Indigenous knowledge and science, technology, and innovation-driven systems for the healthcare industry in South Africa

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A research report submitted to the Wits Business School in the University of the Witwatersrand in partial fulfilment of the requirements for the degree of Master of Management in the field of Innovation studies

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DECLARATION

I, Mr Kagiso Moloto, declare that this research report is my own unaided work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Innovation Studies at the Wits Business School in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other University.

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ABSTRACT

The National Innovation System (NIS) of South Africa, which is predominantly driven by Science, Technology, and Innovation (STI) is entrusted to help elevate the developmental challenges faced by many South Africans. The integration of Indigenous Knowledge System (IKS) into the STI-driven NIS particularly for the healthcare sector could potentially provide solutions to eradicate the triple challenges of poverty, unemployment, and inequality. There is, therefore, a need for a robust institutional support system for a sustainable integration of STI and IKS which could ultimately help increase grassroots innovations.

It is worth noting that there is a general agreement between and amongst policymakers, scholars, and industry role payers that the performance of a country's economy, in a globalising knowledge economy depends to a large degree, on innovation and knowledge. In order to transform and enhance the responsiveness of the STI-driven NIS of South Africa, there is a need to explore additional mechanisms on how to incorporate Indigenous Knowledge (IK) and IKS into the formal STI knowledge systems. With proper policy formulation around this incorporation, South Africa can set itself on a path of development, driven by grassroots innovation for effective medicinal products that can be of benefit for the healthcare sector and South African citizens at large.

This research study aims to explore the extent to which IK, which is the main ingredient of African traditional medicines Research, Development, and Innovation (RDI) is integrated in the South African STI-led NIS for the healthcare system as part of addressing the socio-economic challenges faced by South Africans. The study also explores some of the challenges that that hinder the integration of IKS in the NIS of South Africa, particularly around African traditional medicine. By the use of document analysis and semi-structured interviews, the study suggests that, although there is room for improvement, there is to some extent integration of IKS in the NIS of South Africa from a policy point of view. Numerous challenges that hinder full integration of the IKS in the NIS are also discussed. The study recommends that in order for South Africa to speed track the integration of IKS in the NIS particularly for the healthcare sector, the National

Indigenous Knowledge System Office (NIKSO) could perhaps be upgraded into a full, independent institute or science council that primarily focusses on IKS.

Key words: National Innovation System. Indigenous Knowledge Systems. indigenous knowledge, African traditional medicine, grassroots innovation.

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- And my pillars of strength, my Wife Dr Tebogo Sole-Moloto and my daughter, Mmatsatsi Kamogelo Moloto.

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LIST OF ABBREVIATIONS AND ACRONYMS

4IR	Fourth Industrial Revolution
ARC	Agricultural Research Council
BioPANZA	BioProducts Advancement Network of South Africa
CSIR	Council for Scientific and Industrial Research
CoE	Centres of Excellence
DUI	Doing-Using-Interacting
DSI	Department of Science and Innovation
IS	Innovation System
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
NIS	National Innovation System
NIKSO	National Indigenous Knowledge System Office
NRF	National Research Foundation
OECD	Organisation for Economic Co-operation and Development
IPTTO	Intellectual Property and Technology Transfer Offices
R&D	Research and Development
RDI	Research, Development, and Innovation
SDGs	Sustainable Development Goals
SAHPRA	South African Health Products Regulatory Authority
STI	Science, Technology, and Innovation
TIA	Technology Innovation Agency
NDP	National Development Plan
UNDRIP	United Nations Declaration on the Rights of Indigenous Peoples
WHA	World Health Assembly
WHO	World Health Organisation
WIPO	World Intellectual Property Organisation

SAMRC	South African Medical Research Council
SARChI	South African Research Chairs Initiative
SME	Small Medium Enterprises
STEM	Science, Technology, Engineering, and Mathematics

CHAPTER 1: INTRODUCTION

This introductory chapter presents the outline of the research at hand by outlining the background to the study, problem statement and the purpose of the study. Consideration is given to the significance and limitations of the study. Lastly, the chapter provides definitions of terms used in the research study and ends with a layout of the entire study.

1.1. BACKGROUND

There is a general agreement between and amongst policymakers, scholars, and industry role payers that the performance of any country's economy, in a globalised knowledge economy depends largely on innovation and knowledge. Knowledge and innovation are key for any economy. The foundation of any knowledge economy is premised around a well-functioning National Innovation System (NIS) and knowledge and such knowledge which takes different forms, is accessible through interactions and is largely embedded in the NIS. Sources of new knowledge and innovations are to a large extent, the result of interactions between the following actors, namely the nation state, institutions responsible for Research, Development, and Innovation (RDI) and industry role players These actors are regarded as being key to any NIS (Tödtling et al., 2013).

There is also a general agreement between and amongst scholars and policymakers that the innovation process is an open and interactive process largely based on the exchange and transformation of both tacit and codified knowledge (Tödtling et al., 2013). Industry, institutions of higher learning (such as universities, science, and research councils, etc) and society at large, draw relevant knowledge for innovation from a broad variety of knowledge sources, which can be distributed between and across communities (Tödtling et al., 2013).

A NIS is regarded as a broad framework that identifies and maps out potentially relevant actors for innovation development. It is also viewed as a key driver to foster economic growth and development, tackle social challenges, and increase socio-economic resilience. The application of the NIS concept has become an important policy tool for developing countries to foster transformative change, eradicate poverty and reduce

unemployment and inequality (Hooli and Jauhiainen, 2018). The decision by the South African government in 2020 to change the name of the former Department of Science and Technology to the Department of Science and Innovation is testament that innovation has the potential to enhance productivity, economic growth, and societal development (Department of Science and Innovation, 2020).

Scholars such as Hooli and Jauhianen (2018) emphasise that Indigenous Knowledge (IK) and Indigenous Knowledge Systems (IKS) are potential supportive elements for developing a NIS. Patnaik and Bhowmick (2020) also suggest that an efficient ecosystem which supports innovation is dependent on IK. However, over the years, IKS has been overlooked and undermined, and extensive research has been done about this fact. IDRC and Lanill (1999), have also noted that IKS is usually perceived as old-fashioned, backwards, static, and unchanging. The degradation of IKS by the current Science, Technology and Innovation (STI)-driven NIS could be traced back, to a certain extent to the denial of African humanity, which dates back to colonialism, settler occupation, and human trafficking, which is also linked to a determined reluctance to decolonise the academy. In the context of South Africa, apartheid (which was the end product of both colonial and racist paradigms of domination), helped destroy IKS and African people's way of life and their environment. IKS, particularly in areas of African traditional medicine has had a range of preventative and curative methodologies including techniques such as biotherapy, cupping, spinal manipulation, bone setting, inoculation, and quarantine. Furthermore, surgery which included circumcisions, removal of inflamed tonsils is also central to African traditional medicines (Mokhutso, 2021).

In order to expand, transform, and enhance the responsiveness of the South African STI-driven NIS, particularly for the healthcare sector, there is a need to explore whether IK and IKS are well integrated into the current STI-driven systems. With proper policy formulation and planning, South Africa can set itself on a path of inclusive development and generation of new and effective IK-based medicinal products. There is a general growing acceptance and agreement that communities across Africa and Asia are using IK and IKS to empower themselves (Tharakan, 2014).

IK and IKS are concepts used by researchers and scholars to broadly capture bodies of knowledge and knowledge systems that are localised and unique to a given culture or society (Ellen and Harris, 1997; Ahmed, 1994). IK and IKS emerge from local communities and society's hands-on, know-how, do-how and accumulated experience that includes both locally generated, as well as externally borrowed and adopted knowledge (Ahmed, 1994). IK is often transmitted orally or through demonstration and imitation and it is learned by repetition, thus having characteristics of learning by *Doing* (as individuals build knowledge by engaging in production processes), learning by *Using* (where learning relates to the adjustment that actors must make to ensure that new technologies fit particular tasks) and learning by *Interacting* (where learning comes from working with other system actors) (Lundvall et al., 2011).

IK is also characterised and made unique by the cultural, social, and ideological context within which it is found. IK is always unique to a given culture and society and IKS can cover small indigenous communities to national systems. It is important to note that IK and IKS are separate from modern scientific knowledge systems that is often created by universities and research institutions and are STI-driven. International knowledge is created from modern scientific RDI which forms part of the global scientific and technological enterprise of human civilisation. Unlike IKS and IK, which tend to be verbally based and transferred, modern STI-driven knowledge can only be acquired through formal education for example, book learning, and it is improved by study, training, and mentoring. Thus, the dominant paradigms of modern scientific knowledge systems are reaffirmed learning, forced often at the expense and devaluation of IKS (Tharakan, 2014).

For developing countries, the learning by Doing-Using-Interaction (DUI) mode of innovation fits better when the aim is to integrate IKS and IK into the STI system. This arrangement would facilitate participatory development processes, foster inclusive socio-economic resilience of local communities, and enhance the comparative advantage of a developing country (Hooli and Jauhiainen, 2018). Embracing the role of IK will promote inclusive innovation, and therefore increase participation of IK-holders and practitioners in economic development activities.

1.2. PROBLEM STATEMENT

South Africa, like many other African countries are increasingly recognising the importance of IKS for sustainable community livelihood and development. However, existing STI-driven policy frameworks do not fully protect and promote the use of IKS. According to Mkhutso (2021) developing countries have given more preference to the STI-driven system that is being adopted by developed countries. This has made many developing countries especially in Africa to repeatedly doubt the potency and usefulness of IKS particularly African traditional medicines. There is continuous downgrading of African traditional medicine by developed countries, and organisations such as the World Health Organisation (WHO) continuously demonstrate the fact that, although IKS has suffered several downgrades, it continues to contribute to the healing of diseases, such as malaria, hypertension, diabetes, and obesity amongst others. Despite these facts, IKS is still not recognised for its solutions to the treatment of diseases. While studies have investigated the application of IKS in the treatment of health issues, little is known about how IKS can be incorporated in the modern STI system in the South African healthcare system (Mkhutso, 2021).

Scholars, policy makers and industry role players agree that the use of African traditional medicine, which aminates from IKS, is becoming increasingly important for RDI and healthcare systems in many developing countries. Evidence of significance of African traditional medicine is shown in the use of natural products from the herbal remedy, medicinal plants and functional foods and their constituents in the treatment of various diseases. In the case of South Africa, about 27 million South Africans, especially from the black population use African traditional medicine to treat a variety of ailments (Hughes et al., 2021). The findings by Hughes et al (2021), show that there is evidence of widespread reliance on African traditional medicine in South Africa among urban and rural residents. Rural individuals were shown to rely more on African traditional medicine and hypertension was found to be the most dominant disease among the study participants. In low-to-medium middle-income countries, with limited resources, African traditional medicinal processes can assist public health and community health workers address the unique challenges facing rural populations. It is important to note that although there is evidence of a huge number of South Africans who use African traditional medicine and a

high number of claims of cures of non-communicable diseases (such as diabetes, hypertension, and heart diseases), there is not enough tangible supporting evidence of efficacy. There is therefore an absolute need to validate these claims of cures aminating from African traditional medicines (Mothibe and Sibanda, 2019).

Many plant-based African traditional medicines show promising potential in efficacy, although the majority of plant materials used in these plant-based African traditional medicines and health products remain untested and their use unmonitored (van Wyk and Prinsloo, 2020). A study conducted by van Wyk and Prinsloo (2020), concludes that over-the-counter African traditional health products may have labels but do not include the necessary information regarding their bioactive compounds, the concentrations thereof, or their indications and contra-indications, and this may result in inconsistent dosage application and/or adverse effects. In addition to this problem, many African traditional medicines are sold unpackaged and unlabelled in informal shops and open street markets and are thus vulnerable to chemical and biological contaminants which may compromise the quality of plant-based African traditional medicines and herbal remedies. Therefore, scientifically proven guidelines for collection and post-harvest handling are necessary to prevent contamination of plant products used as African traditional medicines. These scientifically proven guidelines will help to ensure that consumers use safe and effective medicines and healthcare products. It is therefore crucial that RDI be conducted so that the interest of members of the public who use African traditional medicine are protected and more research data on the ingredients of African traditional medicines is recorded (Mothibe and Sibanda, 2019; van Wyk and Prinsloo, 2020). It is on this basis that this study aims to explore from a policy perspective whether IKS, particularly RDI on African traditional medicine is well integrated in the South African NIS. The study also aims to provide recommendation to policymakers on a way to speed up the integration of IKS in the STI-driven NIS for the healthcare system.

This research problem is also relevant to the real world and academia. In South Africa, the importance of IKS is evident by its inclusion in the adopted 2019 White Paper on STI and the Protection, Promotion, Development and Management of Indigenous Knowledge Act of 2019. There is however limited peer-reviewed research on policy interventions and

directives regarding integrating IK (including IKS) in the STI-driven system in the South African healthcare sector for socially impactful innovations (Hooli and Jauhiainen, 2018).

This research project carried out quantitative and qualitative content analysis of three policy documents to explore the extent to which IKS is integrated in the current STI-driven NIS system in South Africa. Semi-structured interviews were used to verify conclusions from the document analysis and to gather information that is not often reflected in official documents. The semi-structured interviews were used for triangulation to increase the reliability and validity of the conclusions from document studies but were also a source of information on the integration of IKS in the STI-driven system.

1.3. PURPOSE AND OBJECTIVES OF THE STUDY

The study aims to explore the extent to which IK is and can be integrated in the STI-led systems for the healthcare sector as part of growing socially impactful innovations in South Africa. The paper will argue that for a long lime, STI-driven systems adopted by developed countries, have been placed over the IKS and the study will also argue that IK and IKS are still very relevant and useful in the 21st century. According to Mokhutso (2021), the debate and intellectual discussion on the issue of "*innocent until proven guilty*" has favoured the current STI-driven system over IKS. The study sees this as a gap and attempts to bridge this gap by investigating additional mechanism and potentials for integrating IKS into the current STI-driven NIS.

The research objective is threefold namely:

1. To explore the extent to which African traditional medicine RDI, which is informed by IKS is integrated in the current STI-driven NIS of South Africa.
2. To explore the potential role of IK as an ingredient for socially impactful innovations.
3. To make policy recommendations on how the untapped IK can be integrated in the STI-led system of South Africa.

1.4. RESEARCH QUESTIONS

Research question 1: To what extent is IK, which is the main ingredient of African traditional medicines RDI integrated in the South African STI-led NIS for the healthcare system as part of addressing the socio-economic challenges faced by South Africans?

Research question 2: Why has there been a passive response by and from IK-holders, Research and Development (R&D) institutions, industry, and Government to integrate IKS in STI systems?

1.5. PROPOSITIONS

Proposition: IK which is the main ingredient of African traditional medicine RDI is to some extent integrated into the South African STI-led NIS for the healthcare system and has the potential to address socio-economic challenges faced by South Africans.

Proposition: The relationship between IK-holders, scientists and/researchers and policymakers is fragile.

According to Asamoah et al., (2023), support for indigenous traditional healing practices within western dominant healthcare systems, such as that of South, has been lacking due to in part to the history of colonisation and differences in worldviews, despite various policy recommendations that have been made. Some of the existing policy recommendations include Article 24 of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which states that "*Indigenous people have the right to their traditional medicines and to maintain their health practices including the conservation of their vital medicinal plants animals and minerals*. Mothibe, and Sibanda (2019), indicate that in South Africa, as in other countries where the dominant healthcare system is based on allopathic medicine, African traditional medicine has not been incorporated in the STI-led NIS. African traditional medicine is still regarded as "*complementary*", "*alternative*" or "*non-conventional*" medicines. Mothibe, and Sibanda (2019), further concede that, although African traditional medicines, which are derived from IK have not been fully incorporated in the healthcare systems and NIS, post-

apartheid government administrations view African traditional medicines and IKS as being integral and a recognised element in the healthcare system. It is important to note that under apartheid, and colonial South Africa, the practice of African traditional medicine was deemed unscientific and illegal. It was considered to be uncivilised, scientifically unfounded, backward and superstitious. The Witchcraft Suppression Act of 1957 and the Witchcraft Suppression Amendment Act of 1970 also declared traditional medicine unconstitutional.

Current scientific research which is being conducted on African traditional medicine in South Africa is driven by the desire for new drug discovery as well as the need to validate the use of African traditional medicines. The South African Government provides a platform within its NIS to conduct such RDI on African traditional medicines through collaboration with and between institutions such the Council for Scientific and Industrial Research (CSIR), Agricultural Research Council (ARC), Technology Innovation Agency (TIA), South African Medical Research Council (SAMRC), public universities as well as the Department of Science and Innovation (DSI). Funding from Government for IKS is facilitated through the National Research Foundation (NRF) and other parastatals organisations. Collaboration in research has shown progress in terms of bringing African traditional medicine into the STI fraternity. The DSI primarily continues to ensure effective coordination and responsiveness to industry and academia. The DSI also works closely with communities in flagship projects that have resulted in patenting and commercialisation of novel products. Through the Bio-economy Strategy, the DSI has led to the development, formulation, patenting, and commercialisation of products that are nutraceuticals such as. Moringa iced tea and Moringa vitamin water and cosmeceuticals such as skin tone evener (Mothibe and Sibanda, 2019).

In addition, a study conducted by Rasethe et al., (2019), suggest that the trading of herbal African traditional medicines generate economic opportunities for vulnerable groups living in peri urban, rural, and marginalised areas and serve as a valuable source of income for several households in different provinces of South Africa.

It is on this basis that the research study expects to find that, from a policy perspective, IK which is the main ingredient of African traditional medicine RDI is to some extent

integrated into the South African STI-led NIS for the healthcare system and has the potential to address socio-economic challenges in South Africa. In addition, the study expects to find that the reason why the integration of IKS in STI systems is slow, is because the relationship between and among IK-holders, scientists and/researchers and policymakers is fragile.

1.6. SIGNIFICANCE OF THE STUDY

The significance of the research study is twofold. The first relates to policymakers and the second relates to the research community.

Since the adoption of the IKS Policy in 2004 and the new White Paper on STI in 2019 by the South African Government, there is growing need to demonstrate the value of integrating IK and IKS in the STI-driven NIS. One of the DSI's legislative mandate is to implement and promote the Protection, Promotion, Development and Management of Indigenous Knowledge Act of 2019. The Act provides, for the protection, promotion, development and management of IK, the establishment and functions of the National Indigenous Knowledge Office and the management of rights of indigenous knowledge communities (Department of Science and Innovation, 2020). Grassroots Innovation through the use of IK (including IKS) is a potentially variable tool to eradicate the triple challenges of poverty, inequality and unemployment. The results of the study are of importance to policy makers given South Africa's aspirations to use IKS as a driver for economic and social development and the desire to emerge as a developed economy by 2030. According to Hooli and Jauhiainen (2018), more research around IK and IKS is required to guide policy formulation. This study will therefore contribute to existing literature by providing more information on integrating IKS into the STI-driven NIS.

