilized than others in terms of tools and technologies for the same purpose.

Therefore, the document of Health Policy states that the National Health Care System is hierarchical, and makes the integration of primary care and specialized care in terms of region. Through it, they established a policy-review on the health system, in which less-prepared institutions across the country report and send difficult cases to a more advanced unit (OLIVEIRA, 2010).

Furthermore, I noticed that the big problem is the lack of well-trained technicians to meet the demand of public health in other provinces. Before that, many young people were forced to acquire training in the capital on their own in order to return to and help their local people. However, this back and forth is done with great sacrifice because the financial difficulties and trips are colossal.

By this token, as Oliveira (2010) stresses, there is a huge lack of professionals trained in public health, hospital management, and health systems. In addition, there is also a lack of hospital electro-technical equipment to undertake analysis and prevent diseases, and lack of strategic programs for the prevention and control of endemic diseases. Hence, the lack of capabilities is detrimental to the durability of hospital equipment.

Therefore, the 2006-2008 Plan of National Health Development (ANGOLA, 2005d) was built towards a creation of strategies to eradicate a range of difficulties such as the lack of technicians and specialists across the country. Moreover, it is characterized by (OLIVEIRA, 2010, p. 151):

- Absence of an employment policy that ensures a sound relationship between training and the needs: arises from the voids between the profiles of posts and those of the holders
- Lack of appropriate description of the posts at all levels
- Lack of career plans strictly following the procedures rational promotion, sanctions, and rewards
- Low staff morale given the low wages in real terms, the lack of continuous training and supervision, and poor working conditions
- The uneven distribution of personnel between rural and urban areas, between different regions, and between different categories of institutions of health.

This uneven distribution stems from the lack of the existence of health facilities, particularly at the municipal and communal levels, whose operation is ensured by basic technical and nursing assistants. In several municipalities, health managers (named or indicated) accumulate various functions, for example, head of municipal section and manager of the municipal hospital. In one of the provinces visited (Huambo), I found a basic nurse who accumulated, beyond the two positions already mentioned, the clinical director of the municipal hospital and nursing director. This is because, according to Oliveira (2010), the lack of staff and/or the need to budget the municipal hospital results in professionals taking on too many positions.

This landscape shows a huge problem in terms of not being able to trust the results with regards to medical analysis. In other words, while these people who are on the ground have a lot of responsibilities and can learn some aspects through their in-the-field experiences, a lack of training can lead to numerous misdiagnoses. Logically, it could turn people away from the medical system. But they do not have a choice when most of the population remains in a poor economic state.

8.2.2 The INSP and Its Challenges

The National Institute of Public Health (INSP) is an organization linked to the Ministry of Health of Angola and is devoted to research in the field of health. This institution, up to the time of the study, has been called to resolve most of the public health situations in the country, directing actions in the fight against HIV and endemic diseases such as malaria, typhoid fever, and cholera that plague the country. INSP is also dedicated to the analysis of water quality.

As pointed out by interviewees above, INSP struggles with the difficulties of other R&D institutions in Angola, such as lack of human capital, equipment maintenance due to the difficult of R&D investment, and a difficulty in building up a national innovation system. As mentioned earlier, the Angolan government approved recently the National Policy on Science, Technology, and Innovation aiming at promoting scientific research and technological innovation. However, the actions aimed at the systematization of innovation are at a very early stage, because the scientific reality is still very incipient. During the 27 years of war, Angola had only one university, directing its activities exclusively in the areas of education and literacy. During this period, the Angolan government was forced to invest heavily in the import of war materials to strengthen the army, due to rebel activity in the interior of the country. Consequently, several Angolan R&D institutions do their investigations in isolation.

Thus, I obtained the following results listed in the table below:

8.2.3 Results Framework: National Institute of Public Health (INSP)

Table 21: ***Results Framework: National Institute of Public Health (INSP)***

#	Item	Finding
1	Type of Institution	• Public Company • Providing services in public health , and Scientific research • Tropical diseases research • As endemic diseases • Water Quality
2	Human Resources	• Personnel Technician Specialty: -1 Doctor;

		- 6 Masters ; - 2 Postgraduates ; - 16 graduates ; - Bachelors 2 : - 32 Basic Technical / Medium (support Research • Administrative Staff : - 23 Administrative workers
3	Scientific Research Career	• It is difficult in the promotion of research; • Waiting for technical career approval policy to support research in the following categories: -Researchers coordinators; - Principal investigators; - Researchers Auxiliary; - Research Assistants; - Research Interns.
4	Infrastructures	• Faire facilities for the type of activity; • Insufficient for the quantity and diversity of work;
5	Technology	• Renovating (acquisition of new technology); • In process of certification of some technology
6	Diffusion	• Does not exist
7	Maintenance of technology and equipment	• Difficulty in maintaining and restocking
8	Lines research and technological development	• Attempts to develop anti-malarials equipments and HIV/AIDS
9	Partnership with R&D Institutions	• There is not a partnership with any other R&D Institution.
10	Financial Self-sufficiency	• Sponsored by the Ministry of Health

Source: Author based on INSP and MINCT, 2011.

8.2.3 Discussions

In general, the institution has been relatively technologically equipped. They use cutting-edge technology. This is a feature of most peripheral countries, as local policies facilitate the import of advanced technologies (CHAMINADE, 2009). The problem remains on lack of human capital, and skills required to manage and fix broken equipment. In this sense, the further the technological distance is among

technicians, the more difficulty they have to get the results of their analysis activities, and because of it, the equipment does not last long.

According to the chart, the INSP is an institution linked to the national health system of the Ministry of Health in order to investigate and create mechanisms for prevention against diseases and endemic diseases. But there are gaps in the full operation of their obligations, given the various difficulties listed below:

1) *Large demand in the analysis of the causes and solution of endemic health problems in the country.*

This issue is of great concern because, out of approximately 18 million inhabitants, the institute has been called to identify the causes and find solutions to outbreaks (cholera, malaria, HIV/AIDS, and other endemic diseases) that occur throughout the territory, since there are no other institutions with the same specialties in the 17 provinces of Angola.

Thus, there is a great need to understand and analyze (VELHO, 2001) the different social forms (cultural, historical issues. See section **4.5**), and policies that are incorporated into various societies, the various levels of development where they are, and their ability to produce and use knowledge for their own progress. The reality of Angola does not escape this thought, for analyzing the Angolan reality; the other provinces are well below the level of social and economic development in relation to Luanda.

The resources allocated to each province do not meet the need to create health infrastructure effectively, let alone the creation of health research institutions to identify and prevent possible outbreaks. Considering the postulates of Pavitt (1984), a national innovation system is the set of institutions involved in the generation, marketing, and distribution of new products, processes, and services, as well as in terms of incentive structure and powers of these institutions of exercising influence on the rate and direction of change that will derive from the technology changes. With this difficulty they are in within the provinces, it is difficult to establish an efficient national innovation system, for the above reasons ratified because there is no

financial capacity and infrastructure for this purpose. Thus, the main objective of INSP tends to be in reactive mode through dealing with epidemiological outbreaks versus preventive mode. In other words, it is dedicated to undertake public health analysis rather than developing research and innovation to help develop preventive medicine.

2) *Lack of most qualified professionals in the area of health and qualified for efficient and effective use of the equipment purchased.*

The qualification of these skilled professionals is a sine qua non for effective and rational use of existing equipment to an applied and relevant research. It is notoriously known that technical training is necessary for the effective success of the actions around research and innovation. Item 2 (table) shows that there is a great shortage of human resources, with only one (1) PhD, six (6) Masters and other staff. In a scientific research institution, is essential to have a courageous framework of PhDs to strengthen the research, to have more scientific property and to facilitate the promotion of learning the scientific method. It was stated earlier that learning leads to technical and structured knowledge and requires the promotion of skills and innovations, including more jobs, wage improvements and welfare of the people. And this is reinforced by Björn & Lundvall (2003) that evoke "the context of learning and knowledge economy" is the flagship for innovation and development.

As stated previously, in this context, “science is not only for supplying the technology of specific findings, but also using for increasingly wider scientific methods of investigation, their laboratory techniques, and the certainty of the importance of research in solving problem" (LONGO, 2004, p.6).

3) *Lack of institutional career researchers.*

This problem is linked to a lack of public policies to regulate and encourage careers with the Ministry of Labor given the bureaucratic and historical problems, especially the civil war. For, given the institutional approach, it is recognized that the history and the context makes a difference when you take into consideration how the actors interact and learn (LUNDVAL, 2003, p.16). As already mentioned, the national

innovation system refers to a set of institutions, mechanisms, and actors who will support and determine the course of the innovations to be implemented in societies (REZENDE & VEDOVELHO, 2005).

This has hampered the organization of the research activities by these technicians, because, some of them are not regulated, and others do not have the skills to undertake their research systematically, and do not have abilities to manage the equipment. In this vein, the government must enhance efforts that allow actors to (SCHUMPETER, 1997) necessarily develop their innovative skills and establish strengthening strategies between institutions to realize the opportunities to innovate their products and processes and, thus, become competitive.