1.7. DEFINITIONS OF KEY TERMS

Indigenous Knowledge (IK): IK is generally used synonymously with traditional and local knowledge to differentiate the knowledge developed by and within distinctive indigenous communities from the international knowledge system generated through universities,

government research centres and private industry (Department of Science and Technology, 2004).

Innovation: Innovation is a concept derived from the Latin word *innovare*, which means "*into new*". The simplest definition of innovation is doing something different. Innovation can also be explained as new idea, product, device, or novelty (Stenberg, 2017).

Innovation system: Innovation system is defined as a network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies or new knowledge either located within or rooted inside the boarders of a nation state (Mazzucato, 2011).

Grassroots innovation is intended to imply indigenous innovation from the informal sector by local communities without formal education and training (Gupta et al., 2003).

traditional medicine: the sum of all the knowledge and practices, whether explicable or not, used in diagnosis, prevention and elimination of physical, mental or social imbalance and relying exclusively on practical experiences and observation handed down from generation to generation, whether verbally or in writing.

Science: Science or western science is the system of knowledge which relies on certain laws that have been established through the application of the scientific method to phenomena in the world. The process of the scientific method begins with an observation followed by a prediction or hypothesis which is then tested. Depending on the test results, the hypothesis can become a scientific theory or 'truth' about the world (The Living Knowledge Project, 2008).

1.8. OUTLINE OF THE STUDY

The rest of the research report is organised as follows. The following chapter 2 will present literature reviews on the attempts to integrate IKS into the NSI, linkages between healthcare and IKS and integrating traditional medicine in the modern western healthcare system. Chapter 3 will present the theoretical and conceptual framework and discuss the NIS theoretical framework, IKS and grassroots innovation concepts. Chapter 4 will present the detailed research design, and the methodology employed in the study. A

qualitative research approach in the form of a content analysis and interviews were utilised. Chapter 5 presents research results and findings from the content analysis and interviews. Chapter 6 discusses the research findings and Chapter 7 provides key conclusions and some recommendation for South Africa to speed track the integration of IKS in the innovation system particularly for the healthcare sector.

1.9. CONCLUSION

This chapter introduced the focus of this study. It provided a background to the study and presented the problem statement and purpose of the study. The importance and benefits of the study are highlighted, and key terms were defined. This chapter also presented an outline of the structure of the rest of the research report. The next chapter presents a comprehensive review of literature that has been carefully synthesised to provide support for the study.

CHAPTER 2: LITERATURE REVIEW

2.1. INTRODUCTION

This chapter investigates the different studies and findings by different scholars in their attempts to integrate IKS into the NIS. The chapter will explore the different learnings and findings from academia focusing on the:

1. Integration of the IKS in the NIS.
2. Relationship between IKS and healthcare system.
3. Integration of traditional medicine in the modern western STI-driven healthcare system.

2.2. THE INTEGRATION OF THE INDIGENOUS KNOWLEDGE SYSTEMS AND THE NATIONAL INNOVATION SYSTEM

Jauhiainen and Hooli (2017), in their study entitled *Indigenous Knowledge and Developing Countries' Innovation Systems: The Case of Namibia* studied and scrutinised the development trajectory of the innovation system using Namibia as a case study, utilising documents, interviews, and studies relating to NIS development in Namibia from the 1990s until early 2016 as the research data. The two scholars learnt that IKS can support a variety of related innovation policies wherein IK is embedded in the NIS. An IK-included NIS can enhance the comparative advantage of a developing country despite the thinness of their STI-relevant organisations and actors in innovation creation. Jauhiainen and Hooli (2017), are of the view that the development path from IK to innovation is straightforward and is connected to an STI-based innovation. This includes the identification of appropriate IK, its further enhancement through systematic R&D and, later, its introduction to the markets. This view is however problematic because one simply cannot discover what has been there and has been always used. IK has its own system of innovation that IK-holders protect or preserve. There seems to be a problem of trying to validate indigenous science using *Scientifi*" or Western approaches. There seems to also be a denial and/or limited acknowledgment that IK is more advanced than the Western scientific system.

Jauhiainen and Hooli's (2017) research case indicates, that the integration of IK is not always due to enhanced related variety of innovation policy and generation of innovations but is also due to political reasons of supporting the rhetoric of national identity and nationalism.

The two scholars point out the risks of IK being treated universally as a common property shared by all inhabitants in developing countries. This is seen in the development and innovation policies of many countries that have introduced IK as an asset in the NIS. The research by the two scholars found that in the case of Namibia, IK was introduced as a rather general attribute that covers the whole country. In the case of Namibia, IK does not "*spread*" equally among residents and there are individuals who possess and develop IK more than others. In relating IK to the innovation system, the scholars recommend that policymakers and researchers need to pay attention not only to specificities of different local contexts but also to the individuals in these localities. In addition, it is recommended that there is a need to adjust the general and universal concept of NIS to include local contexts and practices and include bottom-up participation of IK-holders and local innovations in the innovation-related policies. This recommendation is also supported by Olaopa and Ayodele (2021), in their study entitled *Building on the strengths of African indigenous knowledge and innovation for sustainable development in Africa*. According to Olaopa and Ayodele (2021), if the current generation is to be guaranteed sustainable development and the needs of future generations safeguarded, the process needs to be bottom-up in a way that recognises the participation of the locale through the recognition and integration of their ideas as exemplified in their traditional and cultural practices. By promoting the utilisation of African IK and innovation, the African continent will have a great potential to solve the developmental challenges which are exemplified by unemployment, balance of payment, climate change, environmental degradation, poor resource management, hunger, and diseases amongst others. Sustainable development will therefore be facilitated through involving African locale by integrating African IK and innovation in policy-making processes. Olaopa and Ayodele (2021) also ascertain that, IK and innovation have the potential to facilitate the attainment of the Sustainable Development Goals (SDGs). For achieving the SDG 3: Good Health and Well-being, IK

can be a good driver and facilitator, for instance, IK provides and serves as an alternative to modern medicine.

The majority of people (approximately 80%), living in local areas or communities in developing countries particularly in Africa rely heavily on traditional medicine for healthcare requirements and challenges (Olaopa and Ayodele, 2021). The reason is due to limited access to modern medicine facilities, either because they are exorbitantly pricy and unfordable or are unavailable. In addition, Olaopa and Ayodele (2021) further learnt that IK and innovation can facilitate the process of human capital development. IKS remains a dynamic heritage of a society with intrinsic worth. The two scholars were also able to ascertain that governments have been playing a role in trying to support the development and utilisation of IK through government structures that aim at safeguarding it. Olaopa and Ayodele (2021) point out that the South Africa has adopted an all-inclusive IKS policy which considers various mechanisms for harnessing, utilising, and developing IKS and innovation for sustainable development. Both South Africa and Nigeria have established Centres for IKS and Intellectual Property and Technology Transfer Offices (IPTTO) in their universities for the promotion, preservation, and development of IKS (Olaopa and Ayodele, 2021).

In a study entitled *Indigenous knowledge systems and their relevance for sustainable development: A case of Southern Africa,* Noyoo (2007) argues that IKS can be an invaluable alternative to countries in Africa that are overly dependent on modern technology in their quest to raise the quality of life of their citizens. The main argument is that modernity has not always provided long-lasting solutions in the manner that Africa's natural resources have been harnessed, supposedly for the benefit of its inhabitants – the Africans.

Despite the increasing trend worldwide of integrating indigenous and scientific knowledge, there seems to be little stock taking of literature on lessons of bringing IK and R&D driven science together. Bohensky and Maru (2011), in their study entitled, *Indigenous knowledge, science, and resilience: what have we learned from a decade of international literature on integration* investigated the challenges of integrating IK and scientific knowledge. This study investigated this topic through inductive and deductive

content analyses of a sample of international literature and ascertained that an understanding of similarities and differences between IK and scientific knowledge and the benefits and challenges of integrating these two different knowledge systems is considered to be a prerequisite to knowledge integration. Through their literature analysis, Bohensky and Maru (2011), found that some literature acknowledges the differences between IK and scientific knowledge. For example, scientific knowledge is considered to be better equipped to detect a causal link between land use and threats to pastoralists livelihoods. On the other hand, there is recognition on the value of IK to science assessments, as a source of fine-grained, detailed information about local ecosystem services in areas where little formal knowledge exists. Bohensky and Maru (2011) were also able to identify several shortcomings of IK, such as its inability to evolve quickly enough to accommodate changes in several social systems and its tendency to lack relevance outside the specific indigenous community. From literature, Bohensky and Maru (2011) were able to identify tensions between IK and scientific knowledge. Some literatures suggests that IK is essentially scientific because it is gathered through empirical, experimental, and systematic methods, whereas scientific knowledge, by contrast, may be seen as narrow and naïve in the way it considers and defines questions. Much of the perceived incompatibility between science and other knowledge systems also arises from treating western science or IK as a singular entity when in fact both have multiple forms and dimensions (Bohensky and Maru, 2011).

Such differences do not necessarily impede integration. Findings by Bohensky and Maru (2011) suggest that IK methods and scientific methods are in fact complementary, in the following respects namely:

1. scientific knowledge is diachronic. It is concerned with the way in which something, has developed and evolved through time. For example, scientific knowledge is concerned and tends to collect short-term data over large areas, whereas IK is synchronic. It is concerned with knowledge that exists at one point in time. IKS tends to collect information over long time periods.
2. foci on averages (scientific knowledge) and extremes (indigenous knowledge).
3. scientific knowledge is usually quantitative, and IK is qualitative.
4. scientific knowledge relies on objectivity, whereas IK relies on subjectivity.

Bohensky and Maru (2011) were able to ascertain that IK and scientific knowledge are complementary or parallel rather than fundamentally incommensurable. Differences between them, can be resolved through collective approaches such as Australia's *caring for country* to nurture and maintain ecosystems, by blending conventional fire management regimes and Aboriginal systems of burning (Bohensky and Maru, 2011).

2.3. INDIGENOUS KNOWLEDGE AND HEALTHCARE

According to Rankoana, et al., (2015), the use of IK and practices in healthcare were first recognised by the World Health Assembly (WHA) in 1978 when member states were encouraged to utilise traditional medical practices in primary healthcare. IK is recently regarded as an important commodity in global healthcare development. The need to include local communities, their traditions and practices in primary healthcare was further highlighted by the WHO. The inclusion of local communities meant that their indigenous medical practices could be used to achieve primary healthcare goals because the IKS of healthcare and healing practices has had to meet the needs of the local communities over many centuries and continue to do so. Scholars such Rankoana, et al., (2015), acknowledge that, in order to make primary healthcare readily accessible and acceptable in the local communities, community participation would be essential. In addition, community involvement could enable communities to deal with their health problems in the most suitable ways, and community leaders could make rational decisions concerning primary healthcare and ensure appropriate support for health projects.

The study conducted by Rankoana, et al., (2015), entitled t*he use of indigenous knowledge in primary healthcare: A case study of Makanye community in Limpopo Province, South Africa* explored the importance of IK in meeting primary healthcare needs. The study also examined the IKS and practices which have preventive, curative and protective healthcare in Makanye community in the Limpopo Province. The study concluded that IK still plays a crucial role in meeting primary healthcare needs and could be incorporated into the mainstream healthcare to offer accessible, affordable, and comprehensive healthcare. The study also concluded that IK, used in primary healthcare embraces knowledge about the cause of diseases, knowledge of indigenous plant

medicine administered for preventive, protective and curative care, consumption of subsistence crops, medical ethnobotanical knowledge and the use of traditional medicines. The results of this study could be used to design community-based primary healthcare programmes which will draw from the local communities' knowledge systems of healthcare. The study recommended that further scientific research to explore mechanisms to validate IKS and adopt them to achieve the SDGs to ensure healthy lives and promote well-being for all people.

It is worth noting that knowledge of indigenous plant derived medicine is the oldest form of healthcare known to humans and the art of herbal healing is as ancient as human history. Traditional medicine continues to play a significant role in remedial, prevention and protection of life-threatening diseases such as malaria, tuberculosis and HIV and AIDS in developing countries, though no adequate scientific evidence has been documented about the safety, quality, and efficacy (Medical Research Council, 2008).

According to Lupuwana (2008), well established natural self-medication and healthcare product manufacturers such as Weleda, Lennon and others, have found a niche` in the marketplace with their brands occupying considerable shelf-space in pharmacies and healthcare retail stores in South Africa and such products are marketed as over-the-counter medicine or self-medication products. There is now a concerted effort by institutions of higher learning and science councils to conduct research on the integration of IKS and modern biotechnology applications in scientifically proven plants as the initial part of setting up a manufacturing supply chain in the health and nutrition arena on a platform of agriculture thus setting the stage for the establishment of viable commercial enterprises based in the rural areas with communities taking ownership of such initiatives.

Lupuwana (2008), further indicates that the healing properties of indigenous medicinal plant species have been handed down through generations of traditional medical practitioners and IK-holders who possessed some knowledge and a certain level of skills on indigenous medicinal plant therapies without necessarily being practitioners. In recognising the wide usage of traditional medicine in contemporary indigenous African societies, the WHO and the World Bank have documented that over 80% of the population in Africa use traditional medicine as the first line of defence. There is consensus

generally, that medicinal preparations developed from indigenous African medicinal plant species have found application in the management of a wide range of degenerative medical conditions and diseases with an ethos that is informed by a specific set of cultural beliefs and practices. However, due to the prevailing socio-economic and political dynamics worldwide, western-trained scientists, researchers and medical practitioners on the African continent still struggle to conduct large-scale validation of these medicinal entities through internationally recognised scientific methodologies and protocols (Lupuwana, 2008).

A study conducted by Lupuwana (2008), entitled *integrating natural sciences and indigenous knowledge systems for rural economic development: A model for rural enterprise development, health and nutrition initiatives in the Eastern Cape, South Africa,* demonstrate that the integration of IKS and natural sciences for sustainable rural economic development with the ultimate strategic objective of contributing towards the reduction of poverty, the improvement of the quality and cost-effectiveness of primary healthcare and adequate food production is feasible. The study recommends that the South African Government should accelerate the incorporation of African traditional medicine to complement the current national primary healthcare system which has been established to be highly inadequate in servicing the poorest sectors of the country's population. The incorporation of IKS would result in a gradual paradigm shift on the part of rural communities from a dependence mindset to one of self-reliance that is critical for sustainable rural economic development and the improvement of rural livelihoods. An all-inclusive approach that accords rural communities the status of equal partnership will also have a positive impact on the aspects of planning and implementation of programmes for sustainable rural economic development and biodiversity conservation. Furthermore, recognition of the rural communities as an integral part of the solution towards biodiversity conservation and the sustainable exploitation of natural resources was found to be a critical component for an effective strategy to ensure the continued survival of the endangered plant species.

The concept of *health* is another contentious concept that has different characteristics depending on the context in which it is used. According to Kraemer-Mbula, et al., (2015), the concept of *health* has distinctive characteristics and distinguishes itself from western

or modern views on what *health* means. Whilst in a western context, health may be identified as the state of being free from illness or injury, in the rural, traditional or IKS informed context, the context of *health* acquires a rather holistic perspective. One of its unique characteristics is the attention paid to not only the physical but also mental, emotional, cultural, and spiritual well-being. This is an important distinction that needs to be kept in mind, especially when examining the important role that IKS, in relation to healthcare play in the psychological, cultural, and spiritual dimensions of health. The concept of *health* is deeply rooted in local cultures and belief systems. In this regard, IKS and therefore African traditional medicine, is part and parcel of the way individuals and communities understand the nature of their health problems and the range of available solutions.

2.4. INTEGRATING AFRICAN TRADITIONAL MEDICINE IN THE MODERN WESTERN HEALTHCARE SYSTEM.

Traditional medicine is defined as the service performed through the utilisation of magico-religious acts and therapies (Adu-Gyamfi and Anderson, 2019). The WHO defines traditional medicine as "*the sum total of all the knowledge and practices, whether explicable or not, used in diagnosis, prevention and elimination of physical, mental or social imbalance and relying exclusively on practical experiences and observation handed down from generation to generation, whether verbally or in writing*." African traditional medicinal processes are embedded in IKS. According to Adu-Gyamfi and Anderson (2019), it is an accepted fact that African traditional medicine which is premised from IK, is medicine produced out of the IKS of Africans using natural products such as parts of plants, animals, spices, and spiritual resources such as spirits of the ancestors, deities, beliefs in totems and social codes, mixed with accepted practices of the societies in Africa.

There are various debates on African traditional medicine as distinct from western or biomedicine. western medicine which is sometimes referred to as modern medicine, biomedicine, scientific medicine, or allopathic medicine (Adu-Gyamfi and Anderson, 2019). Western medicine is commonly seen as any medical system that is based on

sound biomedical research associated with diseases of the physical body only, and is based on the principles of science, technology knowledge and clinical analysis. The difference between African traditional medicinal approaches and western approach to medical care is an organisational one. Western medicinal healthcare is usually delivered through hospitals, clinics, and dispensaries where the sick could be attended to in an organised manner while no such equivalence seemed to be part of the African traditional healing methods. Adu-Gyamfi and Anderson (2019), conclusively allude that what distinguishes African traditional medicine from western medicine is that it has a social and religious character, and places emphasise on prevention and holistic health of the entire society not just the individual. Therefore, African traditional medicine is scientific, social, and religious in character.

All medical systems whether African traditional medicines or western STI-driven medical systems have the same objectives of providing healthcare. The WHO and its member countries officially promoted the integration of traditional medicine into the overall national healthcare delivery system. According to Chi (1994), traditional system of medicine has and will still contribute to the medical needs of a huge number of people across the world, although the west has dominated most of the healthcare systems in the world. The experience of Chinese medicine's encounter with modern western medicine in Taiwan and its integration policy can provide some useful insights, lessons, and guidance for other countries such as South Africa who are considering integrating African traditional medicine into their national healthcare system. Below are six recommendations offered by Chi (1994) for integrating African traditional medicine in modern western healthcare systems:

1. **Promote communication and mutual understanding among different medical systems that exist in a particular country**. The lack of understanding will keep each medical system apart from the other and will provide a fertile environment for distrust and suppression. In order to promote mutual understanding, China, for example developed educational and training programmes that helped researchers and students understand the interphase between Chinese medicine and modern western medicine (Chi, 1994).

2. **Evaluate traditional medicine in its totality**. A common approach and starting point of integrating African traditional medicine into the modern western healthcare system is focussed on the research of traditional medicinal plants by physiological, pharmacological, and biochemical studies. In a similar approach, the WHO also advocates the application of modern scientific knowledge and technologies in evaluating traditional medicine. While this is a good starting point, the process of integration should go far beyond the evaluation of medicinal plants. Many traditional medical systems, such as Chinese medicine and Ayurveda medicine of India have more to offer than herbal drugs. This is often overlooked by modern western medicine which often threat the human body not as a whole system but focus on subsystems of the human body such as cells or genes. The strength of both traditional and modern western medicine can therefore be united into an integrated healthcare system. According to Chi (1994), in order to achieve this, a comprehensive knowledge and understanding of both medical systems is essential. In the process of integration, South Africa may find it beneficial to transform or adopt some or all parts of the holistic concept ingrained in African traditional medicine into modern western healthcare system.
3. **Integration at the theoretical and practical levels**. This recommendation by Chi (1994) is concerned with the definition and evaluation of a national integration policy. When a nation officially adopts the policy of integrating traditional medicine into its healthcare system, such policy should not be confused with the policy of coexistence. Many so-called healthcare integrational polices actually just tolerate traditional medicine. A common feature of these so-called policies of integration has few mechanisms for integrating training, education, practice, and RDI of both traditional and modern western medicine.
4. **Equitable distribution of resources between traditional and modern western medicine**. This recommendation by Chi (1994) deals with the public sector resource allocation related with integration. The exclusion or limitation of traditional medicine practitioners in policy making tends to promote distrust between traditional and modern western medicine practitioners. When a country is committed to an integrated policy, the definition and allocation of its medical resources should be determined

jointly by both traditional and modern western medicine practitioners. This is especially crucial when a significant proportion of its population uses traditional medicine. Failure to do so will create inequality in health resource allocation and discriminate against the health of those who use traditional medicine regularly (Chi, 1994).

5. **An integrated training and educational programme for both traditional and modern western medicine.** An integrated training and education programme for both traditional and modern western medicine is key. With a unified medical educational system which trains medical students to practice integrated medical care, most problems of inequitable resource allocation and the friction between the different medical systems will no longer exist. Only when most practitioners from different medical systems begin to cooperate with each other can further integration be contemplated (Chi, 1994).
6. **A national drug policy that includes traditional drugs**. The integration of traditional medicine into a national healthcare system should also include traditional drugs (Chi, 1994).

Asamoah et al., (2023), point out a different paradigm regarding the integration of traditional medicine RDI. Asamoah et al., (2023), argue that it would be challenging to truly integrate traditional medicine RDI into the current western STI-driven medicinal RDI because of the following two reasons:

1. What constitutes indigenous traditional healing includes a wide array of traditional and cultural practices beyond traditional medicine and includes relational components such as family and land and the integrative practice. Land-based activities such as ceremonies, culturally based counselling, harvesting, education and recreation are considered within this integrative practice, which cannot be easily integrated into the western healthcare medical RDI system.
2. Indigenous medical RDI worldviews are homogeneous and indigenous practices are adopted by different indigenous groups and societies. There needs to be an acknowledgement that different indigenous groups have different practices, which would require providing culturally appropriate healthcare within a particular community based on their specific beliefs and culture.

In order to support and integrate indigenous (African) traditional medicine RDI, Asamoah et al., (2023), propose the utilisation of a "*two-eyed seeing*" approach that would blend traditional and STI-driven medicinal RDI. This approach would help different stakeholders, particularly those that are pro-indigenous knowledge to see the strengths of indigenous medicines and the ways of knowing from one-eye, while the pro-western western STI-driven knowledge see the strengthens of western knowledge from the other eye. By blending the two approaches, all stakeholders will be able to see the benefits of both and be able to integrate both knowledge systems.

2.5. CONCLUSION

This chapter provided a brief review of relevant literature surrounding the research areas in this investigation. This chapter discussed the literature relating to the different learnings and findings from academia focusing on the integration of the IKS in the NIS, the relationship between IK and healthcare system and the integration of traditional medicine in the modern western healthcare system.

CHAPTER 3: THEORETICAL AND CONCEPTUAL FRAMEWORK

3.1. INTRODUCTION

In the last decade, research on innovation systems has been gaining ever more significance. Innovation system studies have proved to be highly relevant to technology and innovation policy. The primary purpose of this chapter is to provide a theoretical review on the NIS, IKS and grassroots innovation wherein some of the key assumptions underlying the aforementioned concepts are discussed and explained.

The chapter is followed by a conceptual framework that is built on the three theoretical concepts that will inform the study and aims to presents and articulate the specific constructs or variables that will be applied to the study and their interrelationships.

A conceptual framework is the presentation of qualitative research findings in a manner which improves our understanding of real-world phenomena. It is a set of interconnected concepts that describe a phenomenon effectively, allowing for a comprehensive understanding of its occurrence, whether it be a social, cultural, political, or environmental phenomenon, or a social behaviour phenomenon. Conceptual frameworks aim to provide only an improved understanding and do not offer explanations or predictions of an outcome (Edlmann, 2020).

3.2. NATIONAL INNOVATION SYSTEM THEORETICAL FRAMEWORK

After the end of the second world-war, post the colonialism era, the notion of i*nnovation* become increasingly established in the underlying dialogue of growth and modernisation, which otherwise was termed as *development*. Within a doctrine of the ideological, pollical and economic frame, innovation and development have secured almost a synonymous yet notable place, being the major means through which growth and productivity of a country could be enhanced. Scholars around the globe have studied innovation from that point and their studies of innovation have primarily focussed on the measurement and outcomes of science and technology activities, designing of innovative policies, dynamics in regional sectors and capacity building (Patnaik and Bhowmick, 2020). The past decades have also highlighted the pivotal role of innovation systems in long-term

economic development. Illustrated by the transformative growth of Singapore and South Korea between 1960 to present, the concept of the NIS has gained popularity in public policy. Innovations assist countries to design, build and deploy technologies that solve developmental challenges, empower communities, improve industrial competitiveness, and contribute to economic growth (Hlophe and Dlamini, 2018).

Research on the NIS emerged at the end of the 1980s and was pioneered by Friedrich List, Christopher Freeman, Richard Nelson, and Bengt- Åke Lundvall who approached the issue of systemic treatment of national innovation processes. The initial premises, introduction and building blocks of the NIS framework were originally presented by Friedrich List in his book titled the *National System of Political Economy* which analysed the conception of the National System of Political Economy. List was mainly concerned with the reasons why less developed countries particularly; Germany was technologically able to overtake England and criticised what he called *the cosmopolitan* approach of Adam Smith for being too focused on competition and resource allocation to the neglect of productive forces. List advocated not only protection of small industries, but a broad range of policies designed to accelerate or make possible industrialisation and economic growth and saw these small industries playing a significant role. Most of these policies dealt with learning about new technologies and their application. List's analysis went much further, indicating the need for governmental responsibility for education and training and for developing an infrastructure that supports industrial development. It is therefore thanks to the backing of List that Germany managed to develop one of the best technological education and training systems globally. Not only did List analyse numerous features of the NIS which are at the heart of contemporary studies (for example., education and training institutions, science, technical institutes, user-producer interactive learning, knowledge accumulation, promotion of strategic industries), he also put a lot of emphasis on the role of the nation state in coordinating and carrying through long-term policies for industry and the economy. Equally so, R&D systems, the development of science councils, national labs, institutions of higher learning and other institutions that advised governments. In his endeavour, List predicted that a lot of modern ideas of the NIS, including the importance of technological accumulation through

a combination of technology imports with local activities and pro-active interventionist policies to foster strategic small industries (Freeman, 1995).

While there seems to be no contention on the matter of the origins of the NIS theoretical framework, there is nevertheless something of a dilemma in identifying the individual who first coined the term. Christopher Freeman seems to credit Bengt-Ake Lundvall whereas Lundvall credits Freeman for introducing the term in the literature. A meticulous analysis of the published works reveals that there may be an amicable resolution to these courteous claims, or rather, disclaims. It appears that that the first explicit use of the NIS framework was, however, Christopher Freeman, in his book on Japan, where he emphasised the important role of government in developing a country's technological infrastructure (Manzini, 2012). Christopher Freeman, who is considered the "*founding father"* of the framework assumed a historical approach that is based on contemporary innovation theory with a focus on the interface between the production system and the process of innovation to explain the development process in Japan (Wangwe, 2003). Freeman's analysis of the innovation system saw the nation state and sub-systems playing a central role in the NIS. The arrangement of R&D and production in firms, the interfirm relationships and the role of the nation state were at the centre of Freeman's analysis which brought a deeper understanding of innovation processes, historical insight, and wisdom (Lundvall, 2007).

At the same period, Richard Nelson's analysis had a focus on the creation and origins of knowledge and innovation and viewed the NIS in a rather narrow sense of organisations and institutions involved in searching and exploring such as R&D institutions. Later Nelson, looking into the United States' NIS widened the scope of the Innovation System conceptual framework by including not only the description of the allocation of R&D activities and the source of funding but also the characteristics of industry and important firms, roles of institutions of higher learning and governmental policies which aim at stimulating and shape industrial innovation. Bengt- Åke Lundvall later focused on learning and innovation, realising that learning is mainly an interactive process which evolves users and producers in an interaction resulting in product innovations (Wangwe, 2003).

Components and activities of a National Innovation System

At the end of the second world war, technology policy was based on the linear model of innovation. It was assumed that if a country invested in scientific research, this would create the basis for new technologies and when these are transformed into new products, the results would bring economic growth. Empirical research on technical change and innovation latter demonstrated that this was not what actually takes place in innovation processes. It was shown that the innovation process takes a systemic approach and interaction between different actors is crucial (Muchie et al., 2003). Generally speaking, systems are made up of various components, linkages between these and the environment. This general composition is also applicable to the NIS, which consists of organisations, linkages between these and institutional environments (Balzat, 2002). The NIS conceptual framework takes a systemic view to innovation and, assumes that innovation happens holistically through learning and generation of knowledge between or within different actors or institutions, emphasising the relationship and inter-dependence of networks between or within these institutions or actors (Mazzucato, 2011). The term *systemic innovation* has been used to describe this systemic approach to innovation and could be traced back to the works of Chesbrough and Teece (2002), who explained how more and more innovations require collaborations across organisational boundaries to yield the necessary synergies. Nation states, industries and institutions of higher learning can no longer be taken for granted to produce the next generation of technologies, and that no single innovation can be successfully pursued outside the context of a whole innovation system (Chesbrough and Teece, 2008).

The key assumption of NIS defines the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies or new knowledge either located within or rooted inside the boarders of a nation state. The emphasis is diversity of actors whose interactions and collective agency leads to a single goal which is technological change. The NIS conceptual framework regards the network, interaction and relationships between the government, universities, public research institutions (for example., science councils) and industries, as the suitable level of analysis. as illustrated in ***Figure 1***. The NIS framework aims to addresses the relationship of actors in the system particularly, the state, enterprises, and institutions

responsible for generating knowledge. These actors of the NIS support and facilitate innovation by:

1. performing RDI.
2. Financing RDI.
3. Human capacity development.
4. Technology transfer and diffusion.
5. Promoting entrepreneurship, and.
6. Formulating innovation policy.

The latter is the responsibility of governments representing the nation state and the role of the nation state is to allow and create an enabling environment for industry and research organisations such as universities and science councils to interact in such a way that new knowledge is produced and diffused throughout the economy for structural changes and growth (Chen, 2010; Mazzucato, 2011).

One of the shortcomings of the NIS framework is the lack of its consideration to other actors that could have an influence on the NIS. It is inadequate to only consider actors like industry, research organisations, and the nation state as the sole actors of the NIS. More actors such as civil organisation could influence the NIS. In addition, cluster and network management organisations which support the specific interests of their members are becoming new forms of intermediaries which did not exist at the time of the development of the NIS framework (Warnke et al., 2016). Another element that influences and impacts the NIS relate to the process of internationalisation and globalisation characterised by multinational firms. Some of these big multinational firms are beginning to weaken their ties with their home nation states while beginning to spread their innovative activities. These changes are important as they challenge the traditional role of the NIS, but they do not make it less important to understand how NIS work, therefore these changes are considered minor (Lundvall, 1992).

The NIS can be inter-firm, regional, national, or global. The network is the unit of analysis (not the firm) in the meso perspective. The network consists of customers, subcontractors, infrastructure, suppliers, competencies or functions and links or relationships. The point is that the competencies for innovation are distributed throughout

a network of actors and their links or relationships. The causation is not linear – from science to large scale R&D to applications and innovations as discussed in above, rather it is full of feedback loops from market to technology, and from application to science (Mazzucato, 2011).

The fundamental activity in the NIS is knowledge generation through learning and learning is a social activity that includes interaction between people. In the second half of the 19th century, new developments led to entrepreneurs realising that in the new and fastest growing industries, learning by Doing, Using and Interaction (DUI) had to be accompanied or replaced by more professional and systematic process of innovation and learning (Freeman, 1995).

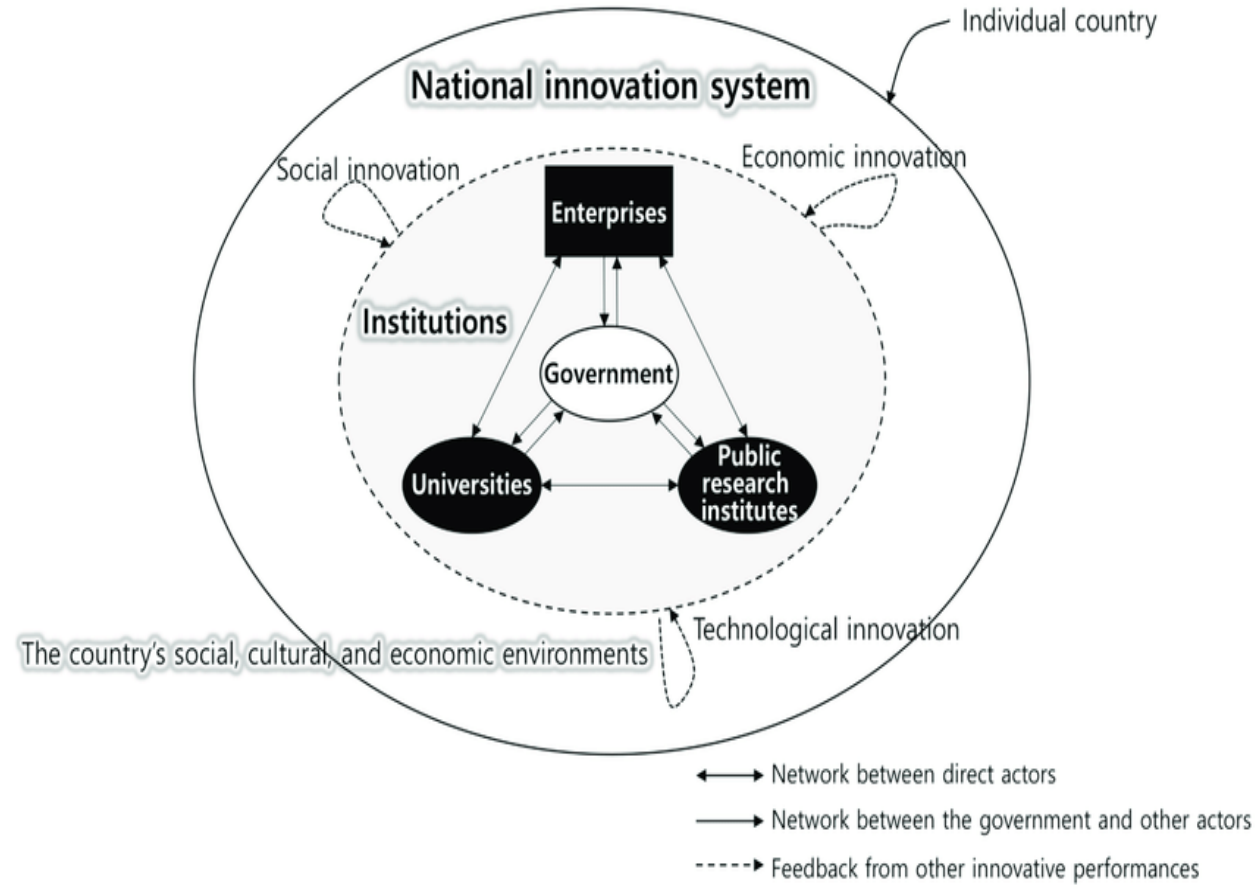

Figure 1: National Innovation System (Development of Innovation Studies in Korea from the Perspective of the National Innovation System 2022)

One of the biggest critics of the NIS is Eduardo Viotti who argues that the unwarranted use of the framework to developing countries could incur serious shortcomings. The reasons for this reside in the great difference that occur between the process of technical change in these economies and those of developed countries. The central problem is the fact that that NIS studies are largely focused on innovation and this in general is a phenomenon alien to developing countries. The process of technical change typical of these countries is essentially a process of learning, rather that of innovation. Developing countries should rather be analysed as National Learning Systems instead (Viotti, 2002).

Another important element of the NIS is its dynamic characteristics which is characterised by both positive feedback and reproduction (Lundvall, 1992). Innovation is a cumulative process which slowly makes use of pre-existing possibilities and components according to the principle of path dependence. Innovations may result in radical breakthroughs from the past rendering obsolete a substantial part of accumulated knowledge. Schumpeter referred to this dynamic process as creative destruction (Wangwe, 2003).

Notwithstanding, the above shortcomings, the concept of the NIS conceptual framework, allows us to focus on much more than just the number of new products or processes that have been brought about in a certain country, within a certain period of time. NIS needs to be understood in a broader sense. The concept does not deal with the innovation phase exclusively, rather, its emphasis on the main determents and the organisation of innovative action. Hence the entire innovation process on the national level, including the pre-commercialisation phase as well as the diffusion phase should be considered. With regards to the former phase, particular interest is given to those factor conditions (for example, the availability of highly skilled personal) that are essential to generate innovations, as well as to institutional framework of an economy. With regards to the latter, the diffusion phase, the knowledge base of national actors and again the institutional environment is equally important to allow for the adoption of new technologies developed abroad or in contrast to facilitate the dissemination of innovations created by domestic actors, throughout the economy. Accordingly, a NIS consists of organisations and institutions that influence each other in developing, absorbing, and diffusing innovations (Balzat, 2002).

The NIS has played a significant role in the development of South Korea, Singapore, Germany, Japan, and other countries, especially in the Organisation for Economic Co-operation and Development (OECD). Scholars such as Watkins et al., (2015) have shown that the development of these countries has been the result of evolving NIS. Nevertheless, the NIS is not a one size fits all concept, individual countries need to develop their own NIS based on their developmental goals. This takes into consideration the resources and endowments of the country, its economic development strategy, and social challenges (Hlophe and Dlamini, 2018).

3.3. INDIGENOUS KNOWLEDGE SYSTEMS

As emphasised in the previous section, knowledge is widely recognised as the key resources for development. The basic component of any country's knowledge system is its IK. IKS is a broad term that is used to describe various knowledge systems that are intimately linked with traditional communities (Zondi, 2021). According to the World Intellectual Property Organisation (WIPO), IK is "*a living body of knowledge, know-how, skills and practices that are formed, sustained and passed through generation of traditional communities, often forming part of its cultural or spiritual identify*" (World Intellectual Property Organisation, 2022). The term *traditional knowledge* is sometimes used in place of IK and furthermore, IK is the property of indigenous communities. Indigenous communities, in their interaction with the environments in which they have resided, have developed a body of knowledge, skills and creative expressions over centuries and this knowledge has formed an integral part of their cultural heritage. Indigenous communities are regarded as the true and rightful owners of indigenous knowledge (Zondi, 2021).