Nevertheless, government plays an important role to fund the research, tools, equipment, and facilities. It must be based on the premise that you cannot do world class research without having access to state-of-the-art equipment and facilities. So, in coalition with other sectors, it is of a paramount importance to support the research community by providing them facilities, so that they can do world class research. In doing so, some of the objectives must be taken into account such as (CTCS, 2014),

1. Fostering world class research
2. Training the next generation of researchers
3. Attracting, and retain the best people in the world to join Angola efforts of development, and
4. Fostering innovation and commercialization

Therefore, those four objectives must be accompanied by research infrastructures which will support them. Otherwise, it could be unrealistic. Thus, as mentioned earlier, in order to strengthen the study, I made at least two trips from Luanda to some of the provinces such as Luanda, Huambo, and Benguela, and I realized that there have been actions to eradicate the asymmetries between the small provinces and the capital Luanda. Thereby, according to the checklist[34] applied during the trips, managers on those spots quoted that, in spite of difficulties, the moment of peace

34 During my trips to those provinces, I had some informal conversations with some managers of small public health centers, schools and NGOs which allowed me to get more information about the state of health facilities and the profile of technicians.

prevailing in Angola has enabled a gradual return of research activities across the country. They reported that there have already been some actions on preventing diseases such as malaria, HIV/AIDS, and typhoid fever.

Managers and technicians quoted that, despite current difficulties, the Ministry of Health (MINSA) is developing several actions that may (or may not. sic) contribute to the improvement of public health services. Innovative technologies acquired by the ministry are very sophisticated. However, there must be a steady training and acquisition of new technical staff in order to foster development and innovation in public health, especially with regards to tropical diseases that plague the country.

Moreover, there is a necessity of a relationship among other municipal public health services in order to strengthen the drive against pandemics and the outbreak of opportunist diseases. In addition, it is paramount to establish partnerships with other departments and agencies to interact and exchange knowledge and information related to health issues (OLIVEIRA, 2010).

According to the manager of INSP, they have an action plan to undertake training activities for technicians and administrative staff as a whole. "*The objective is to educate them in the scientific methods and technologies available in the Institute"*. Hence, the major idea is to promote a greater speed in solving some basic problems such as analysis of water, endemic diseases, and general public health issues. In the perspective of Lopreite and Murphy (2009), investing in people includes two ways of attending to the needs of human resources training.

The first is the creation of opportunities for Angolan researchers and students. So, in the case of the health field, there must be an ability to attract and retain highly qualified scientists and researchers in the country. Therefore, it will depend (LOPREITE&MURPHY, 2009) increasingly on the capacity of our post-secondary and R&D institution and overall research hospitals to provide adequate equipment and research facilities.

The second way of investing in people comes within the development of a technologically- oriented workforce. In this case, the concern is not only the loss of

researchers to the other countries, but also the endowing of students in post-secondary education with the technological capabilities needed to understand the new technologies so that they are able to use them in an effective manner (LOPREITE&MURPHY, 2009). This effectively reinforces the reports from the interviewees about the need of investing heavily in schools, institutes, and universities across the country.

8.2.4 Implications for Health Innovation in Angola

Considering the earlier approaches, it is important to take into account the characteristics of the non-developed countries. As mentioned earlier, Angola has its own features that come from its beliefs, culture, idiosyncrasies, and organizational behaviour. Hofsted (2003) stresses something common in Africa, which is indeed present in Angola. It is described as a spot comprised with moderate collective characteristics. It means that all activities must be undertaken in a common agreement or in a familiar acceptance because it plays an important social role as (KUADA, 2003) the primary social unit in relation to individuals.

In this token, values are determined by reference to the maintenance, continuity, and functioning of the family, and the collective moral rules and obligations of the family that bind individual family members to one another. Within such a social framework, all purposes, actions, gains, and ideals of individual members are evaluated by comparison with the fortune of the family as a whole. The family, therefore limits, influences and, in some situations, determines the individual activities in organizations, institutions, and the broad society.

This is just to say that Angolan policy-makers must create possibilities to foster world-class research, by training the next generation of researchers, attracting, and retaining the best people in the world to join Angola's efforts of development. In doing so, those social and cultural characteristics must be put on the forefront of actions which will enable the building of NIS and R&D related to its realities and challenges.

In other words, the so called DUI – *learning by doing* (ARROW, 1962), *learning by using* (ROSEMBERG, 1982) and, *learning by interaction* (LUNDVALL, 1988) materialized on institutions – firms, R&D institutes, universities, or government agencies - must be enhanced because through it they will be able to build up a health network, taking into account all Angolan values and idiosyncrasies. Therefore, targeting health R&D development without broader attention on issues relating to Angolan needs, could make it harder to reach a high level of public health.

It also important to stress that the Angolan government has been working to improve public health services, hospitals, health centers, and laboratories. However, one of the biggest problems remains in some aspects such as, infrastructure, and catching up across the country.

8.2.4.1 Technical Capacity Able to Handle the Advanced Equipment to Effectively Perform Diagnostics

Overall, the biggest problem I noticed over this study is related to the technical skills of personnel in all institutions across the country. Moreover, the lack of specific technical skills to diagnose each type of health problem is also a challenge across the country. That is, the equipment must be calibrated according to the specificity of the problem to be analyzed. In so doing, it will be possible to accurately find the factors that promote any disease.

As pointed out earlier, until 1975, only three Angolans graduated in Agostinho Neto University (UAN), and about 5000 from 1975 to 2002, when the country reached an effective peace (PNCTI, 2011). During this period, the Angolan government invested the most part of oil and diamond outcomes into the army. In this sense, one of the biggest problems today lies on the failure of professors and highly-trained technicians to meet the national demands to undertake R&D across the country.

Thereby, health Indicators are weak especially in the infant mortality rate and maternal mortality. According to the Angolan government and European Community reports (2013), the mortality rate of children rate under five years is 25%, and the

maternal mortality rate is 14 per thousand. The epidemiological situation is worrying, particularly because of the cholera epidemic. In this context, technical capacity to handle the equipment is of a great importance in order to promote access to clean water, and eradicate tropical diseases.

Despite efforts by the authorities in terms of construction of school infrastructure and training, the quality of educational continues to be a challenge. Because of the issue of capacity building, human resources and infrastructure are the main constraints that hamper building up a NIS which, in turn, affects economic development. One way of doing so is investing heavily in education so that science, technology, and innovation can be a reality across the country. This diagnosis is shared by both national authorities and by all international development partners (PNCTI, 2011).

8.2.4.2 Deficit of Rules and Instruments for the Researcher's Career

The institute has only one PhD and just six Master's degrees in health sciences, which hinders the R&D on the public health and tropical diseases that plague the country.

The PNCTI released data, about the lack of a solid research career in all institutions across the country. In this vein, although there are statutes, it is not robust, and does not meet the demands of the R&D activities. In this token, the Angolan government initiated other reforms of public administration, including the restructuring of the salary of the public service, the identification of the role of public servants, and establishing guidelines to the public activity.

8.2.4.3 Lines of Research and Technological Development and Partnership with R&D Institutions

Casting S&T as a central role of the Angolan development (SALLE, 2006), it is important to put in the frontline the necessity of building policies that contribute to a knowledge advantage and technologic advantage such as those that foster

innovation in health and economic competitiveness. According to the results, the INSP does not have lines of research on its own field, neither does it have any sort of relationship with universities, nor with other R&D institutions. Nevertheless, when we talk about innovation, we often talk about technological innovation, which is a way to finding better ways of doing things for the benefit of the society.

Therefore, the Angolan government must enhance strategies to establish a new way of science and technologic production, putting together the INSP and universities in Luanda. Also, the government must develop strategies of knowledge and technology transfer among universities, hospitals, and labs to the productive sector. In this vein, a NIS building can promote interaction and relationships of these institutions in order to enhance training, and attract technicians and stakeholders. This means that neither companies and knowledge institutions, nor persons, function alone (LUNDVALL, 2003). In doing so, the objectives of Angola in 2025 are to ensure national cohesion, promote peace and tranquility, promote equitable and sustainable economic development, ensure fair income distribution, foster macroeconomic stability, and develop harmonious parts of the country.

8.2.5 Conclusion

Finally, the lack of a linkage between the INSP and an academic institution shows up the difficulties to undertake and develop innovations in the health field. In not doing so, the challenges to eradicate the plethora of tropical diseases and other problems which plague the population will be more detrimental.

A number of less-prepared technicians still remain on the one of the problems across the country. The Angolan government must gamble on training in order to deal with uncertainties and risks associated with new technologies, and create incentives for public and private innovation.

In this vein, the building of a health innovation system could be a paramount strategy in the configuration of a pattern of technological development able to escape the polarity modernization-marginalization which keeps Angola in the position of

underdevelopment. Therefore, for accomplishing it, (BRICS, 2010) new forms of public policies are required, which foster industrialization, and which act toward providing a better connection among the industrial, commercial, technological, and public health policies based on strategies of social inclusion. In so doing, it will generate positive social externalities, and institutional and human capacity in managing new technologies.