While IK is generally holistic in nature, it can be organised according to the functionality relating to different aspects of life. Katerere et al (2019), mention the following eleven categories of IK:

1. Indigenous traditional ecological knowledge – this is indigenous people's knowledge of local species diversity that includes knowledge of plants, animals, etc and their habits.
2. Indigenous agricultural knowledge – this includes knowledge of agrobiodiversity such as crops and animal diversity.
3. Indigenous meteorology – this is the knowledge indigenous people have on weather forecasting and climate. Indigenous meteorology incorporates the indigenous ways of interpreting and predicting weather and the application in decision making.
4. Indigenous cuisine – this includes food preparation, preservation, food diversity and nutrition.

5. Indigenous technologies – this pertains to indigenous metallurgy (metal mining smelting and processing), textiles, crafting (wood carving and weaving) and architecture (building of infrastructures, and indigenous designs).
6. Indigenous cosmetics – this pertains to indigenous oils and beauty creams.
7. Indigenous traditional medicines - these include herbal medicines, ethnoveterinary medicines, traditional pharmacology, and traditional medicinal practices.
8. Indigenous governance systems – these are the indigenous or traditional institutions and systems of governing people, land, and natural resources. Indigenous governance structures and systems include indigenous laws, norms, and collective decision-making processes.
9. Indigenous cultures – these include indigenous or traditional music, dance, poetry, art, craft, and painting.
10. Indigenous philosophies – these are embedded in proverbs, idioms, taboos, stories, and principles such as the philosophy of Ubuntu.
11. Indigenous spirituality or religion – this includes indigenous religions, rituals and humanity, morality, compassion, and gentleness. Such spiritual values are conveyed through culture, myths, proverbs, songs, folk tales, mediums/ancestors, or elders.

Over millennia, indigenous people have developed and sustained extremely practical systems of knowledge and behaviour. For a host of political and historical reasons, indigenous people tend to suffer from neglect and discrimination. In addition, there seems to be no standard definition of IK. However, there is a general understanding of what it means. Some people define IK as the local knowledge that is unique to a given culture or society. Some have defined it simply as local knowledge, while others have expressed it as folk knowledge, information base for a society, traditional wisdom or when it applies to the physical environment as traditional ecological knowledge. Regardless of the definition, there is a consensus that various communities, cultures, and societies have IKS. IKS is defined as the knowledge acquired over generations by communities as they interact with their environment. It mainly refers to a system of understanding one's environment in the broadest sense. IK is the basis for local level decision making in agriculture, healthcare, food preparation, education, natural resources management and a host number of other activities in rural communities, commonly held by communities or

individuals. It is tacit knowledge that is often difficult to codify, embedded in community practices, institutions, relationships, and rituals. IK is stored in people's memories and activities. It is expressed in the form of stories, songs, folklore, proverbs, dance, myths, cultural values, beliefs, rituals, community laws, local language, taxonomy, agricultural practices, equipment, materials, plants species, animal breeds etc. IK is shared and communicated orally, and through culture, indigenous forms of communication and organisation are vital to local-level decision-making processes to preserve, develop and spread IK. IK represents accumulated experiences, wisdom, and know-how, unique to a given culture, society and or community. IKS and IK are very important conceptual framework because indigenous people significantly contribute to global knowledge for instance in medicine and veterinary medicine with their intimate understanding of their environments. IK is developed and adopted continuously to gradually changing environments passed down from generation to generation and closely interwoven with people's cultural values. IK is also the social capital of the poor and is their main asset to invest in their struggle for survival. In the emerging global knowledge-based economy, a country's ability to build and mobilise knowledge capital is equally essential for sustainable development as the availability of physical and financial capital. IK forms the basic component of any country's knowledge system. IK provides problem-solving strategies for local communities especially for the poor and represents an important contribution to global development of knowledge. The livelihood of the rural poor depends almost entirely on specific skills and knowledge essential for their survival. In the developmental process, IK is relevant in various sectors and strategies such as: agriculture, traditional medicine, healthcare, and poverty alleviation (Jaiswal, 2019).

At the foundation of several interpretations, is an agreement that IK is an alternative to mainstream, Western styled or "*modern*" understanding of knowledge. IK covers all fields of human endeavour including, but not limited to, agriculture, environment, pharmacology, healthcare, trade and economics and political systems. Historically, IK has been arrogated derogatory descriptions such as *primitive, backward, savage, rural, unscientific*, and so on. IKS is often repudiated for its lack of *universality*, a concept ascribed only to Western science. IK is to a certain extend culture-specific, whereas formal, western scientific knowledge is *de-cultured*. In the academic and research space,

IKS has been dismissed as archaic, old, and symptomatic of backwardness. The result is that the academia celebrates western-styled knowledge and belittles IK (Ezeanya-Esiobu, 2019). Asamoah et al., (2023), is also of the view that the indigenous holistic model to healthcare often employs traditional (African) healing practices such as rituals which are often viewed as "*unscientific*" to the western biomedical approach. Within the western biomedical worldview, what constitute "*scientific*" is measurable therapeutic potency and outcomes of therapy in that "*if we cannot measure it, it is not real*". However, indigenous healing's epistemology, philosophy and logic have long been a system of knowledge and pedagogy understood only by indigenous peoples.

As a result, promoters of IK and IKS, argue that the western-styled worldview of knowledge has, since its introduction in non-western societies lacked an understanding of the holistic nature and approach of non-western ways of knowing and knowledge generation. It has further been argued that the western perception of IK as mere repetition of practices without any theory to explain them is a depiction of western cultural and intellectual arrogance. In the perception of non-western scholars and IK-holders, a traditional healer or IK-holder, who is able to cure a particular disease using specific herbs has the knowledge and theory of plant species and other characteristics. Promoters of IK further argue against the view that IKS lacks universal usage because of its localised and community-based nature. They argue that this is a simplistic view of the nature of knowledge production and use because all knowledge systems are initially created and utilised locally, but with the potential to be used universally. The western-styled knowledge system has become more dominant than IKS hence the perception of being universal and this is due to the historical power relations introduced by colonialism (Kaya and Seleti, 2013).

Characteristics of Indigenous Knowledge

Ellen and Harris (1997) provide ten characteristics of IK which are discussed below:

1. IK is local, rooted to a particular place and set of experiences, and generated by people living in those places.
2. IK is transmitted orally, or through imitation and demonstration.

3. IK is the consequence of practical engagement in everyday life and constantly reinforced by experience, trial, and error.
4. IK is empirical rather than theoretical knowledge due to characteristics mentioned at (1) and (3).
5. repetition is a defining characteristic of tradition, even when new knowledge is added.
6. IK is constantly changing, being produced, and reproduced, discovered as well as lost.
7. IK is characteristically shared to a much greater degree than other forms of knowledge and it is usually asymmetrically distributed within a population, by gender and age, and preserved through distribution in the memories of different individuals, and specialists may exist by virtue of experience, ritual, or political authority.
8. Although IK may be focused on particular individuals and may achieve a degree of coherence in rituals and other symbolic constructs, its distribution is always fragmentary, it does not exist in its totality in any one place or individual.
9. Despite claims for the existence of culture-wide abstract classifications of knowledge based on non-functional criteria, where IK is at its densest and directly applicable, its organisation is essentially functional, and.
10. IK is characteristically situated within broader cultural traditions, hence separating technical from non-technical, rational from nonrational, is problematic.

Importance of indigenous Knowledge

Indigenous peoples have made significant contributions to global knowledge, for instance in medicine and veterinary medicine with their intimate understanding of their environments. IK is developed and adapted continuously to gradually changing environments, passed down from generation to generation and closely interwoven with people's cultural values. IK is also the social capital of the marginalised, their main asset to invest in their struggle for survival, to produce food, provide shelter or achieve control of their own lives. In the emerging global knowledge economy, a country's ability to build and mobilise knowledge capital is equally essential for sustainable development as the availability of physical and financial capital.

According to Rao (2006), IK forms the basic component of any country's knowledge system. IK provides problem-solving strategies for local communities, especially for the poor and represents an important contribution to global development of knowledge. Muchie et al., (2003), also concedes that the most fundamental resource in the modern economy is knowledge and accordingly, the most important process is learning. Over the last decade, the attempt to get a better understanding of the knowledge-based economy has created a more satisfactory theoretical foundation for the NIS. Knowledge is therefore becoming more and more widely recognised as the key resource for development. In order to enhance the NIS, it is therefore necessary for any country to understand the role and importance of IKS.

It is also worth noting that the livelihood of rural poor depends almost entirely on specific skills and knowledge essential for their survival. In the development process, IK is relevant in the healthcare sector namely, animal husbandry and ethnic veterinary medicine; primary healthcare, preventive medicine, and psychosocial care; community development; and poverty alleviation. IKS is however at risk of becoming extinct due to rapid changing natural environments and fast pacing economic, political, and cultural changes on a global scale. Local practices vanish, as they become inappropriate for new challenges or intrusion of foreign technologies or development concepts that promise short-term gains or solutions to problems without being capable of sustaining them (Rao, 2006).

3.4. GRASSROOTS INNOVATION

Grassroots innovation and innovators have been around for centuries. The earliest humans were grassroots innovators who created new inventions, ideas, and systems (Bernstein et al., 2021). According to a prominent scholar who has written extensively on grassroots innovation by the name of Prof Anil Gupta, maintains that NIS have for a long time ignored the innovations that emanate from traditional or indigenous knowledge in the informal sector. The network of institutions supporting R&D have now become part of the larger system and expenditure on R&D and have become determinant of the innovation potential. The creativity of the informal sector is neither taken note of nor ever measured

to qualify the contribution it could make to the innovation-ecosystem. The NIS does not fully include or prioritise the creativity of grassroots innovations and innovators are supposed to adopt the ideas and innovations developed by the formal system (Gupta, 2013).

While classical innovation tends to focus on large scale, institutional-backed technological advances, grassroots innovation, which is sometimes referred to as *social innovation*, is understood through the everyday practice of individuals. Grassroots innovation is a particularly conditional subject, one that varies significantly between and within countries. Grassroots innovation can be described as home-grown inventions or novelties created by ordinary, less educated people, to address challenges that directly or indirectly influence their lives and communities. Formally, grassroots innovation is defined as indigenous solutions, created by actors in civil society and supported by limited resources, which aim to address local solutions and often achieve sustainable development. The inclusion of *indigenous solutions* is inspired by Prof Gupta, who described grassroots innovation as informal, local and indigenous innovations by the people. Grassroots innovation could also be described as *informal phenomena* including different network architectures and a broad diversity of social actors (Bernstein et al., 2021). According to Maldonado-Mariscal (2022), grassroots innovation includes those new, bottom-up and general solutions that are based on local situations, interests and values of a local group or an indigenous community. Indigenous communities and IK-holders are identified as actors responsible for the creation of grassroots innovations.

Grassroots innovations are however still considered vague in both academia and policy studies, being interchangeably used, and overlapping with other types of community-led innovations — such as social innovation, sustainable innovation, inclusive innovation, frugal innovation, below the radar innovation, pro-poor innovation, and innovation for the bottom of the pyramid. This has unwittingly compounded this challenge of not having a universally accepted definitions of grassroots innovation (Daniels, 2014; Ng, et al., 2022). In a review conducted by Maldonado-Mariscal (2022), it was shown that there is limited literature that specifically addresses grassroots innovation and its place within broader discourses of innovation.

Building on research, knowledge and evidence gathered over the last three decades, Prof Gupta has however made advances to help provide conceptual clarities on the characterises of innovation from, for and by grassroots innovators. While grassroots innovations dominated early human history, the current focus has shifted from grassroots innovations to higher profit, collective innovation efforts undertaken by private institutions, often driven by market-based incentives. Prof Anil Gupta notes that much of the literature is on the innovations for the people. Much less is available on innovations by the people. Grassroots innovations are special because they are often driven by curiosity, altruism, and the desire to solve common societal problems. These unique drivers of grassroots innovation yield benefits that are more directly shared with their fellow community members (Bernstein et al., 2021). In addition, according to literature, the role of innovation at grassroots in contributing to economic growth and development is well researched and documented. This is especially important in sub-Sahara Africa where despite rapid economic growth recorded over the past few decades, poverty, inequality, and unemployment continue to effect sustainable economic growth. By involving non-governmental organisations, formal sector, individuals in the informal sector and local people collaborating with industry, innovation at grassroots level has been shown to respond to local problems, improve the quality of life and support sustainable development (Daniels, 2014).

Grassroots innovations are oriented toward the identification and support of social and ecological ventures developed in and for marginalised rural communities. Grassroot Innovations are premised from locally available IKS and by a group of like-minded innovators who undertake informal efforts to resolve localised problems. Grassroots innovations occur when grassroots innovators use their IK, skills, and experiences to create economically viable innovative solutions that benefit the grassroots communities (Ng et al.2022; Maldonado-Villalpando and Paneque-Gálvez, 2022; Singh et al., 2021). Based on evidence collected by Kraemer-Mbula et al., (2015), it is concluded that although it may sound contradictory, traditional healers and IK-holders have proved to be effective agents for grassroot innovation and change in rural areas as they command authority in their communities, function as psychologists, marriage and family counsellors, physicians, and legal and political advisors. Traditional healers and IK-holders also

function as legitimate interpreters of customary rules of conduct, morality, and values. The healthcare they provide is customer-based and tailored to meet the needs and expectations of the client paying special respect to social and spiritual matters.

3.5. CONCEPTUAL FRAMEWORK

South Africa was one of the first emerging countries to formally adopt the NSI theoretical framework as a way of thinking holistically about innovation. The democratic government began a period of comprehensive STI policy development. It adopted the 1996 White Paper on Science and Technology, the 2002 National Research and Development Strategy, and the Ten-year Innovation Plan for South Africa (2008–2018). Various sectoral and cross-cutting STI strategies were also adopted in areas such as IKS, advanced manufacturing technology, biotechnology, and human resource development. The organising framework for the 1996 White Paper, as well as other STI policies adopted the NIS contextual framework as a set of South African institutions, organisations and policies that interact constructively in the pursuit of a common set of social and economic goals and objectives for the South African government (Department of Science and Innovation, 2019).

Innovation, invention, and creativity, which are employed through the NIS are mayor drivers of growth and advancement in nations across the globe. A country that invests in creating an enabling environment for its human capital to operate at optimum, usually receives yields by way of highly innovative products and services. Localised innovations are a strong and driving force for economic growth. The implication is that, when a product is developed in a particular environment, the innovation needed to improve that product or develop offshoot from that product, is more likely to be generated in environments similar to where the original product was created. In essence, the idea of transferring technology is not sustainable since it is highly unlikely that improved technology will easily take root in a foreign environment and form a basis for more innovation in that territory. It is in this regard that appropriate technologies need to be situated in the pre-existing technological or environmental reality of the innovation. This is where IKS come to the fore (Ezeanya-Esiobu, 2019).

Although the focus for any NIS is on the creation of new or existing knowledge and innovation (whether indigenous or not), the aim is not always on economic growth or social development but on inclusive development. Increasing concern regarding the flows in the mainstream innovation has given rise to a search for alternative modes of innovation and this is where grassroots innovation comes to the fore. For instance, most literature on innovation has been enriched with studies of technology transfer, technology adoption and technology building, which in turn form part of an initiative within the domain of technology development and dissemination. Differentiation between mainstream innovation with innovation at the grassroots level is often made. The former (that is mainstream innovation), within the market-based framing is primarily involved in the production of goods and services for economic growth and is profit oriented, while the latter (that is grassroots innovation) is involved in the framing of social justice, empowerment, and social sustainability, which facilitate the inclusion of the poor into the economic and innovation systems (Patnaik and Bhowmick, 2020). IK and grassroot innovation cover all fields of human endeavour including, but not limited to, agriculture, environment, pharmacology, wealth, trade and economic, political systems and the healthcare system.

In 2019, the South African Cabinet adopted the new White Paper on STI – the highest STI policy document which sets out several policy intents, for a vibrant, inclusive, coherent, and optimally coordinated NIS that optimally contribute to South Africa's socio-economic and environmental priorities. The 2019 White Paper on STI sets the long-term policy direction for the South African government to ensure a growing STI-driven system in a more prosperous and inclusive society. A Decadal Plan (Ten Year Plan) has also been approved by Cabinet and is currently being operationalised by the DSI. This Plan is an implementation policy document for the new White Paper, and it is not just for the DSI, the South African NIS, but it is a Plan for the entire country. The Plan is premised on advancing a whole-of-government approach (and ultimately a whole-of-society approach) to innovation in South Africa. The Decadal Plan philosophy is to continue building the South African NIS, while at the same time pivoting the NIS to have a greater impact on addressing South Africa's national priorities. The Decadal Plan's objectives are not just to grow the science system, but to and increase socioeconomic development

and growth. The Plan identifies and focuses on large scale innovation programmes that address specific South African challenges in the healthcare systems amongst others (Department of Science, Technology and Innovation, 2022).

Healthcare is a basic human right guaranteed by the South African Constitution. Section 27 of the Constitution provides that everyone has the right to access healthcare services, and no one may be refused emergency medical treatment. Yet, South Africa stands at a crossroads concerning tremendous societal health challenges. With less than 1% of the world's population, the country has a disproportionately high HIV and tuberculosis burden. Healthcare services are further burdened by a rise in cardio-vascular and other non-communicable diseases. In addition, the homicide rate in South Africa is five times the global average, indicating a need for stronger mental health services. The challenge has been described as a lethal cocktail of four colliding epidemics: maternal, new-born and child health; HIV/Aids and tuberculosis; non-communicable diseases; and violence and injury. Innovative tools and services are needed to tackle the quadruple burden of disease that dominates the health landscape and the socio-economic disparity between urban and rural areas. Covid-19 demonstrated that South Africa (like the rest of the world) can no longer depend on a single health system intervention (dominated by the current STI-driven system), especially where pandemic preparedness is central. Endowed with unique megadiversity and rich in IK related to medicinal plants, South Africa is well positioned to develop a sustainable and complementary IK-based healthcare system. In line with its inclusivity principle, the Decadal Plan embraces two STI health systems, prioritising both a contemporary 4th Industrial Revolution precision and digital approach, and IK-rooted health innovation responses. The IK-based healthcare innovation approach seeks to mainstream African traditional medicines for the treatment of all priority health conditions, including cancer, diabetes, tuberculosis, HIV/Aids, and emerging and re-emerging infectious diseases like COVID-19. There is therefore a need to prioritise the integration of African traditional medicines into the health system. As part of the Decadal Plan, South Africa's African herbal medicine interventions will need to focus on new regulations (in collaboration with the South African Health Products Authority), building capacity for clinical trials, the registration of medicine for clinical application, industrialisation, and commercialisation. The establishment and building of capacity in

best practices and standards will need to be a prioritised. This approach will support both inclusive innovation and manufacturing value-chains, where IK-holders and IK-practitioners will be co-owners of industries across the value chain. The Decadal Plan will also need to facilitate the development of a clinical medicines curriculum for higher education degrees, piloting the use of primary, secondary, and tertiary health facilities to bring proprietary IK-based medicines into the current national healthcare system (Department of Science and Innovation, 2022).

It is noteworthy that South Africa is amongst the leading countries that have a wide variety of untapped IK and high utilisation of IK-based medicines. Like other African countries, South Africa has a pluralistic system of healthcare, in which modern medicine practice coexists with other non-conventional health systems. These include a variety of indigenous systems based on traditional practices and beliefs. It has been estimated that 80% of Africans use IK-based medicines, compared to 60% of the world's population in general and these medicines are used for many ailments and conditions including HIV/AIDS, diabetes mellitus, hypertension, pain, gynaecological disorders, mental disorders, and asthma. It is also reported that in seeking health, African people consult IK-holders or traditional healers first before a conventional health provider. A large proportion of the African population make use of the dual health care system, in which both the conventional and IK-based medicines are demanded depending on the ailment (Mordeniz, 2019).

According to the United Nations Development Programme (2020), STI policy in South Africa has not been adequately inclusive and has impacted grassroots innovation. Grassroots innovations are a form of inclusive innovation that solves personal and community challenges of marginalised and low-income indigenous communities. Since grassroots innovators, have a focus on providing solution to local problems, their role in the innovation system is to build more sustainable, cohesive, and inclusive societies. It is on this basis that the NIS, IKS and grassroots innovation for inclusive development for the healthcare sector is waived together as illustrated in ***Figure 2***. Based on the above and the overall conceptual framework, there is one major reason why it is important for the South African government to prioritise incorporating IKS in all its policies. Incorporating IKS in the NIS has the potential to contribute to local empowerment and

development, increasing self-sufficiency and strengthening self-determination. Utilising IKS will give legitimacy and credibility in the eyes of both local people, researchers, and scientists, increasing cultural pride and would thus provide motivation to solve local problems with local ingenuity and resources. Local capacity-building is a crucial aspect of sustainable development and researchers, scientists and policymakers should design approaches and policies that support and strengthen IKS and institutions (IDRC and Langill, 1999).

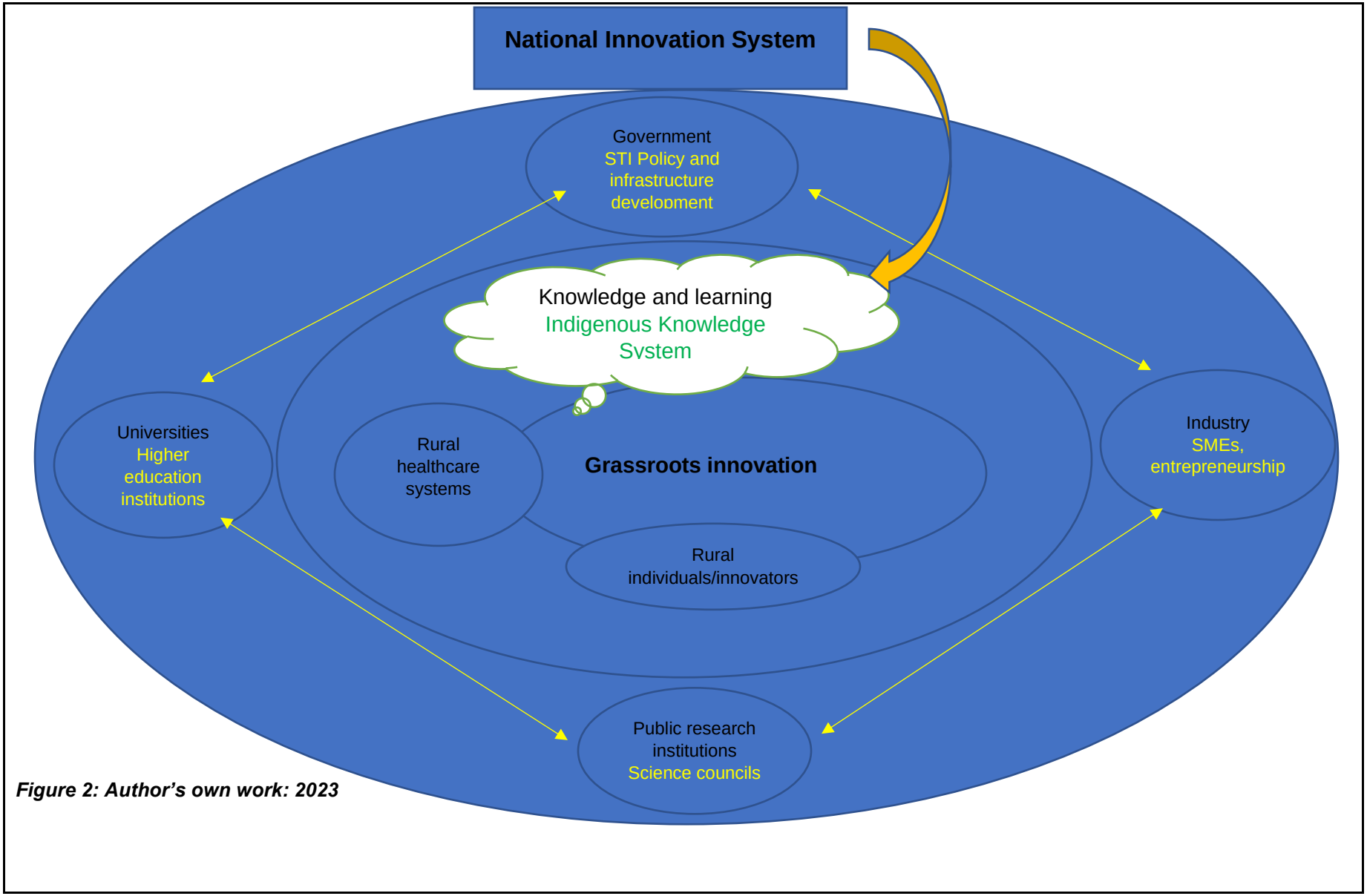

Figure 2: Author's own work: 2023

3.6. CONCLUSION

This chapter provides a brief theoretical review on the NIS theoretical framework, IKS and grassroots innovation theoretical concepts where some of the key assumptions underlying the aforementioned frameworks are discussed and explained. The chapter outlined a conceptual framework which aims to waive together the NIS framework, IKS and grassroots innovation in the context of South Africa and in the context of the research areas being investigated. The next chapter presents the research methodology used in the study.

CHAPTER 4: RESEARCH STRATEGY AND METHODOLOGY

4.1. INTRODUCTION

This chapter presents the research methodology used in the study by discussing its research techniques as well as the design implemented. It will begin by discussing the ontological approach to the study. It also provides an overview of research approaches and research design, justifying the approach and design as being appropriate for the study in terms of addressing the research question. The primary aim of the study is to explore the extent to which IKS is integrated in the current South African STI driven NIS.

4.2. ONTOLOGICAL APPROACH TO THE STUDY

Ontology is the study of "*being*" and is concerned with "*what is*" for example the nature of existence and structure of reality. Ontology is defined as "*a concept concerned with the existence of and relationship between different aspects of society such as social actors, cultural norms and social structures*" (Jupp, 2006). Ontological issues are concerned with questions pertaining to the kinds of things that exists within societies. Key ontological questions are concerned with whether there is a social reality that exists independently of human conception and interpretation or not. In very broad terms, social sciences have been shaped by two overarching ontological positions in relation to these issues namely realism and idealism. Realism is based on the idea that there is an external reality which exists independently of people's beliefs or understanding of it. Idealism on the other hand, assets that reality is fundamentally mind-dependent: it is only knowable through the human mind and through socially constructed meanings and no reality exists independently of these (Ormston et al., 2014). This study has thus adopted the realist position. Within the ontological approach, there are a variety of positions, for example. views of the world and knowledge namely objectivism and constructionism (Al-Saadi, 2014). A key idea of the objectivism approach is that researchers should attempt to distance themselves from any influences that might corrupt their analytical capacity. Another key idea of objectivism is that knowledge about the world can be acquired through direct observation rather than deduced from abstract propositions. All knowledge about the world originates from our experiences and is derived through the

senses. The key idea of constructivism, on the other hand holds the view that there are ways of knowing about the world other than direct observation; namely, our perceptions and interpretations of the world around us. People use their perceptions to interpret what their senses tell them. As such, knowledge of the world is based on our understanding which arises from our reflection on events rather than only on lived experiences. In a clear opposition to the objectivist tradition, constructionism approaches argue that knowledge is produced by exploring and understanding (not discovering) the social world of the people being studied, focusing on their meaning and interpretations, for example, meanings are socially constructed by the social actors in a particular context (Ormston, et al., 2014). This study has thus adopted the objectivists approach.

4.3. RESEARCH DESIGN, AND SAMPLING

The main types of research design include quantitative and qualitative research methods. In this study, the mixed methods research design was used in order to explore the extent to which IKS is integrated in the current STI-driven NIS of South Africa focusing on the healthcare sector. This approach was selected because it provides both depth and breadth that enables the researcher to obtain the thick descriptions and to obtain depth of information for a better understanding of the phenomenon under investigation. Mixed methods approach for gathering and evaluating data assist to increase the validity and reliability of the research (Raphasha, 2016).

Qualitative methods emphasise aspects of meaning, process, and context: the "*why*" and the "*how*" rather than the "*how many*" (Litossetiti, 2003). While quantitative research involves analysing numerical data, qualitative research interprets the text emanating from policy documents, press reports or notes taken during participants observation. Both qualitative and quantitative methodologies are deemed as relevant for the study of this nature since the best way of tackling this type of research problem entails assessing policy documents though a process of content analysis. The choice of both designs and methods was based on the nature of the study and the data needed for the study. Both qualitative and quantitative data was obtained through content analysis of policy documents and semi-structured interviews and quantitative data was extracted from the

additional content analysis of policy documents. For semi-structured interviews, non-probability sampling was used. In a non-probability sample, units are deliberately selected to reflect particular features of, or groups within the sampled population. The sample is not intended to be statistically representative: the chance of selection for each member is unknown but, instead the characteristics of the population are used as the basis of selection (Ormston et al., 2014).

Two non-probability sampling techniques, namely purposeful and snowball sampling methods were used in the study. In these methods, instead of selecting a fixed sample, every subject who meets the criteria is selected until the required sample size is achieved. This method is classified into three types, one of which is snowball sampling. Snowball sampling is applied when it is difficult to access subjects with the target characteristics. In this method, the existing study subjects, recruit future subjects among their acquaintances and this process continues until data saturation is achieved. This method is most effective when the members of the population are not easily accessible (Naderifar et al., 2017).

These techniques are best suitable because South Africa has very few policy makers and experts in the IKS field, and these techniques encourages inclusivity. Respondents were sampled from various strata of the discipline. Diverse responses representing various aspects from government, researcher and scientists were prioritised in order to identify essential success elements, challenges and interventions for the conceptual framework.

4.4. DATA COLLECTION METHOD

Document analysis was the primary method used for data collection. An approach involving quantitative and qualitative content analysis were used to explore the extent to which IKS is integrated in the current STI-driven NIS of South Africa, with a focus on the healthcare sector. Semi-structured interviews were used to triangulate the finding of the content analysis.

Content analysis

Quantitative and qualitative content analysis of three policy documents was used to explore the extent to which IKS is integrated in the current STI-driven NIS system in South Africa. The official documents include the 2019 White Paper on STI, the STI Decadal Plan (2022 to 2032), the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019 and the Indigenous Knowledge System Policy of 2004. Each document was assessed against the following three categories:

1. Complementary policy goals, priorities, and scope.
2. Policy structure and procedures for policy integration, and
3. Mechanisms and policy instruments to steer integration.

The policy documents are publicly available and were accessed from the organisations website. These documents reflect government aims and priorities in relation to South Africa's NIS. The reason for doing the content analysis was to get a deeper knowledge about whether there is an intention or convergence of IKS into the NIS of South Africa with a particular focus on the healthcare industry. The nature of the study required an extensive use of documents analysis to gain a better understanding of policy issues that exist. Content analysis is objective and gives unbiased results. If replicated by another researcher, the analysis and interpretation would show similar results. By means of content analysis, a large body of qualitative information may be reduced to a smaller and more manageable form of representation (Smith, 2000).

Content analysis is defined as a "*systematic and replicable technique for compressing many words of a text into fewer content categories based on explicit rules of coding*" (Krippendoff, 2004). Content analysis can be defined as a technique to extract desired information from a body of material by systematically and objectively identifying specified characteristics of the material (Smith, 2000: 314).

Content analysis can be quantitative or qualitative. The methodology adopted in this study utilised a combination of qualitative and quantitative analysis to explore the extent to which IKS is integrational in the NIS of South Africa. Quantitative content analysis involves the reporting of results in numerical terms or by using statistics. This involves the counting of articles and keywords and was applied to this research by counting the frequency of the keywords in the three policy documents. The documents were analysed

by how frequently key words are mentioned in the documents. The search of keywords allows a quick comparison of the words used by the policy documents and to observe where the greatest emphasis is present (Raphasha, 2016). Quantitative content analysis was done using Computer-Aided Text Analysis (CATA) Software which searches for count words frequencies and phrases.

Semi-structured interviews

Semi-structured interviews were used to verify conclusions from the document analysis and to gather information that is not often reflected in official documents. The semi-structured interviews were used for triangulation to increase the reliability and validity of the conclusions from document studies but were also a source of information on the integration of IKS in the STI-driven system. Semi-structured interviews provide reliable, comparable qualitative method of inquiry that allows for a pre-determined open-ended set of questions with a certain degree of flexibility for the interviewer to explore themes or responses further (Cohen et al., 2007).

Semi-structured interviews were conducted with policymakers from government, researchers, and scientists. A standardised interview guide with both structured and semi-structured questions was used to collect data from these respondents and the draft interview guide is attached in ***Appendix A***. The same fundamental questions were used for each of the interviews in order to get the broader aspects of assessing the integration of IKS in the NIS. By using the same question, it is easier to compare possible similarities or differences.

In-depth and semi-structured interviews are best suited as they afford respondents the freedom to share and express their views more openly and in detail (Moreton-Robinson and Walter, 2009). A total number of 6 respondents were sampled using a combination of convenient and snowball techniques and this is reflected in ***Table 1***. All respondents were requested for permission to be recorded through an audio recording device. The duration of the interviews ranged between 30-60 minutes.

Table 1: Number of respondents

Government policymakers ***(n=2)***	Scientists and researchers ***(n=4)***
2 (Department of Science and Innovation officials)	4 (two researchers from the University and two from science councils)

The semi-structured interviews were used for triangulation to compare if similar findings are produced. According to Arksey and Knight (1999), triangulation is an approach that can be used to reinforce the confidence of research findings. Triangulation can reduce research bias to an absolute minimum and increase the probability of generalising the findings of a study as the data is gathered from different angles and by different methods. Triangulation facilitates validation of data through cross verification from more than two sources, therefore the use of content analysis and semi-structured interviews to examine the same dimension of the research problem increases the validation. According to Patton (2002), triangulation does not just help show similarity of findings but also help to find inconsistencies that help add to the richness of the data and interpretation of explaining why things are operating the way they are.

Data collected from interviews were audio recorded using a recording instrument(s), in addition to researcher notes.

4.5. APPROACH TO DATA ANALYSIS

The data was analysed using thematic content analysis including data collected from policy documents and semi-structures interviews. Deductive thematic analysis was selected for the study. Deductive thematic analysis allows the researcher to impose their own structure or theories on the data and then apply these during analysis of the data. Thematic content analysis was therefore used to reduce and categorise the large volume of material into a more meaningful units from which interpretation could be made. Frequency analysis was used for quantitative content analysis focusing on the occurrence of keywords and phrases.

4.6. UNIT OF ANALYSIS AND STUDY POPULATION

This study was conducted exclusively in South Africa. A multidisciplinary approach was adopted in conducting this study, and as a result the study population was a wide range of respondents responsible for IKS-related work within various organisations within the South African NIS. The unit of analysis included government policymakers, scientists, and researchers. Individuals who were severely ill, those who are unable to hear or speak and those who declined to participate were excluded from the study.

4.7. POTENTIAL LIMITATION AND SCOPE OF THE STUDY

The study was only limited to the content analysis of the three policy documents. There is also geographical limitation to the study. It only focuses on the integration of IKS in the STI-driven NIS of South Africa. The purposive and snowball non-probability sampling methods that were used have the following limitation: The obvious disadvantage of convenient sampling is that it is likely to be biased because it is not representative of the entire population. In addition, when using purposive sampling, the respondents selected may not be applicable to the research problem. Therefore, there is a potential risk of collecting poor quality data due to poor research outcomes (Etikan et al., 2016).

4.8. ETHICAL CONSIDERATION

Ethical approval to conduct the study was sought from Wits University Ethics Committee. Respondents were requested to sign a consent form, and the template is attached in ***Appendix B***. The study did not inflict any harm on the respondents and responses were treated as confidential. Respondents were granted the right to discontinue with an interview as they see it necessary and those that took this decision were not prejudiced in any way. There was also no compensation for participating in this study and the use of data was solely used for the purpose of the study.

4.9. TRANSFERABILITY, CREDIBILITY, DEPENDABILITY, AND CONFIRMABILITY

Transferability is concerned with aspects of applicability. The research project meets the transferability criteria because the researcher provides a thick description of the participants and the research process to enable the reader to assess whether the findings are transferable to other settings. The research project provides a rich account of descriptive data such as the context in which the research will be carried out, the sample strategy, interview guide and inclusion and exclusion criteria. Credibility is the concerned with aspects of truth value. Strategies to ensure credibility are prolonged engagements, persistent observation, triangulation, and member checks. The research project meets the credibility criteria because the researcher will use methodological triangulation by using multiple methods of data collection. Dependability includes the aspect of consistency while confirmability is concerned with the aspect of neutrality. In order to ensure that the criteria for dependability and confirmability are met, the researcher provided an audit trail in the form of research materials adopted and findings (Korstjens, and Moser, 2018).

4.10. CONCLUSION

This chapter provided a detailed account of the research design and methodology adopted to realise the goals of the study. The research design, methodological approach, data analysis, validity, and reliability, as well as ethical considerations were explained in detail. The following chapter will present the research findings of the study.