In this sense, the linkage between these actors can help in strengthening a NIS as these linkages will address the various deficiencies and challenges identified in Angola as a whole. Thus, having robust R&D programs that incorporate (BERNARD, 2004) private and public research laboratories and universities with a sound basis of technical skills and human capital. Moreover, it will boost innovation.

8.3 SONANGOL REFINERY

8.3.1 Introduction

As pointed out earlier, the Angolan economy has achieved very high growth rates in the past twelve years, striving to control the inflation. Between 2003 and 2008, the average economic growth rate stood at 14.8% per year, placing Angola amongst the top countries with the highest growth globally. Nevertheless, the impact of the global financial crisis and the fall in oil production caused a significant slowdown in growth between 2009 and 2011 to an average of only 2.5%. In 2012, it increased by 4.3% in Angolan oil production, with 1.66 million to 1.73 barrels/day. It contributed decisively to boosting economic activity, as well as, contributing to a strong development of the non-oil sector. It also increased the GDP growth at 8% (BANCO BIC, 2014).

However, the Angolan economy still remains dependent on the oil sector, which represents about 50% of GDP, despite the gradual growth of the non-oil economy. In this vein, Angola has been putting resources into some actions in order to diversify and develop other sectors such as agriculture, fisheries, forestry, industry, and services (MINFIN, 2014). Nevertheless, the country still strives to overcome the many challenges of reconstruction. One of the challenges centers around how to ensure

that the vast natural resources of Angola, such as oil, water, and minerals, contribute to the increase of technical skills of Angolans.

In this token, this chapter has the objective of discussing the state of oil refinery, and its difficulties and challenges in undertaking its activities, taking into account the technologies and human capital there.

8.3.2 The Oil industry and challenges to diversify the economy in Angola

As pointed out earlier, the Angolan government has much work to diversify the economy, rather than depending heavily on oil outcomes. An interesting project is the establishment of an Agro-Mining Public Company to foster the integrated and sustainable development of the agricultural sector, making the use of the potential of productive natural resources, which include minerals applicable to agriculture. This program aims to increase and improve quantitatively and qualitatively production on existing farms, and encourage the emergence of other products in order to meet consumer needs through national production.

Therefore, to support the creation of competitive enterprises, the Ministry of Industry has set up a support fund which is designed to help entrepreneurs facing cash flow problems or those who wish to invest in the modernization or recovery companies, as well as innovative projects. The fund aims to reduce regional imbalances, and promote start-ups and modernization of others. According to the Finance Ministry, Angola has the ambition to continue to grow in a sustainable way in the coming decades, with forecasts of 2025 pointing toward the cumulative growth of non-oil GDP to triple in the next 15 years. It is estimated to result in a considerable increase in energy consumption - more than double compared to the current landscape, a reality where access to energy is very essential, both for citizens and for businesses, and particularly for industry. In this vein, the idea is to use the double logic of improving the quality of life of Angolans, and to boost economic growth (MINFIN, 2015).

Currently, this sector is dominated by a few state-owned enterprises benefiting from subsidies and tariff protection and has some pep in industries that produce low-cost goods (beverages, cement, etc.) (Info-Angola. Accessed in 04/15/2015) .

8.3.3 Refinery

Historically, the hydrocarbon process in Angola began in the 50's. During this period, it was decided the construction of the refinery would be mounted by the extinct PETRANGOL, one of the branches of the former Belgian group PETROFINA SA.

This is a conventional refinery type "Hydro Skimming" whose activity is essentially vocational for producing LPG, gasoline, jet fuel, and diesel to the Angolan domestic market. Refinery Sonangol is the only refinery in Angola until the date of the survey. Upon building, the capacity of the refinery was 100,000 tonnes per year or about 2,000 bpd. During 1972-1973, the refinery had been substantially expanded to 1.5 million tonnes / year (30,000 bpd). Currently the refinery is powered by 15% of the annual production of just over one million bpd. Angola annually imports 250 million dollars of derivatives. This quota is excluded LPG, which is no longer imported since 2005 (http://www.snl-distribuidora.com. *Accessed in 03/19/2014*).

Taking into account the categories listed below, we obtained the following results listed in the table:

8.3.4 Results Framework – Sonangol Refinery

Table 22: *Results Framework – Sonangol Refinery*

Nº	**Item**	**Finding**
1	**Type of institution**	• Production; Public company • Comprises refinery + port discharge;
2	**Human Resources**	• Average age 46; renewal process frameworks; • Constant training;

		• 1153 (768 Contractors + 8 from Sonangol + 375 from Refinery)
3	**Scientific Research Career**	• Do not have any program for scientific research career.
4	**Infrastructures**	• Old; created in1958
5	**Technology**	• Ship (rented) transportation of crude oil; • Processes 6500 barrels/day • Units processing: vacuum distillation; • atmospheric; Pur-isom, NAFTA HOS; utilities; treatment • gas; platforming; Merox (not working); • Simple Technology: takes 60% capacity • Barrel + 40% exported; • Products obtained: naphtha, gas, gasoline and other (40%) • Storage: 44 tanks (6 crude) • derivatives analysis technology • Information Technologies for internal network and database
6	**Technology maintenance and equipament**	• By 3 Engineers • basic and Medium Technical stuff
7	**Diffusion**	• Not reported
8	Lines research and technological development	• There is no scientific research program Specified
9	Partnership with com HE/R&D Institutions	• Receive requests for visits and internships of HEI* and Secondary Institutes; • Cooperates with the National Oil Institute (INP) in Province of Kwanza Sul.

*Higher Educations Institutions

Source: Author, based on Refinery and MINCT reports.

8.3.5 Discussions

In order to realize the real situation of the refinery, one can notice that they use cutting-edge technology. But they are also faced with the lack of specialized human resources to deal with the technical demands. The company is a branch of the so-called Sonangol[35], a public company steered by the Angolan government. As mentioned earlier, it was established with the goal of empowering regional companies and addresses their oil production across the country. As this case study has shown, even with it being a big company, it has a major deficit in machinery to meet production demand, and a big difficulty to maintain it.

However, in order to address the concerns of the lack of human capital, they are strengthening relations, especially with a public secondary school related to basic oil studies. It is located in the Province of Kwanza Sul, and is managed by the Angolan government.

Regarding the use of oil across the country, the Refinery does not have the capacity to fill it up because of all these points mentioned above. Even though they enhance training, according to reports, they also have an issue where their personnel are not getting replenished. The concern is that when all these people retire, they are faced with a lack of replacement. In this vein, policy scope could be expanded, since there

35 On the threshold of the Independence, there was a task force aiming at supporting the oil industry and to mobilize Angolan citizens to invest in the oil business. Aiming at restructuring and improving the Angolan Industry, it was replaced by the National Commission for the Restructuring of the Oil Industry, which promoted the nationalization of **ANGOL – Sociedade de Lubrificantes e Combustíveis-Sarl ,**which was established in 1953 as a subsidiary of the so-called SACOR, a Portuguese company, and marketed and distributed fuels, lubricants and liquefied gas in Angola. From this shift, in 1976, there came up the establishment of two companies: **Sonangol U.E.E. and Direcção Nacional de Petróleos,** both geared by the Ministry of Industry. ANGOL had been established in 1953 as a subsidiary of the Portuguese company SACOR, and marketed and distributed fuels, lubricants and liquefied gas in Angola.
By the Decree 52/76 it was instituted **Sonangol - Sociedade Nacional de Combustíveis de Angola**, U.E.E - as a state owned company whose mission was the management of hydrocarbon resource exploration across the country. Despite having the government as the sole shareholder, Sonangol has always been geared as a private company and is under strict performance standards to ensure efficiency and productivity. Therefore, Sonangol bought the premises of Texaco, Fina and Shell and through an agreement acquired those of Mobil. In this process Sonangol also absorbed former employees of oil companies that once operated in Angola.
The absence of qualified nationals for the local oil industry, forced Sonangol to begin paying special attention to the training and professional development of its employees. The first group of students was sent to Italy with scholarships co-aided by ENI - Italian Oil Company. A second, larger group went to Algeria. The first sponsored students graduated and returned to Angola by the end of 1970s. They became the driving force behind a more modern Sonangol. Over the years, it became a Group, focusing its activities on diversifying its business. In this vein, Sonangol has developed joint-ventures and established companies that promote both the social development of Angola and the expansion of Company (Sonangol EP 2002-2013).

are difficulties to fill up all spots for better producing. It could be involved in a (KINDER, 2010) wide range of activities such as conducting joint research projects, knowledge and technology transfer, directed training, and institutional capacity building. Without investment in human resources, it is impossible to promote scientific research and innovations. As pointed out earlier, taking into account the recommendations of the Oslo Manual, it is important to develop these training opportunities in order to foster technical innovations, and promote capabilities to use technologies adequately with critical sense and responsibility.

Different from the other companies in developed countries, apart from the political and bureaucratic management, this company also deals with the problem of space. It is located in the middle of the city, which constitutes a potential threat to the security of the population.