CHAPTER 5: RESEARCH FINDINGS

5.1. INTRODUCTION

While the preceding chapter describes the research design and methodology, this chapter provides the results of data analysis and finding of the study. The study seeks to answer the following two questions:

1. To what extent is IK, which is the main ingredient of African traditional medicines RDI integrated in the South African STI-led NIS for the healthcare system as part of addressing the socio-economic challenges faced by South Africans?
2. Why has there been a passive response by and from IK holders, R&D institutions, industry, and Government to integrate IKS in STI systems?

Document analysis and semi-structured interviews were used to respond to the research objectives. The results are divided into two sections. The first section deals with the findings from a quantitative content analysis and qualitative content analysis to assess the extent to which IKS is integrated into the current STI-driven system of South Africa's NIS focusing on three policy documents. The Ministerial Review Committee on STI Landscape in South Africa was also assessed to substantiate the findings. The second section reports on the findings from the semi-structured interviews that served as complementary evidence for the triangulation process.

5.2. RESULTS FROM CONTENT ANALYSIS OF OFFICIAL DOCUMENTS.

Overview and results from collected official documents.

A summary of government official documents used for content analysis is presented in this section. The documents include:

2019 White Paper on Science, Technology, and Innovation

The 2019 White Paper on STI was approved by Cabinet in March 2019. The White Paper sets a long-term policy direction for the South African Government to ensure the growing role for STI, which is aligned to developmental challenges of the country. The paper is based on the extensive review of the NIS of South Africa and focuses on using STI to accelerate inclusive economic growth and to assist South Africa to benefit from global

development such as rapid technological advancements, geo-political and demographic shifts. The 2019 White Paper seeks to ensure that South Africa benefits from the potential of science, technology to advance the objectives of the National Development Plan (NDP). Chapter 3 of the White Paper focuses on a coherent and inclusive NIS, which seeks to intensify the interactions and partnerships from different actors across society within the NIS and thus enhancing coherence amongst agendas of NIS actors. The 2019 White Paper is the highest STI policy document which sets out several policy intents, South Africa wants to achieve to make STI work for South Africans and adopts a whole-of government and society approach to innovation. This ought to include the private sector, instilling a culture of valuing STI and integrating STI into government planning and budgeting at the highest level. This would be the biggest challenge; and creating a more innovative-enabling environment. The White Paper also outlined six policy intents:

1. Coherent and inclusive governance – which includes an annual STI plenary chaired by the Presidency, where business, civil society, academia, and government could discuss Suth Africa's National Science and Innovation needs. Besides that, would be a Ministerial STI structure, chaired by the Minister of Science and Innovation to adopt an innovation compact to drive coordination, approve decadal plans, and secure resources.
2. Enabling innovation – which includes aligning incentives, growing business, and Small Medium Enterprises (SME) support.
3. Targeting new sources of growth for example., Green Economy and the (Fourth Industrial Revolution (4IR).
4. Expand and transform human capabilities – which includes the increase of the Science, Technology, Engineering, and Mathematics (STEM) pipeline. The expansion of Centres of Excellence (CoE), South African Research Chairs Initiative (SARChl) and increased support for women and emerging researchers.
5. Expand and transform research enterprise – these include focusing on research in national priorities and funding them appropriately and developing a diversity of knowledge fields, for example, trans-disciplinary research, IK, innovation, and business science. These would be specific areas of work.

6. Increased investments for STI – which includes integrating STI into government planning and budgeting at the highest levels.

Since the White Paper is not an implementation strategy, the policy actions proposed in the White Paper is implemented in terms of the Decadal Plan (Department of Science and Innovation, 2019).

Science, Technology, and Innovation Decadal Plan (2022 to 2032)

The DSI has finalised the Decadal Plan (2022 to 2032) which will be an implementation plan and framework for the 2019 White Paper to guide on how to achieve the objectives, of the 2019 White Paper. The Decal Plan which has now been adopted by Cabinet is not solely a plan for the DSI but is a plan for the whole of South Africa. The primary goals of the Decadal Plan are to grow the South African science system and increase socioeconomic development and growth. The Plan is not technology specific, nor it is scientific discipline specific. It is about the societal challenges South Africa and the globe are facing especially those that STI is needed to respond to. The plan also includes a new commitment to invest in the basic sciences and social science, and this is mainstreamed across all areas of the Plan. Another commitment is to focus on just transitions, especially in the energy field. The Plan identifies three Societal Grand Challenges namely: Climate Change and Sustainability; Future Proof Education and Skills; and the Future of Society. In addition to the three Societal Grand challenges are three Large STI Programmes namely: Innovation for a Healthy Population, Innovation for Energy Security; and Innovation for a capable and inclusive state. When it comes to economic growth, the Plan talks to the sources of new economic growth for a re-industrialised modern economy (with a focus on digitisation and the digital economy) and modernising existing industries (with a focus on agriculture, manufacturing, and mining). A new governance system is being developed to include the establishment for a STI Presidential Council and a STI Inter-Ministerial Council for consultations and decision-making. The first Presidential Council Plenary chaired by the President and attended by senior government officials, academia, industry, and civil society leaders is yet to be

convened to map out the first STI Compact (Department of Science and Innovation, 2022).

The Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019

The first international instrument to afford recognition to IK and expressly call for its protection is the United Nation Convention on Biological Diversity adopted in 1992. The objective of the Convention is to facilitate the conservation and sustainable use of biological diversity while providing for fair and equitable sharing of the benefits of genetic resources. South Africa signed and ratified this Convention as well as the Nagoya Protocol (adopted in 2010) and used its policy approaches to create a legal framework for the protection of biological and genetic resources. The then Department of Science and Technology and now the DSI drafted the Indigenous Knowledge Bill in 2014 in pursuit to protect, promote, develop, and manage IKS by means of *sui generis* protection. The Bill was tabled in Parliament in 2016, and the Portfolio Committee on Science and Technology called on the public to share written comments on the Bill. On 14 August 2019, the Promotion, Protection, Development and Management of Indigenous Knowledge Act was subsequently signed into law. After 25 years of democracy in South Africa, IKS was accorded the same worth as any other knowledge system in the country. Summarily, the Act provides for the formal establishment of the National Indigenous Knowledge System Office (NIKSO). This national office is responsible for the implementation of the Act, including creating a registration office controlled by an IK curator. It must be noted that the Act exclusively protects registered IK. In implementing the Act, NIKSO must maintain a register of IK, facilitate redress and development of IK in traditional communities. The Act also provides for the recordation and controlled dissemination of IKS, in the patents office particularly, through the National Recordal System and the National Indigenous Knowledge Management System. These systems specifically provide defensive protection in that they reduce the probability that patents would be improperly issued on a subject matter belonging to a traditional community. The Act also provides positive protection by stating that IK is regarded as being property of traditional communities as defined in section 25 of the Constitution of the Republic of

South Africa. It further confers exclusive rights on IK holders such as the right to share in benefits accruing from any commercialisation of IK, the right to be acknowledged as the source as well as the right to restrain any unauthorised use of IK (Zondi, 2022).

Indigenous Knowledge System Policy in South Africa

The Indigenous Knowledge Systems Policy, adopted in November 2004, was the result of an interdepartmental effort to create a guide for the recognition, understanding, integration and promotion of South Africa's wealth of IK resources. One of the areas of action identified by the policy is the protection of IK, and the holders of such knowledge, against exploitation. This will also include ensuring that communities receive fair and sustained recognition and, where appropriate, financial remuneration for the use of this knowledge. In 1999 the then Department of Arts, Culture, Science and Technology approached Cabinet to formulate a policy on IKS. An inter-departmental task team embarked on what turned out to be a complex process of consultation and research which took a lot longer than anticipated. However, the result was a policy which encompassed a wide scope of actions and recommendations pertaining to IKS, including, inter alia, integration of IK into the national education, research and development systems, proposed administration of IKS, institutionalisation, funding, and legislative imperatives. The Indigenous Knowledge Systems Policy was adopted by Cabinet in November 2004 and since then, various departments have been tasked with developing policies and legislative amendments that will support the objectives of the Indigenous Knowledge Systems Policy. For example, the then Department of Trade and Industry initiated amendments to the Patents Act of 1978, now the Patents Amendment Act of 2005 and the then Department of Environmental Affairs and Tourism initiated amendments to the biodiversity legislation, Biodiversity Act of 2004 (South Africa Government Gazzette, 2008).

Results of qualitative content analysis

This section presents the results for the qualitative content analysis of the aforementioned official documents. The 2019 White Paper on Science, Technology, and Innovation

(including its implementation Plan, the Decadal Plan) was analysed and compared with the Indigenous Knowledge System Policy (including the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019) to assess the extent to which IKS is integrated in the STI-driven system of NIS of South Africa.

Complementary scope, mandates, and priorities for the integration of indigenous knowledge

The primary vision of the 2019 White Paper is to create an environment where STI enables an inclusive and sustainable South African development in a changing world. This policy document, together with its implementing Decadal Plan acknowledges that IK provides business opportunities and therefore, regulations and legislative frameworks must be drafted to protect, promote, develop, and manage South Africa's indigenous knowledge. The policy document further concedes that in developing countries, such as South Africa, IK and know-how are particularly relevant and the DSI will continue with initiatives to strengthen the recoding and utilisation of IK, to the benefit of the knowledge holders and the country. Inclusive innovation for inclusive development in which all citizens share in the benefits, is central to the 2019 White Paper and the Decadal Plan. This encapsulates a broader view of actors, in the forms of innovation and the spatial footprint of innovation. It means supporting communities and civil society to innovate, embracing a more diverse knowledge system (including IKS and addressing the "*decolonisation of knowledge*"). When it comes to the healthcare sector, the Decadal Plan concedes that the Covid-19 pandemic demonstrated that South Africa (like the rest of the world) can no longer depend on a single healthcare system intervention, especially where pandemic preparedness is central. Endowed with unique megadiversity and rich IK related to medicinal plants, South Africa is well positioned to develop a sustainable and complementary IK-based healthcare system. In line with its inclusivity principle, the Decadal Plan embraces two STI health systems, prioritising both a contemporary 4IR precision and digital approach, and IK-rooted health innovation responses. To realise the integration of IKS, into the healthcare sector, the Decadal Plan advocates for an increased access to affordable healthcare services through the development of RDI capabilities in new treatment and prevention through the use of precision medicine, digital

health, and use of IK in vaccine production (Department of Science and Innovation 2019, 2022).

The Indigenous Knowledge Policy preamble states that the Government of the Republic of South Africa is committed to the recognition, promotion, development, protection, and affirmation of indigenous knowledge. The objective of the Policy is to create an enabling framework to stimulate and strengthen the contribution of IK to social and economic development in South Africa. The main IKS policy drivers in the South African context include amongst others the following:

1. Practical measures for the development of services provided by IK holders and practitioners with a particular focus on traditional medicine, but also including areas such as agriculture.
2. Interface with other knowledge systems, for example IK is used together with modern biotechnology in the pharmaceutical and other sectors to increase the rate of innovation.

The IKS Policy, similarly, to the 2019 White Paper on STI concedes that interfacing IKS with other knowledge systems provides critical opportunities for new products and services. According to the Indigenous Knowledge System Policy, the key elements that will create a positive synergy between IKS and the NIS of South Africa are:

1. The creation of a legal benefit-sharing framework.
2. The establishment of a formal recordal system for indigenous knowledge.
3. Legislation to ensure minimum standards in Information and Material Transfer Agreements in respect of IK research.
4. The promotion of IK links with the science base by means of targeted funding instruments, and.
5. Amendments to the South African Patent Legislation to enforce IK (Department of Science and Technology, 2004).

The content analysis shows that both the 2019 White Paper on STI (inclusive of the Decadal Plan) and IKS Policy (inclusive of the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019), to some extent have

complementary scope, mandates, and priorities in relation to the integration of IKS in the NIS of South Africa.

Initiatives, indicators, and factors hindering the integration of indigenous knowledge systems in the National Innovation System.

Some of the initiatives/indicators advocated by the Decadal Plan investigate the percentage of RDI expertise, research studies and recommendations on IKS implemented and percentage (preferably 90%) of patents on IK registered in the Intellectual Property database (Department of Science and Innovation, 2022). The 2019 White Paper on STI and the Decadal Plan however do not make any mention of the factors that hinder the integration of IK in the NIS, particularly around African traditional medicine. None of the official documents explicitly mention the establishment of a common assessment, monitoring and evaluation mechanisms/ methodologies, and tools to assess the integration of IKS in the NIS.

The Indigenous Knowledge Policy, however, indicates that the most important issues hindering the practice of African traditional medicine fall into four categories namely:

1. National policy and regulatory frameworks – crucial to overall delivery.
2. Safety, efficacy, and quality - crucial to extending and regulating traditional medicine.
3. Access - making traditional medicine available and affordable; and
4. Rational use - ensuring appropriateness and cost-effectiveness.

The Policy acknowledges that there is a need to intensify RDI work in this area, particularly as it relates to recording and supporting traditional healers on safety and accessibility, among others (Department of Science and Technology, 2004).

Institution or agency that would oversee the integration of Indigenous Knowledge System in the National Innovation System

Both the 2019 White Paper on STI and its implementation Plan, the STI Decadal Plan do not make explicit mention of any institution or agency that would ensure the integration of IKS in the NIS particularly for the healthcare sector. The Indigenous Knowledge Policy,

on the other hand calls for an establishment of an Indigenous Knowledge System Fund to support institutions that will assist Indigenous and local communities in the categorisation and characterisation of their biological resources, innovations, practices, and technologies. Funding IK research presents a unique opportunity for trans-disciplinary, multi-collaborative and participative research to enrich the NIS.

The Indigenous Knowledge System Policy (and the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019) also calls for the establishment of the NIKSO and its function within the DSI. The core functional areas for the Office include the recognition and promotion of IK and knowledge systems and to implement the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019. In addition, the Policy calls for the establishment of an Advisory Committee on IKS, to advise Government on all matters pertaining to the recognition, promotion, development, protection, and affirmation of IKS reporting directly to the Minister responsible for STI.

Lastly, the IKS Policy calls for the establishment of IKS Centres and special laboratories for the development of IK, in addition to integrating IK research within existing research institutions. Indigenous technologies laboratories can serve as points of entry in the search for local options and broad-based approaches to the innovation of technologies and management of natural resources (Department of Science and Technology, 2004).

RESULTS OF QUANTITATIVE CONTENT ANALYSIS

The below table provides a summary of the official documents used in the content analysis.

Title	Year of adoption/publication	Number of pages
2019 White Paper on Science and Technology	March 2019	88

Science, Technology, and Innovation Decadal Plan (2022 to 2032)	2022	112
Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019	August 2019	28
Indigenous Knowledge System Policy	November 2004	42

Table 1: Overview of official documents used in the content analysis (n = 4)

Frequency of keywords in the official documents

The quantitative content analysis was conducted by counting the frequency of the keywords in the four official documents. The documents were analysed by how frequently keywords are mentioned in the documents. The search of keywords allows a quick comparison of the words used by official documents and to observe where the greatest emphasis is. The following tables shows the quantitative content analysis of keywords with the highest frequency counts per official document.

Table 2: Keywords with the highest word frequency counts in the 2019 White Paper on Science and Technology

Keywords	**Frequency**	**Percentage**	**Rank**
Innovation	439	1.10	1
Science	416	1.04	2
Technology	339	0.85	4
Knowledge	126	0.31	5

Indigenous	6	0.02	7
Research	359	0.90	3
Communities	7	0.02	6

Table 3: Keywords with the highest word frequency counts in the Science, Technology, and Innovation Decadal Plan (2022 to 2032)

Keywords	**Frequency**	**Percentage**	**Rank**
Innovation	559	1.23	1
Science	226	0.50	3
Technology	198	0.43	4
Knowledge	97	0.21	5
Indigenous	9	0.02	7
Research	325	0.71	2
Communities	21	0.05	6

Table 4: Keywords with the highest word frequency counts in the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019.

Keywords	**Frequency**	**Percentage**	**Rank**
Innovation	4	0.04	3
Science	2	0.02	6
Technology	3	0.03	5
Knowledge	166	1.48	2
indigenous	228	2.03	1
Research	1	0.01	7

Communities	16	0.14	3

Table 5: Keywords with the highest word frequency counts in the Indigenous Knowledge System Policy.

Keywords	**Frequency**	**Percentage**	**Rank**
Innovation	78	0.33	7
Science	110	0.47	5
Technology	138	0.59	3
Knowledge	240	1.03	1
Indigenous	214	0.92	2
Research	126	0.54	4
Communities	94	0.40	6

As expected, the keywords "*knowledge", "innovation" and "indigenous"* are the most frequently used concepts in all the official documents.

Table 6: Frequency counts of phrases in the official documents

Phases	**2019 White Paper on Science and Technology**	**Science, Technology, and Innovation Decadal Plan (2022 to 2032)**	**Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019.**	**Indigenous Knowledge System Policy**
	Frequency	Frequency	Frequency	Frequency

National Innovation System	184	169	0	2
Indigenous knowledge systems	1	3	15	31
Science, Technology, and Innovation	312	360	0	0
Grassroots Innovation	8	4	0	2
Inclusive Innovation	2	5	0	0
Indigenous knowledge	3	3	15	31

5.3. RESULTS FROM THE SEMI-STRUCTURED INTERVIEWS

This section of the chapter presents the findings of the study which were obtained through the semi-structured interviews. The semi-structured interviews served as complementary evidence during the triangulation process with secondary data. A total of six interviews were conducted with the aim of capturing their perspectives around the extent to which indigenous knowledge systems is integrated in the current of NIS of South Africa.

The study also investigated new ways of how the untapped IK could be integrated into the STI-led system from the perspective of, policymakers, scientists, and researchers.

Complementary scope, mandates, and priorities for the integration of indigenous knowledge focusing on policies, strategy, and legislation on IKS.

Q1: National policies or strategy dedicated to IKS.

Respondents from universities, science council and government indicated that that there are policies, strategies and legislations that are dedicated to IKS in South Africa. The first policies adopted by the then Department of Science and Technology is the Indigenous Knowledge System Policy which was adopted by Cabinet in November 2004 which directed the creation of an Indigenous Knowledge System unit within the Department. The Policy aims to recognise, affirm, develop, promote, and protect IK in South Africa and recognise the potential of IK to enhance human understanding and well-being. The Policy has four drivers:

1. The affirmation of African cultural values in the face of globalisation.
2. The development of the services provided by IK-holders / traditional healers.
3. Promoting the contribution of the IK to the economy, and
4. Interfacing with other knowledge systems.

It is worth noting that, a strong focus of the Policy is on intellectual property and the Policy aims to address problems of knowledge exclusion and representativeness in society. The Policy also places emphasis on the need to affirm African cultural values in the face of globalisation, to promote a positive African identity, to find practical measures for the development of services provided by IK-holders and practitioners, with a focus on traditional medicine to enhance the contribution of IK to the economy. For example, IK is used together with other modern biotechnology in pharmaceutical and other sectors to increase the role of innovation (Department of Science and Technology, 2004).