Regarding the human resources, I noticed that the average age of workers is around 46 years old. Although the board reports that there is constant training, the number of highly-trained technicians is negligible in meeting the challenges and the extension of the refinery. Of the 1153 workers, more than half come from contractors, i.e., they are part of the stakeholders who offer their services and buy them their derivatives.

Moreover, the Refinery is engaged in formalized activities of distribution. It works in a network with other companies who deliver the oil across the country. However, it does not have a feasible security project in atmospheric and climate science research. The need for an investment in the environment asset is not only considered urgent, but it too continues to be an overall concern given the emissions from burning fossil fuels.

8.3.6 Skills-Training

By this token, knowing that there is not a specific research program in order to think about the environment and the ecosystem, a relationship with higher education and R&D institutions are of a great importance. One of the points is to push to protected spots be marine to free the fish from destructive practices. It means that, in tandem

with these institutes, they can encourage stronger planning processes to reduce any negative impacts of ocean and shore-based industry. Thus, promoting a clean energy production and consumption to reduce dependence on fossil fuels, must be the centre of their attention. Because shore and off-shore oil exploitation is simply too dangerous for the ecosystem when it is not done with common sense and/or without an ecological mindset.

The jobs in the oil and gas industry are relatively well-paid jobs since the average income among employees of those industries is the highest of all sectors of the economy (NAZHMETDINOVA, 2012). Knowing that the Refinery is a public company, consequently, these jobs provide higher tax revenue for the government. Nevertheless, I noticed that the productivity has been inefficient, and it has lost potential. Although the wages somehow are high, the productivity should be high due to the high investment in capital and technology (Clayton Research, 2001). However, as discussed earlier, the lack of skills are the problems that hinder such efficiency.

Regarding the magnitude of the company, it has only three engineers to manage and maintain the technologies in use. Nevertheless, some geologists, geophysicists, petroleum engineers, and companies involved in this process could be called closely to amalgamate thereby increasing efficiency, and thinking about other issues such as hindering the results of emissions from extracting and burning fossil fuels (MALLETT, 2009).

8.3.7 Conclusion

Finally, the conclusion reached is that the refinery as a whole plays a huge role in the Angolan economy. But the concern relies on lack of human capital and infrastructure. Moreover, there is a gap in terms of a relationship with other institutions such as universities and R&D institutions across the country in order to augment the skills related do the field. Thus, because the oil and gas sector is so important to the Angolan economy, those efforts are focused on profit maximization. However, without putting some efforts into training Angolans on these technologies, then the dependency cycle continues.

By this token, a transferable skills-training between the Refinery and R&D and higher education institutions could bring several benefits for the company and, overall, for the Angolan society. Undergraduate and graduate students, for example, can benefit from acquiring transferable skills as they are studying, which can help them succeed in carrying out their projects in company. On the other side, researchers in the workplace also will benefit from the ongoing acquisition of transferable skills in order to update and build on existing competences or to fill in gaps so that they can work more effectively and benefit from a variety of opportunities with the so-called “learning by doing” (OECD, 2012).

8.4 EJN SOLUÇÕES

8.4.1 Introduction

Created in 2009, **EJN** is a private company under Angolan law, located in Huambo province. It is scoped to implement projects relating to the management, collection, treatment, and distribution of water resources to the population, as well as for sanitation. Thus, the company's mission is to offer and provide solutions in water supply, sewage, and solid waste, contributing to the socio-economic and environmental development.

It is characterized by a watershed that extends almost throughout the country, Angola is characterized as an important world reserve of this precious resource, which is strategic to meet the needs of the population in terms of drinking water. The challenge is part of the construction of water supply systems for improving public health in both urban and rural areas.

Taking into account the categories listed below, we obtained the following results listed in the table:

8.4.2 Results Framework – EJN SOLUÇÕES

Table 23: ***Results Framework – EJN SOLUÇÕES***

Nº	Item	Finding
1	**Type of institution**	• Private company; • Water treatment
2	**Human Resources**	• Average age 43; • The majority of technicians comes from Bazil • Difficulties in training local staff;
3	**Scientific Research Career**	• Do not have any program for scientific research career.
4	**Infrastructures**	• created recently
5	**Technology**	• Imported technology from Brazil
6	**Technology maintenance and equipment**	• By 2 Engineers • Basic and Medium Technical staff
7	**Diffusion**	• Not reported
8	Lines research and technological development	• There is no scientific research program Specified
9	Partnership with HE/R&D Institutions	• There is not a partnership

*Higher Educations Institutions

Source: Author, based on EJN reports.

8.4.3 Discussions

EJN is a small and private company focused on water treatment. It uses technologies related to water treatment plants (WTP). Using conventional treatment (coagulation, flocculation, sedimentation and filtration) by mean of WTP, they transform inadequate water for human consumption on a product in accordance with the standard for potable water. For this end, processes and operations that generate waste are needed (TUON, 2015).

Currently, it is undertaking its activities in a small municipality in the interior of Huambo province. They get the water from a river, and after treatment, it is sent to the city. The technical staff is divided in two groups. The majority of senior

technicians comes from Brazil, where the technology used comes from, because Angola does not produce technologies of water treatment. The local technicians staff compounds the minority which hold the basic and medium skills.

Nevertheless, the great lack of resources and finances makes it difficult to undertake the work proposed by the company. According to the technical manager, the company has had many problems with finances, because the services rendered to the government have not been properly paid.

As pointed out earlier, EJN is located in the interior of Angola, where the Angolan main river sources are. However, it has been hard to following the commitment in improving its activities in order to solve several problems related to water problems which plague the local population such as distribution, fever typhoid, diarrhoea and other issues related to water. It happens because, first, the majority of well trained human capital comes from Brazil, and they do not stay for so long in the setting. Secondly, even though there is a local manager who had education in Brazil, it has been tough to deal with other local institutions such as the new university, local politicians.

8.4.4 Conclusion

Summing up, generally, it is clear, on one hand, a large gap around the technical capabilities at EJN. The vast majority of senior technicians are from Brazil, because local technicians do not have a technical capacity to manage the imported technologies. According to the collected data, local technical staff, although they have attended basic courses, they suffer with a lack of more robust technical skills. According to one the national employee, *"we had training in technical school of hydraulics, but it did not have adequate laboratories for training."*

On the other hand, EJN with a lack weak attention from the Local Government. In general, there is a large deficit in investment and financing small and medium enterprises in Angola. This is a concern arising in developing countries, in which

entrepreneurship is on the margins of state's attention. However, it is of paramount importance to create conditions for the development of small businesses, aiming at investment and technical training. In the Schumpeter's view, easing bank credit, followed by robust policies for small and medium enterprises is the key to technological innovations and the emergence of innovative entrepreneurs.

PART VII: CONCLUSIONS

9 CONCLUSION

9.1 Purpose, Research Questions, Arguments, and Recommendations

The purpose of this study has been to critically examine the historical and educational process that Angola has experienced, to face the challenges of strengthening the National System of Science, Technology and Innovation to develop the country. In addition, it stems from the idea of building a National Innovation System (NIS) in Angola, through which all actors – government, universities, firms research intitutes – must get together in order to put the country on the pathway to the socio-economic and technologic development.

Thus, within the approaches undertaken throughout this work, the Angolan government is producing a reasonable number of graduates. However, first, as interviewees affirm, it is not producing a large number of graduates with Science and Technology degrees. As a result, the picture of Angolan R&D is quite weak because there is a huge lack of quality skills and expertise in research centers, and in higher education institutions such as universities, institutes and faculties. Second, the Angolan firms, seen as a set of professional financial organizations, suffer from a large deficit of expertise, hampering the innovative (process and product) activity in order to boost and strengthen the national economy. This makes them remaining in a steady level of nascent and emerging companies. Third, all of these actors and/or institutions function somewhat isolated.

In this regard, the National Innovation System in Angola cannot arise because the majority of firms, researchers, and universities (public and private) are not connected. In this vein, overall, the Angolan companies, universities, even the government, are likely to have hard time to stay abreast of the latest advancements on science and technology, as well as global economic growth. Hence, as mentioned across this study, it is important enhancing efforts on knowledge by means of learning and

interaction among actors – government, companies, universities, and research institutes. By this token, Angola must build skills, strong policies and institutions, experience, tacit knowledge, local networks, augmented by knowledge and technology international exchange.

Thus, what was found is that, despite the efforts of the Angolan government, there is still quite a deficit of human capital to effectively handle the imported technology in Angola. In general, according to the surveys on institutions, Angola imports advanced equipment, but it is struggling with a lack of qualified staff.

Therefore, the Angolan companies still depend on the support of foreign technicians to manage and solve big issues. Moreover, according to interviewees, the back and forth of expatriates has entailed a large outlay of funds rather than increasing the quality of education and training across the country.

9.2 Infrastructures

As mentioned earlier, Angola suffered greatly from the civil war that lasted 27 years. During this period, much of the infrastructure was destroyed. Infrastructure is central to every aspect of life, because it plays a core role in fostering productivity and growth in country, and in a modern economy it plays an important role to the welfare. In the context of Angola, it is still incipient. Therefore, creating infrastructures connected to science and good policies, it will enable to change such a landscape and overall provide core services across the country. I believe it could be one of the means to boost the economy of the country.