Another related policy or strategy that was adopted by the Department is the Bio-Economy Strategy. The strategy is not an IKS encompassing strategy but aims to bring together South Africa's rich natural biodiversity, indigenous knowledge, and applied biotechnologies.

Respondents also indicated that that South Africa has adopted legislations that speak to Indigenous Knowledge System as a driver of socio-economic development. For instance, the Department of Science and Technology is a custodian of the legislation called *the Protection, Promotion, Development and Management of Indigenous Knowledge Act of 2019*, which seeks to promote, manage, develop, and protect Indigenous Knowledge

including indigenous knowledge practitioners. This Act emerged when South Africa adopted *sui generis* legislation to protect registered indigenous knowledge. In 2013, South Africa passed the Intellectual Property Laws Amendment Act 28 of 2013 which recognised IK as protectable subject matter with the context of the existing copyright, trademark, and performers' protection legislation. The decision to amend existing Intellectual Property Laws as opposed to introducing *sui generis* Protection for IK attracted vociferous criticism. Against this backdrop, the Protection, Promotion, Development and Management of Indigenous Knowledge Act of 2019 was passed in August 2019. This addition offers a *sui generis* approach to the protection of indigenous knowledge. The Act encapsulate almost every conceivable indigenous knowledge-related consideration, including protection from unauthorised use, misappropriation and misuse, the regulation of the equitable distribution of benefits, the promotion of the commercial use of IK in the development of new products, services and processes and the recognition of IK as prior art in the context. The act only recognises IK which has been duly registered namely that it: has been passed from generation to generation within an indigenous community, has been developed within an indigenous community and is associated with the cultural and social identity of that indigenous community (South African Government, 2019).

Other legislation flagged by respondents are the Patent Amendment Act of 2005, and the Intellectual Property Amendment Act of 2022, which speak strongly to IKS. These acts were amended in order to include intellectual property of indigenous biological resources, IK and generic resources within the ambit of the act. This Act primary focusses on access and benefit-sharing and stipulates that if for an example, an individual has an invention, and is seeking protection through the patent system, the individual will need to disclose whether that invention has been informed by indigenous knowledge. Should the invention be informed by IK, the inventor is required to possess prior consent from the IK holder and thereafter conclude a Material Transfer and Benefit-Sharing Agreements. Similarly, if an organisation be it a university, science council or pharmaceutical company identifies a plant or animal species that was used by a community or an indigenous practitioner to heal a certain illness, that pharmaceutical company has the obligation to recognise and acknowledge the contribution of the community or the IK practitioner through the

aforementioned Agreements. IKS is also seen as a new source of growth for socio-economic development in the STI Decadal Plan of 2022 to 2032.

Q2: Ensuring that IK-based innovations are brought into the healthcare industry value chain?

Respondents indicated that the South African Health Products Regulatory Authority (SAHPRA), which is a regulator provides the necessary approvals for any health product to be admitted in the market and for commercialization processes. The DSI, working closely with research scientists would facilitate the RDI to validate the Proof of Concept of the IK-holder or community by generating scientific data in the laboratories that confirms its effectiveness.

Respondents also indicated that the main challenge of institutionalising traditional medicine or healthcare products that emanate from IKS to enter into the primary healthcare industry is as a result of regulations intended for human and animal use. The SAHPRA require that, for any product to be registered as a complimentary medicine, herbal medicine or a pharmaceutical drug, there needs to be scientific and clinical evidence to prove that it is safe, effective and is of good quality for human consumption. RDI becomes very important and therefore partnerships (between the Government, industry, and IK-holders) and resources (for example, funding, quality scientists) and infrastructure would to be required. This process has become a huge hurdle for IK-based healthcare products to enter primary and secondary markets. Respondents indicated that the Department of Science and Innovation is currently working with SAHPRA to develop specific regulations for IK-based or traditional medicines in the country.

Q3: Relationships between IK-holders/practitioner, and Industry role players.

Respondents indicated that the DSI has a great and outstanding good relationship with IK-holders and IKS communities of practice. The Department also has a good relationship with research scientists and provides funding support R&D and High-end Skills (for example, Masters and PhDs) because they are at core of RDI. The relationship with industry is not that good, because industry partners are seemly a bit uneasy about

IKS and the work the Department does. Bio traders who just want to harvest raw material and sell it in bulk see government policies and its interventions impeding their work. Big industry companies, however, appreciate the local research and innovation that the Department is advancing. The relationship is still growing.

The Department and its associated science councils work very closely with IK-holders and agreements such the non-disclosure agreements, research collaboration agreements and benefit-sharing agreements get concluded between the different stakeholders.

Initiatives, indicators, and factors hindering the integration of IKS in the STI-driven system of the NIS of South Africa.

Q4: Integration of IKS into the National Innovation System particularly for the healthcare industry.

Respondents indicated that IKS is not well integrated in the currently NIS (as a whole) to the level that the Department would like to see. As a whole, the NIS is still elitist and racist. In order to deal with this, Department has successful set up IKS labs across the country in order to interphase the IKS and mainstream STI.

Respondents also expressed that the huge challenges of integrating IKS into the NIS of South Africa is due to be a lack of coordination between government departments, agencies, IK-holders, communities, and industry role players. Respondents seem to have the opinion that the creation of an institute or science council dedicated to IKS could help enhance the integration of IKS in the NIS. Similarly, having hospitals dedicated to IK-based health products and registered IK-practitioners (dual healthcare systems similar to China) could help enhance such as integration. Respondents also indicated that some South Africa universities know offer curriculums dedicated to IKS at undergraduate level and development has the potential to enhance the integration. Respondents also strongly believe that collaborations with communities is crucial. Policymakers, industry role players and researchers need to understand what IKS is from the perspectives of communities and IK-holders in order for this integration to work.

Q5: Main challenges of integrating IKS in the South African National Innovation System particularly for the healthcare industry.

Respondents indicated that the following eight challenges hinder the integration of IKS in NSI:

1. Buy in of all stakeholders and lack of champions to drive IKS practices. (This has been the biggest challenge).
2. Lack of sufficient resources and little investment (particularly financial resources).
3. Beneficiation (equitable beneficiation).
4. Fragmented system, alinement, and lack of a national coordination system. The different role players have different mandates and there is a challenge to integrate everything from a national perspective in order to advance the sector.
5. The sector is largely informal and needs to be formalised.
6. Limited human capacity development (quality of scientists and researchers and Illiteracy among IK-holders).
7. Lack of general awareness of IKS (particularly IKS legislations). and
8. The indoctrination that IKS is bad, which leads to sceptical behaviours.

Q6: Mechanism to mitigate these challenges.

BioProducts Advancement Network of South Africa (BioPANZA) is trying to coordinate the sector better.

Q7: Capacity building for IKS.

Respondents indicated that an introduction of a curriculum at universities specifically focusing on IKS could help build capacity for IKS. There is also a need for a critical mass of postgraduate students that need to be funded through the National Skills Fund. High-end Infrastructure development (for example, IKS research dedicated laboratories) at universities could also enhance human capacity for IKS.

Q8: Inclusive development for IK.

Respondents indicated that IK-holders are definitely not included in the South African NIS especially from a formal point of view, however, there are pockets of integration. It was indicated that the DSI is trying to create an environment where IK-holders are included in the NIS through platforms such as the IK-based bio innovation programme, where collaborations between research institutions, SMEs and IK-holders is encouraged and supported. However other Government departments do not have such platforms in place.

Q9: Fostering collaboration between IK-holders, R&D institutions, industry, and government.

Respondents indicated that Government, through the DSI is taking an inclusive innovation approach which includes R&D institutions, IK-holders, and industry role players, however communities are not included. Government needs to also include communities during the policy development process especially those communities that are, directly affected by the policy. IKS policy developers need to take them alone every step of the way through concept development and policy development and ensure that their inputs are captured. Regulatory reform and curriculum development will be key.

Q10: IK-holders as agents for socially impactful innovations.

Respondents certainly believe that IK-holders are agents for socially impactful innovations and prototypes and products have been developed. The challenge is to formalise the sector because it is largely informal. Since it is informal, IK has very limited impact to society. The informality of the knowledge holder or community needs to be turned into a formalised and commercialisable structure wherein IK-holders or communities own their products, own the value chains and own Intellectual Property. Should they wish to sell or upgrade their healthcare products, Government needs to assist them to get to a level where they can have their products in pharmacies or retail shops and not just be limited to local customers which the current practice.

There are lot of IK-based products in the areas of cosmetics and nutraceuticals that emanate from:

1. hoodia plant products

2. Aloe products and
3. Moringa products

5.4. CONCLUSION

The chapter presented the key research findings of the content analysis and semi-structured interview. The aim of the chapter was to relate the research findings to the research questions in order to attempt to provide answers. The semi-structured interviews served as complementary evidence for the triangulation process. These findings will serve as a significant source of information regarding the extent to which Government of South Africa intents to integrate IKS in the currently STI-driven NIS, particularly for the healthcare system. The next chapter presents the analysis of the research findings.

CHAPTER 6: DISCUSSION

6.1. INTRODUCTION

In the preceding chapter, the findings of the study were presented. The interpretation and discussion of these findings will follow in this chapter. This study used a combination of document analysis methods and semi-structured interviews to answer the research question. In order to answer the main research question of this study, document analysis methods were used to assess the extent of integration focusing on the 2019 White Paper on Science and Technology (including its implementation Plan, the Decadal Plan on STI and the IKS Policy (including the Protection, Promotion, Development and Management of IK Act 6 of 2019). The first section responds to the first research question regarding the extent to which IKS is integrated in the current NIS of South Africa for the healthcare sector. The second section will discuss some of the challenges and opportunities of integrating IK in the STI systems with a focus on the healthcare sector.

It is crucial to point out that the South African healthcare system is currently engaged in the complex project of establishing universal health coverage that ensures the system's ability to deliver comprehensive care that is accessible, affordable, and acceptable to patients and families, while acknowledging the significant pressures to which the system is subjected to. South Africa faces healthcare challenges in three major areas: the growing quadruple disease burden, systemic and structural challenges in service delivery; and societal challenges associated with poverty and unemployment. South Africa's quadruple burden of diseases consists of HIV and AIDS, communicable disease, non-communicable disease, and violence and injuries. The South African health system faces a range of systemic and structural challenges, which include widespread inefficiencies, staff shortages, variability in skill sets between rural and urban areas, and suboptimal care levels and patient management (de Villiers, 2021). The integration of IK in the current STI-driven system could assist in alleviating some of the aforementioned challenges in the healthcare system.

6.2. INDIGENOUS KNOWLEDGE INTEGRATION IN THE STI-LED SYSTEMS AND HEALTH SYSTEMS OF INNOVATION IN SOUTH AFRICA

The overall findings presented in the Chapter 5 suggest that there is to some extent integration between the 2019 White Paper on Science and Technology (including its implementation Plan, the Decadal Plan on STI and the IKS Policy (including the Protection, Promotion, Development and Management of IK Act 6 of 2019) and the findings from the content analysis and the semi-structured interviews reveal that all the categories of complementary policy goals, priorities, and scope to steer integration are adequately integrated across the official documents. In line with the literature review discussed in chapter 2, the South African government (particularly the DSI), as stipulated in the official documents analysed in the previous chapter, recognise that an IK included NIS can enhance the comparative advantage of any developing country despite them having less developed STI institutions and actors in innovation creation (Jauhiainen and Hooli 2017; Department of Science and Innovation, 2004, 2019, 2022). The South African DSI, similarly, as discussed by Olaopa and Ayodele (2021), also acknowledge that there is a need to adjust the general and universal concept of the NIS to include local contexts and practices that include bottom-up participation of IK holders (including traditional healers) and local context in the innovation related policies of South Africa. In addition, the DSI as advocated by Olaopa and Ayodele (2021) aim to support the development, utilisation and safeguarding of IK through government structures. This is done through the National Indigenous Knowledge Registration System (NIKRS) initiative which is currently being developed in phases with the first phase focusing on African traditional medicine and traditional herbal foods. Another initiative initiated by the DSI, which helps to compliment and integrate IK research methods with scientific research methods as advocated by Bohensky and Maru (2011), is the Pharmacopoeia platform. This platform is a database that holds information regarding quality, efficacy, and safety of African traditional medicine in South Africa. This database draws on published resources on indigenous plants, their botanical distribution and their uses for medical purposes which are digitised to provide information, cross-reference and research outputs that can be used by researchers, scientists, community members, traditional healers, IK practitioners, holders, and a wide range of global users. This database is however not intended for medicinal, or health advise and may not be used as a substitute for professional consultation from experts (National Indigenous Knowledge System Office Portal, 2022).

As mentioned by Lupuwana (2008), well established African traditional medicines and healthcare product manufacturers such as Weleda, Lennon, and others, have found a niche in the marketplace with their brands occupying considerable shelf-space in pharmacies and healthcare retail stores around the country and such products are marketed as over-the-counter medicine or self-medication products. However, in order for these products emanating from IK to maximise their reach into the healthcare industry value chain, Government needs to spearhead the process through governmental structures. This could be done by ring-fencing adequate STI funding and equitable support for RDI of IK-based health products. The importance of funding is also echoed by a study by Asamoah et al., (2023), which concluded that financial difficulties hinder the successful running of African traditional medicines RDI programmes.

Once these products are developed, the National Department of Health and SAHPRA will need to be the primary consumers of such products. As a starting point, these two entities will further need to work together to develop policies and regulations that are pro-development and not regulations that are too restrictive. Dedicated expertise within the Department of Health and SAHPRA should be sought to ensure that policies around the RDI of IKS and products emanating from IK are indeed supported and also ensure that the industrialisation of these products is supported.

It is worth noting that a characteristic that is present in all definitions of the NIS is that of the existence of interactions or *"networks*" between the actors of the NIS. The use of the term "*network*" in the characterisation of the NSI suggests a sense of connectivity, where an effect on one actor brings a change or influences the other actors of the network. It also implies that there would be agreed objectives, a pooling of financial and other resources and a coordination of efforts. This conception therefore emphasises the importance of coordination between and among key NSI actors in order to promote innovation (Manzini, 2012). A limited role of key NSI players therefore would present a weaker process of integrating IKS into the mainstream.

In the case of South Africa, there seems to be a political will to integrate IKS in the current NIS of South Africa, particularly for the healthcare sector, however political commitment, and directives to sufficiently institutionalise and integrate IKS seems to be lacking.

6.3. CHALLENGES AND OPPORTUNITIES OF INDIGENOUS KNOWLEDGE INTEGRATION IN SCIENCE, TECHNOLOGY, AND INNOVATION SYSTEMS

Some of the challenges (some discussed in the findings chapter) that hindering the integration process of IK in the healthcare sector include:

1. **Name-calling or sceptical behaviours towards indigenous practices**: Although 60% of the South African population utilise the services of traditional health care practitioners, traditional healers and IK holders are often labelled as witches. Some communities and some faith believers also label traditional healthcare practitioners as evil worshippers possessed by evil spirits (Moloko-Phiri et al., 2022). A study conducted in sub–Saharan Africa referenced by James, et al (2018), indicate that responds indicated that they were reluctant to use traditional medicines due to the perceived demonic nature of traditional, complementary African medicines.
2. **The unregulated nature in which IKS is practiced**: Although traditional healthcare practitioners and IK holders are recognised, the regulation of these traditional healers for the NIS is problematic. This becomes a challenge as there are false traditional healers who consult in the name of true traditional healthcare practitioners, hence tainting the good name of those who are honest, resulting in all of them being labelled as fake (Moloko-Phiri et al., 2022).
3. **Lack of recognised practice facilities and support from Government:** Traditional healthcare practitioners and IK holders lack facilities to perform their practices. This exacerbates the situation, wherein the reputation of IK-holders or practitioner get questioned and the absence of well-grounded methods to assess the treatment they provide, undermines their credibility and casts doubts upon the trustworthiness of their profession. The traditional healthcare practitioners in the country are also faced with challenges of the dominating western healthcare sector. Traditional healthcare practitioners, generally also experience the challenge of a lack of adequate financial support and recognition from the Government (Moloko-Phiri et al., 2022).
4. **Lack of collaboration between different actors**: Although IK holders are recognised, there is still a lack of collaboration between IK holders, scientists, and researchers and between traditional healthcare practitioners and practitioners in formal healthcare sector. In South Africa, there is little formal collaboration between

allopathic and traditional healthcare practitioners despite discussions and recommendations made about the need to include IK practitioners in the NIS for the healthcare system. Researchers, scientists, and formal healthcare professionals are not prepared to work and associate with traditional healthcare practitioners and IK holders as they are considered unclean and untidy with poor educational backgrounds. Perhaps the subordination of IKS has closed doors to genuine collaboration. IK holders may decide to preserve their IP fearing misappropriation of their IK due to a lack of understanding of the way IK works (Moloko-Phiri et al., 2022).

5. **Prioritisation of western biomedical model over the indigenous wholistic model**: One of the major challenges that continuous hinders the full integration of IKS in the current STI-driven NIS of South Africa is the constant prioritisation of western biomedical model over the indigenous wholistic model. The western biomedical model is being used as the main system of healthcare delivery to both non-indigenous and indigenous people in many countries including South Africa. This perpetuates a situation where IK-holders and practitioners increasingly being hesitant to share data and information for fear of exploitation. Little knowledge on how these traditional healing practices work with the evidence-based western biomedical model, the full integration and support of these practice becomes even more challenging in mainstream healthcare systems (Asamoah et al., 2023).
6. **Shortcomings of legislations concerning IKS**: Although the findings of the study suggest that, from a policy perspective, integration of IKS in the NIS of South Africa is seemingly on track, there are however a few challenges and shortcomings which government should be aware of. According to Tong (2019), the Protection, Promotion, Development and Management of Indigenous Knowledge Act of 2019 has implications for any person who uses or intends to use IK in South Africa, including creators and owners of intellectual property. Where a community has registered its IK, any person who is not a member of that community must acquire consent to use the knowledge. In addition, users who derive a benefit from commercial exploitation of the knowledge, will have to factor in a claim by the community for a fair and equitable sharing of monetary and non-monetary benefits. Those who have been using IK commercially prior to the commencement of the legislation will face a change in circumstances once

the obligation to share the benefits kicks in. According to the transitional arrangements, continued use of the IK must be regulated in terms of a licence agreement entered within 12 months from the date of commencement of the Protection, Promotion, Development and Management of Indigenous Knowledge Act of 2019. There is no indication that users can expect to be granted a licence to continue or on terms which would make it viable to do so. The implication is that indigenous communities will have to register such pre-existing IK, presumedly also within 12 months if the obligation on pre-existing users is to make sense. However, it remains to be seen what would constitute a realistic time period to expect communities to register pre-existing IK. Since the Act does not apply outside of South Africa, the indigenous community will not be able to rely on the Act to claim benefits from commercial success derived from the use of the IK outside of South Africa. For IK which originates in a foreign jurisdiction and is used in South Africa, the application of the Act is dependent on a reciprocity agreement being in place to protect South African IK in that jurisdiction. Finally, perhaps the most pressing concern is the relationship between the Act and the protection and recognition of overlapping IK under the Intellectual Property Laws Amendment Act 28 of 2013 and the Patents Act of 1978. The Act explicitly states that it "*does not alter or detract from any right in respect of any statute or the common law"* and that compliance with "*any procedures or requirements laid down in the Act does not constitute compliance with any procedures or requirements imposed in any other Act"*. The implication is that any creation or innovation which involves IK may be regulated by more than one, possibly conflicting, law. This also puts a damper on any hopes that the much-maligned Intellectual Property Laws Amendment Act 28 of 2013 is on its way out.