As pointed out earlier, National Innovation System (NIS) is a set of institutions involved in the generation, commercialization, and diffusion of new and improved processes and services and products. However, in relation with others developing countries, Angola deals with huge constraints in infrastructures. Thereby, strengthening institutions in this country is a big challenge. As pointed out across this study, the NIS could play a key role in solving many problems in country. Thereby, the Angolan government is striving to rebuild infrastructure in order to strengthen the

system and R&D. Overall, there are some points that need much attention from the policy-makers such as:

a) There are difficulties in recruiting and framing intermediate technical support to research careers
b) It has been hard to boost IR&D[36] institutions
c) Angola imports a large number of advanced technologies, but not all are operational
d) There are problems in the maintenance of acquired technology
e) There are, sometimes, difficulty in the acquisition of specific reagents and consumables to enhance all sort of analyses and so on

In general, there is a need for a short technical training plan, medium and long term, within the framework of an institutional development project to define the lines of inquiry and their respective projects. In addition, they must be associated with better partnerships with national and international universities, and with different actors in order to contemplate a broader level, to innovate processes and products, and enhance research related to local issues such as effective eradication of tropical diseases, food security, State security and so on.

Once war is ended, the government must consider its crucial role to change this landscape. It can ease the absorption of capabilities (catch up), to improve knowledge and technology transfer. Also it can enable human resources to operate in several areas, reconstructing R&D infrastructures. Hence, improving research and development infrastructure, it will not only boost economic growth and productivity growth, but it will also diminish the gap between Angola and rich countries in terms of pursuing high-return investments.

36 IR&D is R&D undertaken by industry. As such, expenditures on IR&D should be regarded as synonymous with business enterprise expenditure on R&D (BERD) as collected and reported by the OECD.

9.3 Policy Challenges

The National Innovation System plays a core role to exert an influence on the rate and direction of change that will foster innovation.

Unanimously, the respondents presented a set of information, arguing that to a better innovation performance, Angola needs a combination of science, technology, engineering, and strong policies, and an adaptive and entrepreneurial universities. Within the answers, performance management of science activity is greatly affected by underlying logic and the approach of science organization in Angola, and this logic and approach is undergoing fundamental change. It means that police-makers must enhance strategies to connect all actors of the national innovation system that will effectively enable a larger scientific production and innovation towards the welfare of the population and a robust economic performance.

Moreover, they pointed out that Angola has a big gap on R&D activities that hinders its innovative and competitive position in Africa due to the lack of investment in science, technology, and innovation. In addition, as mentioned across this study, the country is totally dependent on Oil, and it has been hard to boost its economy through other resources. The country has vast reserves of natural resources such as renewable energy that can be used to produce clean, sustainable electric power and deliver potable water to its people, including hydro, solar power and wind sources.

As mentioned throughout this study, the Republic of Angola has had terrific economic growth in last 10 years. It occurred because Angola is one of the biggest oil producers in the world. Nevertheless, data highlight that Angola is highly dependent on oil exploitation, which puts it very far from being socially and economically stable over time because the worldwide instability on barrel prices. Moreover, the overall investment levels in science, technology and innovation is still quite below those required to boost the socio-economic development. It explains the difficulties of R&D activities, lack of human capital, and lack of infrastructure across the country. In so doing, Angola can ideally overcome its great dependency on oil, thereby adding to state revenues, and returns to population. To this end, it requires a long-term

planning and modeling strong public policies to promote lower deployment costs for its population.

Overall, some specific actions must be taken into account in order to succeed in strengthening the System of Science, Technology, and Innovation of Angola such as,

1. Creating R&D universities, focusing on STI, Engineering, Mathematics, Chemistry and Physics
2. Strengthening public and private inter-university networks
3. Strengthening the catalytic role of public investment in mobilizing private investment through Public-Private Partnerships for the development of STI across the country
4. Setting-up and supporting the strategic framework for Science, Technology, and Innovation for Angola in order to accelerate the transition of Angola to knowledge and innovation-based economy
5. Working towards the establishment of a Trust Fund to support STI initiatives across the country
6. Systematizing the evaluation and monitoring of policies, plans, and initiatives
7. Continuing efforts to improve the status of researchers by establishing incentive mechanisms to increase research and encourage applied research.

As mentioned earlier, one of the main ideas of the National Innovation System is around the challenge to put all actors working together. Committed with a strong strategy, it can promote innovative solutions and bring business profitability and welfare in the country. Moreover, as I mentioned earlier, it can increase economic growth, create substantial employment opportunities, improve living standards, and eradicate the extreme poverty across the country.

It is noteworthy that the whole process of innovation (process, product or organizational) only happens more closely with the development of skills through learning by doing connected with learning by solving problems. In this token, **Dn** and **Ar** pointed out stressing that the new universities in Angola could work linked to other sectors to spur local socio-economic development. This is the process of acquiring knowledge by systematically using advanced knowledge for solving the local

problems. Therefore, this process shall succeed through an interrelation among actors, which is one of the ideas of the National Innovation System (NIS). In my point of view, this is the backbone for an affective and strong NIS.

The innovation system is a mean through which all actors such as universities, Research Institutes and researchers, government, and companies work connected. To strengthen the NIS of Angola it is needed strong policies and a fusion of several disciplines and large outlays on research, testing, certification, and building of both experimental and production facilities. For this end, it is important that Angolan policy-makers understand the idiosyncrasies of Angola such as, culture, languages, faith, and traditional organization augmented by the strive to survive during the civil war and post war.

Despite the impressive economic growth in Angola in the last couple years, the population is still poor by global standards[37]. Much of this poverty, as pointed out by the interviewees (**Dn** and **Gn)**, can broadly be attributed to some points such as lack of human capital, limited availability of social services, affordability and accessibility to energy, and water treatment. As pointed out earlier, during the civil war, firewood was collected and used for cooking and construction, augmenting deforestation across the country. However, to date, it is still an activity for the poorest people across the country. As a result, it has contributed to the so-called global warming, shortage of rainwater, and desertification. Moreover, as a result, respiratory diseases across the country have been overwhelmingly increasing.

As the surveys showed, human capital is much more assumed to be one of the most important key factors to developing a country. Although Angola holds many natural resources, and imports cutting-edge technology, a key problem is that it does not have reasonable, qualified human resources to meet the challenges in this post civil war. Some other problems are related to entrepreneurship. Also, they strive, hardly paving the way for incremental improvements in the new universities across the country. As shown earlier, the Angolan population is extremely young, meaning that 48% are younger; only 2.4% are more than 65 years, and the life expectancy is

37 In Angola, the subsistence agriculture is the main resource for the majority of the population. It occupies about 85% of the workforce, and it accounts less than 10% of total GDP. Half of consumption comes from food imports (BANCO BIC, 2014).

around 50 years old, and the percentage of illiterates throughout the country is as well low. More than half of Angola's population has only completed primary school, less than a quarter have lower secondary education, and a lower rate completed higher education. As a result, the majority of youth works in the informal economy.

In this regard, working in a multidisciplinary perspective is of paramount importance to ensure that the transfer of knowledge and technologies overcome the actual problems that plague Angola. The so-called third mission of the university comes up with a key idea in order to diversify research – Social Sciences, Physical Sciences, and Engineering – and embraces the challenges of increasing the economy through science, technology, and innovation.

As I pointed out earlier, the R&D activities were almost nil for about 27 years because there were no plausible conditions for this purpose. The Angolan provinces were isolated; roads had been destroyed. Only one university (Agostinho Neto University) was not able to develop the third mission, nor develop research institutions able to undertake their job. Therefore, the knowledge and technology transfer inevitably passed into the second position.

Thus, the National Innovation System comes up with a symbolic and useful tool once all actors can work together in a same understanding to eradicate the biggest problems across the country, and boost the economy.

According to findings, there are not indicators of science, technology and innovations of Angola yet. It is known that the indicators play a key role in order to pay attention to some issues across the country. Moreover, they are of a great importance because they can contribute to a better strong of policies in the area of science, technology, and innovation at national, regional, and provincial levels. In addition, it can support and strengthen Angolan's capacity to develop and plan development. In so doing, it will provide strong support in terms of capacity-building in R&D and innovation.

To succeed in generating the targeted research outputs needed to foster R&D, the Angolan government will need sufficient, sustainable funding of strategic research

and diffusions programs in connection with national, regional, and provincial priorities. However, it must be combined with talented, well-trained researchers in a safe and efficient environment.

As these diffusions of technological innovation processes are more enhanced in Angola for instance, more technological innovation will become a culture across the country. The smaller the gap among peripheral countries and developed countries, the greater the ability of catching absorption up. However, knowledge and skills are extremely necessary for the successful adoption of any technology. Thus, one of my opinions to strengthen innovation in Angola is that policy-makers must work in tandem with Angolan scholars, the market, companies in order to strengthen the NIS, and find a pathway to the development.