7. **Fragmented state of IKS**: Another huge challenge hindering the integration of IKS in the NIS is the fragmented state of the system. South Africa has different national Departments administering IKS related legislative frameworks; however, they define IKS differently which has the potential to create misunderstanding. The DSI, for instance, place a lot of emphasis on communities and have the opinion that IKS is community owned. The Department of Environmental Fisheries and Forestry on the other hand use the term traditional knowledge which can either be individually owned

or community owned. This poses a confusion to the research community and the sector. It is however important to note that South Africa has very strong legislative frameworks.

Some of the low hanging fruits or opportunities that could help drive the integration of IKS in the healthcare sector include examining the existence of traditional fruits, traditional edible insects, indigenous practices in rehabilitation and indigenous healthcare practices in addressing mental illnesses. Indigenous practices in healthcare promotion and disease prevention are utilised by millions of people all over the world. However, such practices are not well-documented. The majority of South Africans utilise national resources such as herbs, roots and leaves in healthcare promotion and disease prevention and access their healthcare services through traditional healthcare practitioners and traditional medicines. Traditional fruits such as *thanzwa* or *sourplum, tsuma* (Vangueria infausta), *thungulu* or *num-num*, *nombela* or *lychees and habu* (watermelon) contain vitamins C and D, which protect our bodies by enhancing the immune system and assist in preventing conditions such as colds and influenza. Many other indigenous fruits consumed by indigenous people are nutritious, and some contain vitamins and minerals which are essential for growth, prevention of disease and promotion of healthcare. Edible traditional insects such as mopani worms are highly rich in protein and fats. They can be taken as a snack or with porridge and contain properties that protect our bodies from worn-out tissues and provide energy and warmth. Protein from these insects helps in the prevention of malnutrition and is used traditionally in the prevention and treatment of Marasmus and Kwashiorkor. Traditional or indigenous practices also play a vital role in the rehabilitation of patients. One of the ways of rehabilitation is thorough cleansing, where the blood of a slaughtered animal is used to wash a sick person so that the person is completely healed. Herbs can also be used for the same purpose, where they are mixed with water and used to wash the body for several days. In South Africa, among *Vatsonga*, some rehabilitative practices include bathing children who are recovering from measles, in a clay pot called *xirhengele* with water mixed with red soil called *tsumani* to hasten recovery. Indigenous healthcare practices play a substantive role in addressing mental illnesses in different communities in Africa. Mental illness is a healthcare problem that disturbs an individual's thinking and capacity to cope with everyday life. In South

Africa, mental illness, often referred to as *bogafi* in the Setswana or Sepedi language is highly prevalent, and people consult traditional healers of indigenous knowledge holders daily in search of treatment (Moloko-Phiri et al., 2022).

6.4. INCLUSION OF GRASSROOTS INNOVATION IN THE MAINSTREAM NATIONAL INNOVATION SYSTEM OF SOUTH AFRICA

As indicated earlier in Chapter 3, the NIS has for a long time ignored the innovations that emanate from traditional or IK in the informal sector namely grassroots innovations (Gupta, 2013).

According to Daniels (2014), the recognition of innovation at grassroots level, has become a prominent feature in scholarship on inclusive and sustainable development, and STI discourse. Grassroots innovation has the potential to open up spaces for knowledge production (particularly that originates from IKS) that could be relevant to innovation policy, bringing about much needed plurality in the pursuit of economic development. Based on a study conducted in Nigeria, Daniels (2014) proposes the following policy interventions and support that can help promote grassroots innovation:

1. **Foster collaborations**: One of the challenges discussed earlier relates to the lack of collaboration between IK holders, scientists, and researchers and between traditional healthcare practitioners and practitioners in formal healthcare sector. There is therefore an important, need, to fostering collaborations between the different stakeholders. Policy support in this area may also extend to include blending of the current western STI-driven knowledge systems and IKS, in public policy - for example in the adaptation, diffusion, scaling up and commercialisation of products. Appropriate government policies may help link business, economic, legal, STI sectors and support innovation at grassroots, for instance by engaging intermediaries and knowledge brokers and bridging gaps (Daniels, 2014).
2. **Build Capabilities:** Building capacities and mechanisms for mapping, scouting, documentation, database development and dissemination of innovation at grassroots is critical in order to ensure that the innovations remain inclusive, continues to create wealth for the local innovators, and contributes to sustainable development. Building

capabilities will help facilitate policy support that enables the development and implementation of a framework that better clarifies to NIS actors and stakeholders (regulators, policymakers, industry, academia and so on) what innovation at grassroots is, how it may be captured, and its role in fostering sustainable development (Daniels, 2014).

3. **Strengthening National System of Innovation**: Government policy support geared towards strengthening the NSI may help clarify the role of actors and institutions in promoting, facilitating, shaping, and enhancing the potential gains of innovation at grassroots towards addressing local needs and contributing to national development (Daniels, 2014).
4. **Knowledge sharing and diffusion and application of STI**: Another area policy intervention may be needed is in strengthening knowledge sharing and diffusion amongst and between the grassroots innovators and with the formal NIS. Policy support may also help in the transfer and application of advancements in modern STI to innovators at grassroots. STI can provide technical support bases, aid experimentation of new ideas by local people, enhance creativity and entrepreneurship, and potentially boost profitability (Daniels, 2014).

If implemented, these policy interventions have the potential to assist in the integration of IKS in the STI-driven NIS and help build and strengthen the fragile relationship between and among IK-holders, scientists and/researchers and policymakers.

The 2019 White Paper on STI and its implementation document, the STI Decadal Plan 2022-2032, recognise that grassroots innovation, as a particular priority within the broader innovation for inclusive development agenda, has gained prominence in STI initiatives, both globally and in South Africa. The two policy documents undertake to support and make funding available for grassroots innovation. Government also undertakes to further leverage the potential of publicly funded Intellectual Property to support grassroots innovation (Department of Science and Innovation 2019; 2022).

6.5. CONCLUSION

In this chapter, the analysis of the research findings has been presented by responding to the first research question regarding the extent to which IKS is integrated in the current NIS of South Africa for the healthcare sector. The chapter also presented some of the challenges and opportunities of integrating IK in the STI systems with a focus of the healthcare sector. The next chapter presents the conclusions and recommendations of the study.

CHAPTER 7: CONCLUSION AND RECOMMENDATION

7.1. INTRODUCTION

This study explored the extent to which IK and Indigenous IKS are integrated in the STI-led systems for the healthcare sector as part of growing socially impactful innovations in South Africa. The previous chapter described in detail the findings of this study after an analysis of the data gathered. The purpose of this chapter is to draw conclusions and make policy recommendations for present and future research based upon the findings.

The primary research questions of the study were as follows:

1. To what extent is IK, which is the main ingredient of African traditional medicines RDI integrated in the South African STI-led NIS for the healthcare system as part of addressing the socio-economic challenges faced by South Africans?
2. Why has there been a passive response by and or from IK-holders, R&D institutions, industry, and Government to integrate IKS in STI systems?

7.2. KEY CONCLUSIONS OF THE STUDY

This study also agrees with policymakers and scholars that the performance of any country's economy, in a globalising knowledge economy depend to a large degree, on innovation and knowledge. A knowledge economy is founded around a well-functioning NIS and such knowledge which takes different forms. Scholars such as Hooli and Jauhianen (2018) emphasise that IK and IKS are potential essential elements for developing a NIS that is inclusive, however, over the years, IKS has been overlooked and undermined. IK and IKS are concepts used by researchers and policymakers to broadly capture bodies of knowledge and knowledge systems that are localised and unique to a given culture or society (Ellen and Harris, 1996; Ahmed, 1994). The degrading of IKS by the current STI- driven system could be traced back, to a certain extent to the denial of African humanity, which dates to the conquest, human trafficking, settler colonialism and occupation, which is also linked to an obstinate reluctance to decolonize the academy. It is important to note that IK and IKS are separate from modern scientific knowledge

systems, international or modern knowledge which includes knowledge created by universities and research institutions and are STI-driven (Tharakan, 2014).

Document analysis and semi-structured interviews were used for data collection for the study in order to explore the extent to which IKS is integrated in the current STI-driven NIS of South Africa and to identify challenges for integrating IKS in the NIS. The official documents for the document analysis included the 2019 White Paper on STI, the STI Decadal Plan (2022-2032), the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019 and the Indigenous Knowledge System Policy of 2004. Data collected were assessed against the following categories:

- **Complementary policy goals, priorities, and scope**: The content analysis observed from the semi-structured interviews and the document analysis suggest that the 2019 White Paper on STI (including of the Decadal Plan) and IKS Policy (including the Protection, Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019), are to some extent have complementary scope, mandates, and priorities in relation to the integration of IKS in the NIS of South Africa. The overall findings presented also suggest that there is to some extent integration of IKS in the NIS of South Africa.

- **Factors hindering the integration of IKS in the NIS**: Respondents from the semi-structured interviews indicated that IKS is not well inclusive in the currently NIS to the level that the Department of Science and Innovation would like to see. There have been some minor successes, but the country is way off the mark in terms of integrating IKS in the NIS generally. The 2019 White Paper on STI and the Decadal Plan do not make any mention of the factors that hinder the integration of IK in the NIS, particularly around traditional medicine. None of the official documents explicitly mention the establishment of a common assessment, monitoring and evaluation mechanisms/ methodologies, and tools to assess the integration of IKS in the NIS. The Indigenous Knowledge Policy, however, indicate that the most important issues hindering the practice of traditional medicine fall into four categories namely:
    - National policy and regulatory frameworks.

- Safety, efficacy, and quality
- Access; and
- Rational use.

The Policy acknowledges that there is a need to intensify RDI work in this area, particularly as it relates to recording and supporting traditional healers on safety and accessibility, among others.

Other challenges that hinder the integration of IKS in NSI, flagged by responds include:

- Lack of buy in of all stakeholders and champions of IKS. (This has been the biggest challenge)
- Lack of sufficient resources and little investment (particularly financial resources)
- Beneficiation (equitable beneficiation)
- Fragmented system, alinement, and lack of a national coordination system. The different role players have different mandates and there is a challenge to integrate everything from a national perspective in order to advance the sector.
- Limited human capacity development (quality of scientists and researchers and illiteracy among IK-holders).
- Lack of general awareness of IKS (particularly IKS legislations).
- The indoctrination that IKS is bad, which leads to sceptical behaviours.

- **Institution or agency that would oversee the integration of Indigenous Knowledge System in the National Innovation System**: Both the 2019 White Paper on STI and its implementation Plan, the STI Decadal Plan do not make explicit mention of any institution or agency that would ensure the integration of IKS in the NIS particularly for the healthcare sector. The Indigenous Knowledge Policy, on the other hand calls for an establishment of an Indigenous Knowledge System Fund to support institutions that will assist Indigenous and local communities in the categorisation and characterisation of their biological resources, innovations, practices, and technologies. The Indigenous Knowledge System Policy (and the Protection,

Promotion, Development and Management of Indigenous Knowledge Act 6 of 2019) also call for the establishment of the NIKSO.

7.3. RECOMMENDATIONS

In order for South Africa to speed track the integration of IKS in the NIS particularly for the healthcare industry, the NIKSO could perhaps be upgraded into an institute or science council that primary focusses on IKS. Similarly, the establishment of a dual healthcare system where IK and western healthcare system coincide may help enhance such integration. This institute/science council could cover the entire value-chain, involving an interface of medicines emanating from IK into the health, STI systems, R&D, teaching, training, primary production, industrialisation, commercialisation, and clinical application. Thematic areas could include Cosmeceuticals, medicines emanating from IK (for example., natural medicines), nutraceuticals, health infusions and vaccines. The proposed IKS Institute/Council would develop safe, quality, efficacious and fit for intended purpose of medicines emanating from IK. The mission would be to employ African traditional medicines RDI, and commercialisation for socio- economic growth. The primary objectives of the Institute would be to harness the sustainable use and application of the biodiversity of South Africa to enhance the socio-economic contribution of medicines emanating from IK. Specific objectives could include:

1. The promotion of unified collaboration for research, innovation, and skills development.
2. The establishment of an integrated innovation value-chain for medicines and products emanating from IK products, inclusive of various indigenous communities of practice.
3. Support of technology transfer and acceleration for wealth creation and development of thriving and healthy societies.
4. The establishment of world-class plant-based manufacturing industries for commercialisation of safe, quality, and efficacious medicines and products emanating from indigenous knowledge.
5. The development of common research methodologies for standardisation of IK-based plants medicines and products.

6. The contribution towards economic development, job and wealth creation, and skills development in addition to curriculum development and teaching. Human capital developed will produce intellectual property, leveraging infrastructure funding and attract international resource sharing.

The strategic priorities of the proposed IKS institute would be informed by global health challenges, such as:

1. Emerging and re-emerging infectious diseases such as Covid-19, tuberculosis, malaria, HIV/AIDS, etc.
2. Non-Communicable Diseases like diabetes, cancers, hypertension, etc.
3. Neurodegenerative diseases like stroke, dementia, etc.
4. Human capital and skills development for research, teaching, manufacturing, and clinical application.
5. Infrastructure development, for example., laboratories and manufacturing facilities.
6. Enterprise development for manufacturing, marketing, and commercialisation.
7. Piloting an integrated and dual healthcare system where IKS and western STI-driven healthcare systems coincide.

At the inception of proposed IKS institute, a committee to steer the formative aspects of the Institute will need to be established. The Committee could comprise of officials from the DSI, Department of Health, Department of Agriculture, Fisheries and Forestry and other Departments that have a stake in IKS health matters, prominent researchers, scientists, and representatives/organisations of IKS holders (including traditional healers) and representatives of IK communities. This holistic approach would promote inclusive and sustainable development of economies, wealth, and self-reliance on health for the whole of South Africa. This could also be viewed as a solution to the rising cost of medicine development and medicines that aim to address emerging and re-emerging epidemics and pandemics for rapid and emergency responses. The success of the institute will depend on meaningful and participatory collaboration of various role-players. It will be imperative that IK-holders, traditional healers, and communities be afforded the right and opportunity to participate in the inception of the Institute. Therefore, consortia and agreements will need be forged among government departments, academia,

communities, private sectors, IK-holders and, to a certain extent, other countries, and international organisations. A well-aligned funding model will also need to be created, and this will need to be a one-stop-shop that funds IKS RDI. The fund will need to be designed in such a way that there is continuity from product development and technology transfer to enterprise development, manufacturing, and commercialisation.

There will certainly be need for a feasibility study or additional research to inform the implementation strategy and funding models for the proposed IKS institute. High level studies will be necessary in order to determine the value of this proposed initiative, full costs, management models and shared responsibilities.

When it comes to the regulation of traditional medicine, the Government of South Africa may consider relaxing the regulation by allowing some IK products that have a proven history of long use to be registered as herbal or complimentary medicines. The country will need to explore new ways on how to regulate African traditional medicines or healthcare products emanating from IK without neglecting IK holders and communities. It is also important to note that countries such as Mali as mentioned by Kasilo et al., (2019), have introduced several complementary structural and functional approaches for evaluating the competency of traditional health practitioners, registering them, and integrating them into the healthcare delivery system. The department certifies and registers those traditional health practitioners who meet stipulated criteria. One crucial criterion is the evaluation of the individual's practice involving 30 cases per disease regarding efficacy and safety for about 4 months. The proposed establishment the institute on IKS could look into introducing a similar system to evaluate the competency of African traditional medicine in South Africa.

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ANNEXURE A: INTERVIEW GUIDE

Date of Interview: _____

Time of Interview [hh:mm (use 24-hour clock)]: _____

Name of Interviewee _____

Name of organisation/affiliation _____

Position _____

Interview questions (10)

Theme1: Policy and strategy aspects.

1. Does the Department of Science and Innovation or your organisation have a national policy or strategy dedicated to IKS? If yes, when was it last updated?
2. How does the Department of Science and Innovation or your organisation ensure that IK-based innovations are brought into the healthcare industry value chain?
3. Does the Department of Science and Innovation have a relationship with IK-holders, and Industry role players? If yes, how would you characterise this relationship?

Theme 2: Integration of IK in the National Innovation System of South Africa.

4. How do you think IK can be integrated into the National Innovation System (NIS) particularly for the healthcare industry? Do you think the establishment of an IKS Institute or Council could enhance the integration of IKS in the NIS?
5. What do you think are the main challenges of integrating IKS in the South African National Innovation System particularly for the healthcare industry?
6. How do you or our organisation intervene in dealing with these challenges?

7. What can be done to build capacity for IKS for it to be useful for the healthcare industry?

Theme 3: An Inclusive National Innovation System

8. Do think the South African National Innovation System is inclusive for IK-holders/practitioners? If not, how do you think the government/industry/science councils/universities can intergrade IK-holders for a more inclusive National Innovation System?

9. What do you think needs to be done to foster collaboration between IK-holders, R&D institutions, industry, and government?

10. Do you think IK-holders are agents for socially impactful innovations? If yes, which new products have been developed for the healthcare industry by IK-holders?

ANNEXURE B: CONSENT FORM

Dear Respondence

My name is Kagiso Moloto and I am currently a Master's student at Wits University Business School, enrolled for the Master of Management in Innovation studies (MMIS) and as part of my studies, it is expected that I conduct a research project entitled *Indigenous knowledge and science, technology and innovation-driven systems for the healthcare industry in South Africa.*

I hereby request your participation in this research project as one of the respondents. Should you decide to participate, please be informed that this interview is recorded and will strictly be used only for the purpose of this study. You are welcome to have a witness or observer in the study and you are also advised to decline or to request to withdraw from the interview should you feel the need to at any time. In addition, you are free to withhold any information you feel is confidential. Please request for more clarity should you fail to understand the questions asked. With this aforementioned background, do you consent to participate in this interview? _____

Name of Respondent: _____

Signature of Respondent: _____

Date: _____

Name of Witness: _____

Signature of Witness: _____

Statement by Researcher

I have provided all the information to the potential respondent and to the best of my ability made sure that the respondent understands that he/she will be interviewed. I do confirm that the responded was offered an opportunity to ask questions for clarity or anything about the study. I also confirm that the participant was not forced, threatened, or coerced into giving consent, and that consent has been given freely and voluntarily.

Name and signature of Researcher: _____