9.4 Human Capital & National Learning Systems – Challenges

As shown across this study, the truth is that brain-drain is one of the biggest issues in Angola. Difficulties of recruitment of highly qualified human capital, and their departure into more lucrative spots especially in international organizations abroad, has been the “Achilles Heel” of the country. Hence, it resulted in the loss of considerable experience and expertise in Angola after colonial liberation.

As addressed by the interviewees and the findings from the surveys, the process of technical change of Angola is limitedly to the absorption and improvement of innovation undertaken in the developing countries. It strengthens the idea through which learning is of utmost importance to obtaining endogenous knowledge which allow the country to deal with already existing knowledge or techniques. In other words, learning (VIOTTI, 2010) should be the absorption of innovations produced elsewhere, and the generation of improvements in the vicinity of acquired knowledge or techniques.

All of such a mindset makes the picture of the so-called National Learning System which comes up as a first step towards a strong National Innovation System, in which the actors’ activities should be centered, above all, in *learning* rather than to *innovation.* As mentioned earlier, because of the rising complexity of new

technologies and economic trends across the world, Angola needs to build up strong policies, enhancing a fusion of several disciplines and large outlays on research, testing, certification, and building of both experimental and production facilities.

In this token, knowing that the country lost much of its human capital, strategies should be at the forefront of the Angolan government. They must increase the learning capacity on engineering and design, (STI, technology catching-up) in order to diminish the gaps in management capacity, fostering learning organizations in tandem with technical centers. Moreover, they must improve knowledge and technology transfer abroad in order to, first, attract brilliant people, and second, to have world class researchers and technicians.

In this vein, it is of paramount importance focusing in two mindsets around National Innovation System. First in mapping indicators of national specialization and performance with respect to innovation, research and development efforts, and science, technology organizations. Second, it is useful taking into consideration social institutions, macro-economics regulation, financial systems, education and communication infrastructures and market conditions, as far as these have impact on the learning and competence-building process. As well, it is important to create strategies to improve the quality of secondary and tertiary-level science and technology skills, to boost creativity augment with a fund for research expertise.

Thus, Angola has its innovation policy (PNCTI), which is the key drive to strengthening the NIS through domestic strong rules and stimulate the process of innovation. In this token, policy makers must understand that creating a National Innovations System, which fits the development targets, is important to perceive the potential resources in each province, municipalities, and villages across the country.

Taking into account these circumstances, as previously mentioned, Angola must have the mindset to strengthen its institutional labour skills, creating an environment to boost innovative capabilities that can bear difficulties and opportunities. In doing so, some strategies must be taken into account such as – creating new initiatives aimed at promoting STI for the transformation of current labour landscape, considering human resources development, and encouraging private initiatives and

entrepreneurship in science, technology and innovation to boost inclusive and sustainable growth in order to create jobs for the youth population. Otherwise, strengthening NIS would remain only on projects.

In addition, despite these things, such as post civil war, bottlenecks in education, health problems and lack of infrastructure, is a great opportunity to build up a wonderful country. Nevertheless, Fostering meaningful ways, working across committees, scholars, directorates, different departments, and agencies to integrate human capital, financial, and other measures of STI activities must be connected with *"Learning"*. In doing so, the innovative process will likely to be effective.

Finally, other studies will also need to explore to a much larger extent the National Innovation System strengthening in Angola, taking into account its idiosyncrasies. This relates not only the mechanisms that are usually traced in formal innovation studies and in OECD and/or Triad, but also the more hidden and subtle links that are underlined in the actual context across the country.

Thus, relying on views offered by the different authors and this study per se, I hope that this discussion can further stimulate development of conceptual frameworks and analytical perspectives capable of dealing with the realities, challenges, and opportunities to boost the development of Angola and other developing countries.

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APPENDICES

APPENDIX A

ROADMAP TO IMPLEMENT THE INTERVIEWS

Were consulted in advance the subjects with end of giving the nod for the purpose of conducting the interviews. Also, there was a letter addressed to the Ministry of Science and Technology of Angola, ensuring that the information collected will be treated with the utmost responsibility.

1. NAME (can be fictional), ORIGIN;
2. VOCACIONAL TRAINING:
    - Course
    - Titration
    - Country of training;
3. OCCUPATION AT THE MINISTRY; PROFESSOR IN AN UNIVERSITY?
4. HOW WAS YOUR ENTRY IN THE DESIGN OF INSTITUTIONALIZATION OF SCIENCE, TECHNOLOGY AND INNOVATION POLICY (PNCTI) OF ANGOLA ?;
5. HOW YOUR TRAINING THEORY AND EXPERIENCE IN FOREIGN COUNTRIES CONTRIBUTED TO YOUR PERFORMANCE IN THE PROCESS OF INSTITUTIONALIZATION PNCTI?
6. IS THERE ANY PART OF DOCUMENTS YOU HIGHLIGHT REGARDING THESE INFLUENCES OF YOUR EXPERIENCE IN OTHER COUNTRIES?
7. YOUR WAY OF THINKING **CT&I** HAS ANY INFLUENCE OF YOUR ETHNIC BACKGROUND?
8. KNOWING THAT PNCTI OF ANGOLA WAS BASED ON STUDIES, WHAT FUNDAMENTAL IMPORTANCE HAD **UNESCO** FOR THAT?
9. WHICH DOCUMENTS (OF THE COUNTRIES CONSULTED) HELPED SIGNIFICANTLY IN THE INSTITUTIONALIZATION OF **PNCTI** OF ANGOLA?
10. IN WHICH LEVELS DO YOU PERCEIVE THE SCIENTIFIC RESEARCH IN ANGOLA?
11. IS THERE A SYMBIOSIS BETWEEN SCIENTIFIC AND INDUSTRIAL DEVELOPMENT IN ANGOLA?
12. APPROVED THE PNCTI, WHICH WILL BE THE MECHANISMS AND STRATEGIES FOR IMPLEMENTATION TO PROVIDE THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT OF ANGOLA?
13. IF YOU WERE REFERRED ON MEASURES TAKEN TO SPEED UP THE PROCESS OF SCIENTIFIC, TECHNOLOGICAL AND INDUSTRIAL DEVELOPMENT OF ANGOLA, HOW WOULD YOU ANSWER?

14. KNOWING THAT THE HIGHT TECHNICAL PERSONEL ARE THE BASIS FOR THE SUSTAINABLE DEVELOPMENT OF A COUNTRY, WHAT IS YOUR VISION ABOUT THE FORMATION OF HUMAN RESOURCES CONSIDERED IN PNCTI?

15. IF YOU WERE CONSULTED WITH THE CREATION OF 7 NEW UNIVERSITIES, WHAT YOU SAY ABOUT THEIR SCIENTIFICAL, TECHNOLOGICAL AND INDUSTRIAL ROLE THEY CAN PLAY IN EVERY REGION WHERE THEY ARE SEATLED?

16. IS THERE A SYMBIOSIS BETWEEN SCIENTIFIC AND INDUSTRIAL DEVELOPMENT IN ANGOLA?

17. APPROVED THE PNCTI, WHICH WILL BE THE MECHANISMS AND STRATEGIES FOR IMPLEMENTATION TO PROVIDE THE SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENT OF ANGOLA?

18. IF YOU WERE REFERRED ON MEASURES TAKEN TO SPEED UP THE PROCESS OF SCIENTIFIC, TECHNOLOGICAL AND INDUSTRIAL DEVELOPMENT OF ANGOLA, HOW WOULD YOU ANSWER?

19. KNOWING THAT THE HIGHT TECHNICAL PERSONEL ARE THE BASIS FOR THE SUSTAINABLE DEVELOPMENT OF A COUNTRY, WHAT IS YOUR VISION ABOUT THE FORMATION OF HUMAN RESOURCES CONSIDERED IN PNCTI?

APPENDIX B

ORGANIC STATUTE MINISTRY OF HIGHER EDUCATION AND SCIENCE AND TECHNOLOGY[38]

Chapter I - MISSION AND TASKS

Article 1 (Mission)

The Ministry of Higher Education, Science and Technology, abbreviated to MESCT has the task of proposing the design, conduct, execution and control of Executive policy in the areas of Higher Education and Science and Technology.

Article 2 (Powers)

In pursuit of its mission are tasks of the Ministry of Higher Education, Science and Technology:

a) To propose and coordinate the implementation of policies of Higher Education, Science and Technology, as well as their modes of organization, financing and evaluation;
b) To promote the development, modernization, quality, competitiveness and the evaluation of subsystem Higher Education and the National Science and Technology System;
c) To encourage and develop activities in higher education and science and technology in national and international agenda, promoting the development of higher education and disseminate scientific and technological knowledge;
d) To encourage and support training and qualification of human resources in areas of higher education, scientific research and technological development;
e) To propose and implement internal scholarship allocation policies and external to nationals for attending higher education courses;
f) To promote equal opportunities in access to higher education and ensure high professional and scientific qualifications;

38 Adapted from the Site of the Ministry of Science and Technology.

g) To promote, in conjunction with other ministries, the development of technological capacity of the country, the information and knowledge society;
h) To promote the cooperation between the higher education subsystem and the National System of Science and Technology and between them with the productive system;
i) To promote and support technological innovation projects of interest to the development of the country;
j) To promote, encourage and support the establishment of consortia, networks and programs between institutions of higher learning, scientific research institutions;
k) To promote, encourage and support the creation of businesses open to innovation, technology demonstration and fundamental and applied research;
l) To coordinate actions of bilateral and multilateral cooperation, and to ensure the commitments of Angola in regional and international level in the field of higher education and science and technology subject to the duties of the Ministry of Foreign Affairs;
m) To promote the development of scientific and technological culture, stimulating and supporting dissemination activities, information and education and scientific experimentation;
n) To promote the continuous observation, assessment and inspection of higher education institutions and institutions that make up the National System of Science and Technology, under the law;
o) To approve the academic calendar of the subsystem of higher education and to monitor its implementation;
p) To ensure the coordination and the top-level sequence with the previous levels of the education system and demand strict compliance with the students access criteria;
q) To propose the creation and closure of public higher education institutions as well as the authorization of creation and closing of private higher education institutions and public-private;
r) To Approve the creation and closing of higher education;

s) Promoting the collection, registration, protection and development of traditional knowledge;
t) Develop proposals for the funding of educational institutions higher as well as scientific and technological activity, observing the rules for their application;
u) Encourage the participation of society in the implementation of the Executive in higher education and science and technology programs;
v) To ensure the accreditation, supervision, evaluation and safeguard mechanisms of quality and legal protection in the process of technology transfer;
w) To promote the policy of registration regulation of scientific works, patents and copyrights, resulting from scientific research and innovation technology;
x) Organize the National Spatial Data Infrastructure in the country through compilation and production of geographic information to support Institutions of higher education, scientific research and other related;
y) Exercise other activities as may be assigned by law and certain superiorly.

CHAPTER II - ORGANIZATION IN GENERAL

Article 3 (Organizational Structure)

The organizational structure of the Ministry of Higher Education, Science and Technology comprises top management central bodies, advisory bodies, instrumental support services, technical support, central executive services and protected organs.

1. central organs of top management:
   a) Minister of Science and Technology
   b) State Secretary of Science, Technology and Innovation
2. Consultative bodies:
   a) Conselho Consultivo;
   b) Conselho de Direcção;
   c) Conselho Nacional da Ciência e Tecnologia.
3. Instrumental support services:
   a) Minister office;

b) State Secretary of science, technology and innovation Office;

4. Technical Support Services:

a) General Secretary;
b) Legal Office;
c) Office of Studies, Planning and Statistics;
d) Exchange and International Relations Office;
e) Inspection Office;
f) Centre of Dcoumentation and Information.

5. Central executives services:

a) National Directorate for Scientific Research;
b) National Directorate for Technological Development and Innovation.

6. Protected Bodies:

a) National Center for Scientific Research;
b) CentroTecnológicoNacional;
c) National Fund for Scientific and Technological Development;
d) National Institute Accreditation Regulator and Transfer
e) Technology;
f) National Institute of Traditional Knowledge;
g) National Center for Capture and Satellite Image Processing

APPENDIX C

REMUNERATION FOR RESEARCHERS SCIENTIFIC STATUS

REPÚBLICA DE ANGOLA

Ministério da Ciência e Tecnologia

CONSELHO DE MINISTROS Decreto n.o 40/01 de 29 de Junho

Considerando que a ciência e a tecnologia são factores indispensáveis para o progresso de qualquer sociedade;

Considerando que o desenvolvimento e progresso tanto da ciência como da tecnologia dependem essencialmente do exercício da actividade de investigação.

Atendendo que as condições de guerra destruíram grande parte das infraestruturas de investigação científica a nível do País o que proporcionou a desmobilização dos poucos investigadores;

Convindo que a reactivação do sector de investigação implica necessariamente que se crie condições aliciantes para o fácil recrutamento e estabilização socio económica de investigadores e do pessoal auxiliar técnico e administrativo;

Tendo em conta que nas actuais condições do País a estabilização socioeconómica dos investigadores passa pela valorização e dignificação da profissão do investigador científico o que reclama que se estabeleça um estatuto remuneratório compatível;

Nos termos das disposições conjugadas da alínea h) do artigo 110.o e do artigo 113.o ambos da Lei Constitucional, o Governo decreta o seguinte:

Artigo 1 É aprovado o regime remuneratório do investigador científico anexo ao presente diploma do qual é parte integrante.

Artigo 2o É revogada toda a legislação que contrarie o disposto no presente decreto.

Artigo 3o As dúvidas e omissões que se verificarem da interpretação e aplicação do presente decreto serão resolvidas por despacho conjunto dos Ministros da Administração Pública, Emprego e Segurança Social e da Ciência e Tecnologia.

Artigo 4o Este decreto entra em vigor na data da sua publicação.

Visto e aprovado em Conselho de Ministros, em Luanda a 23 de Fevereiro de 2001.

REPÚBLICA DE ANGOLA

Estatuto Remuneratório do Investigador Científico

CAPÍTULO I

Artigo 1 (Objecto e âmbito)

O presente diploma aplicase ao pessoal investigador, cujo quadro de pessoal contenha as categorias descritas no artigo 2.o.

CAPÍTULO II

Artigo 2(Carreira de investigador científico)

Para efeitos do presente diploma, a carreira de investigador científico integra as seguintes categorias:

a. Investigador Coordenador;
b. Investigador Principal;
c. Investigador Auxiliar;
d. Assistente de Investigação;
e. Estagiário de Investigação.

Artigo 3.o (Reenquadramento do pessoal investigador)

O processo de reenquadramento dos quadros técnicos superiores envolvidos em actividades de investigação científica e desenvolvimento experimental realizarse-á de acordo com as regras estabelecidas no estatuto da carreira do investigador científico.

Artigo 4(Equivalência entre a carreira docente universitária e a carreira de investigador científico)

A transição da carreira docente universitária para a carreira do investigador científico farseá nos seguintes termos:

Ao professor titular é atribuída a equivalência de investigador coordenador;

REPÚBLICA DE ANGOLA

Ao professor associado é atribuída a equivalência de investigador auxiliar;
Ao assistente é atribuída a equivalência de assistente de investigação;
Ao assistente estagiário é atribuída a equivalência de estagiário de investigação.

Artigo 5. (Composição dos quadros)

A alteração da composição do quadro do investigador científico, nos organismos de investigação científica, a sua promoção e equivalência, serão efectuadas por despacho conjunto do Ministro da Ciência e Tecnologia, Ministro de tutela da respectiva instituição, do Ministro da Administração Pública, Emprego e Segurança Social, do Ministro das Finanças e do Ministro da Educação e Cultura.

CAPÍTULO III

Artigo 6.o (Regime de dedicação)

1. O pessoal investigador científico pode exercer as suas funções em regime de tempo integral (dedicação exclusiva) ou excepcionalmente em regime de tempo parcial, como colaboradores.
2. Ao investigador em regime de tempo integral é exigida a presença mínima na instituição de 30 horas semanais.
3. O pessoal investigador científico em regime de tempo parcial trabalhará na instituição de acordo com a carga horária que for acordada.

Artigo 7.o (Remuneração)

1. O pessoal investigador científico, em tempo integral com dedicação exclusiva, para além do salário, será remunerado com um subsídio de exclusividade, nos termos da alínea a) do artigo 8.o do presente diploma.
2. A remuneração do pessoal investigador científico em regime de tempo parcial farseá proporcionalmente ao número de horas de trabalho na instituição, tendo por base o vencimento da categoria e os direitos fixados para o pessoal investigador em tempo integral.

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Artigo 8.o (Subsídios e gratificações)

Para além dos subsídios e gratificações gerais da função pública, os investigadores poderão beneficiar dos seguintes subsídios especiais:

a) Subsídio de dedicação exclusiva – ao investigador em regime de dedicação exclusiva é atribuído um subsídio de 20% do salário-base;

b) Subsídio de risco e/ou contágio – ao investigador, que pela natureza do trabalho está sujeito a risco e/ou contágios, é atribuído, sobre o vencimento-base mensal, o subsídio de 30%.

c) Subsídio pela ocupação de cargo de direcção e chefia – ao pessoal de investigação que exerça funções de direcção e chefia nas instituições de investigação, é atribuído sobre o vencimento-base mensal o subsídio de:

- Director geral.....30%
- Director-adjunto.....20%
- Director da Estação Experimental.....15%
- Chefe de departamento 12%
- Chefe de repartição ou secção 10%

d) *Subsídio de orientação* – ao pessoal de investigação que exerça as funções de orientador de investigação, é atribuído, sobre o vencimento-base mensal, o subsídio de 15%;

e) *Prémio de Publicação* – ao investigador, autor ou co-autor de publicação técnica ou científica a 25% do vencimento-base mental.

APPENDIX D

Angola

The Global Competitiveness Index in detail

INDICATOR	SCORE	RANK/128
1st pillar: Institutions		
Property rights	3.5	111
Diversion of public funds	2.8	97
Public trust of politicians	2.3	70
Judicial independence	2.8	93
Favoritism in decisions of government officials	2.4	104
Government spending	2.5	105
Burden of government regulation	2.3	117
Business costs of terrorism	5.8	19
Reliability of police services	3.3	95
Business costs of crime and violence	2.4	119
Organized crime	4.5	76
Ethical behavior of firms	2.7	128
Efficacy of corporate boards	3.2	126
Protection of minority shareholders' interests	3.5	107
Strength of auditing and accounting standards	3.3	121
2nd pillar: Infrastructure		
Quality of overall infrastructure	1.9	121
Quality of railroad infrastructure	1.5	99
Quality of port infrastructure	2.5	98
Quality of air transport infrastructure	3.3	101
Quality of electricity supply	2.2	115
Telephone lines*	0.6	120
3rd pillar: Macroeconomy		
Government surplus/deficit*	4.3	15
National savings rate*	20.8	62
Inflation*	23.0	127
Interest rate spread*	55.0	122
Government debt*	484.3	114
Real effective exchange rate*	44.4	125
4th pillar: Health and primary education		
Business impact of malaria	3.0	125
Business impact of tuberculosis	3.6	119
Business impact of HIV/AIDS	3.4	105
Infant mortality*	154.0	128
Life expectancy*	40.0	125
Tuberculosis incidence*	309.9	102
Malaria incidence*	10,139.1	117
HIV prevalence*	3.9	111
Primary enrollment*	29.9	123
5th pillar: Higher education and training		
Secondary enrollment*	n/a	n/a
Tertiary enrollment*	1.0	118
Quality of the educational system	2.2	122
Quality of math and science education	2.4	122
Quality of management schools	2.1	127
Local availability of research and training services	2.2	125
Extent of staff training	2.7	111

INDICATOR	SCORE	RANK/128
6th pillar: Market efficiency		
Agricultural policy costs	3.3	101
Efficiency of legal framework	2.8	107
Extent and effect of taxation	3.8	36
No. of procedures required to start a business*	13.0	99
Time required to start a business*	124.0	118
Intensity of local competition	2.8	127
Effectiveness of antitrust policy	2.3	127
Imports*	61.1	35
Prevalence of trade barriers	5.0	38
Prevalence of foreign ownership	3.8	120
Exports*	80.0	10
Hiring and firing practices	3.6	80
Flexibility of wage determination	5.6	39
Cooperation in labor-employer relations	4.4	83
Reliance on professional management	3.5	111
Pay and productivity	2.8	123
Brain drain	2.8	78
Private sector employment of women	4.1	108
Financial market sophistication	2.2	119
Ease of access to loans	2.5	98
Venture capital availability	2.4	109
Soundness of banks	4.9	88
Local equity market access	1.8	126
7th pillar: Technological readiness		
Technological readiness	2.2	122
Firm-level technology absorption	3.3	125
Laws relating to ICT	2.2	120
FDI and technology transfer	4.7	80
Mobile telephone subscribers*	6.9	113
Internet users*	1.1	114
Personal computers*	0.2	123
8th pillar: Business sophistication		
Local supplier quantity	3.1	124
Local supplier quality	2.7	127
Production process sophistication	2.6	112
Extent of marketing	2.7	122
Control of international distribution	3.0	122
Willingness to delegate authority	2.3	128
Nature of competitive advantage	2.7	107
Value chain presence	2.2	125
9th pillar: Innovation		
Quality of scientific research institutions	2.5	122
Company spending on R&D	2.5	112
University-industry research collaboration	2.3	108
Gov't procurement of advanced tech products	2.9	117
Availability of scientists and engineers	2.4	127
Utility patents*	0.0	80
Intellectual property protection	2.6	106
Capacity for innovation	2.3	125

Source: http://www.mdic.gov.br/arquivos/dwnl_1257766509.pdf

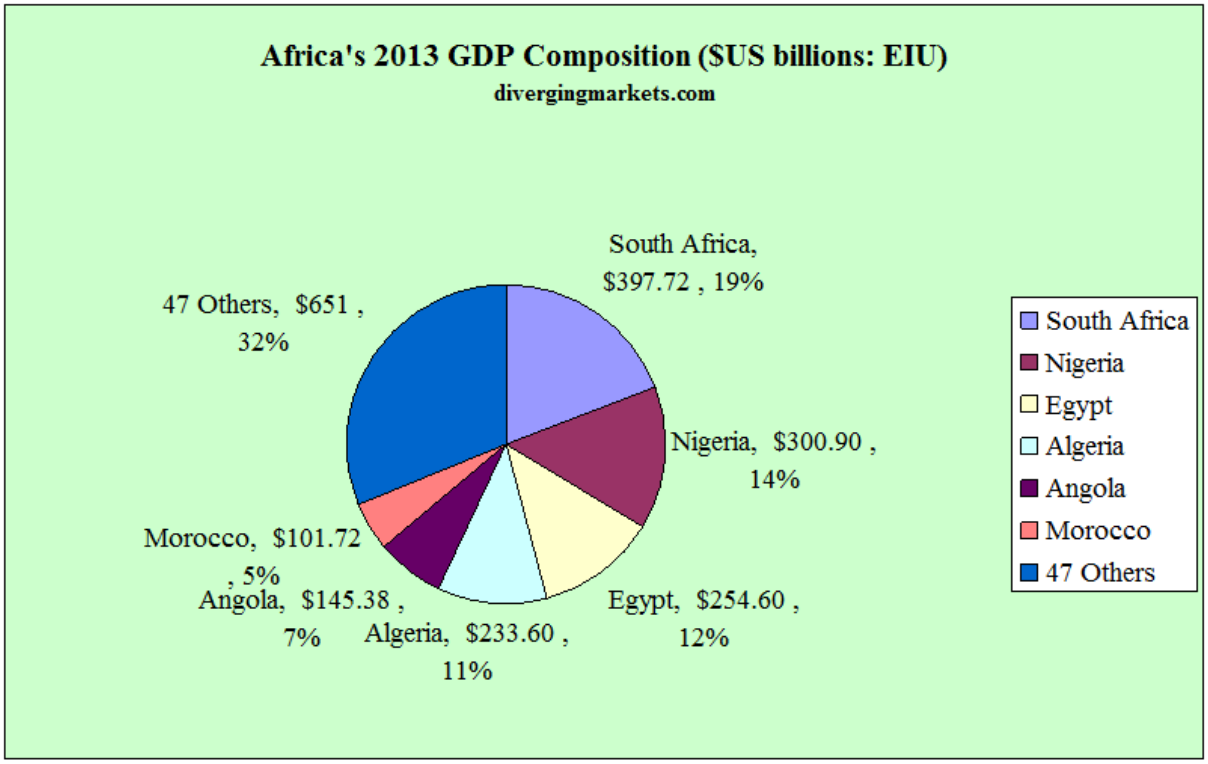
APENDIX E

Institutions of Scientific Research and Technological Development

01	Centro de Botânica	16	Instituto de Desenvolvimento Florestal (IDF)
02	Centro Nacional de Investigação Científica (CNIC)	17	Instituto Geógrafo e Cadastral de Angola (IGCA)
03	Centro Tecnológico Nacional (CTN)	18	Instituto Geológico de Angola (IGEO
04	Instituto Angolano de Normalização e Qualidade (IANORQ)	19	Instituto de Investigação Agronómica (IIA)
05	Instituto de Combate e Controlo das Tripanossomíases (ICCT)	20	Instituto de Investigação Veterinária (IIV)
06	Instituto de Defesa Nacional (IDN)	21	Instituto de Línguas Nacionais (ILN)
07	Instituto Nacional de Apoio às Indústrias Pesqueiras (INAIP	22	Instituto Nacional de Pesca Artesanal e Aquicultura (IPA)
08	Instituto Nacional de Café (INCA)	23	Instituto Nacional de Saúde Pública (INSP)
09	Instituto Nacional de Investigação e Desenvolvimento da Educação (INIDE)	24	Laboratório de Engenharia de Angola (LEA)
10	Instituto Nacional de Património Cultural (INPC)	25	Laboratório Nacional de Controlo de Qualidade (LANCOQ)
11	Instituto Nacional de Ordenamento de Território e Desenvolvimento Urbano (INOTU)	26	Museu Nacional de Antropologia (MNA)
12	Instituto Nacional de Investigação Pesqueira (INIP)	27	Museu Nacional de História Natural (MNHN)
13	Instituto Nacional de Geofísica e Meteorologia (INAMET	28	Arquivo Nacional de Angola
14	Instituto Nacional de Cereais (INCER)	29	Instituto de Desenvolvimento Agrário (IDA)
15	Museu Nacional de História Militar (MNHM)	30	Serviço Nacional de Sementes (SENSE)

Source: Ministry of Science and Technology. **Potencial Científicoe Laboratorial em Angola**. Direcção Nacional de Investigação Científica, 2011/2012.

APENDIX F



Source: Diverging Markets. http://www.divergingmarkets.com. Accessed in 10/21/2015.