National E-health Innovation

Conduct of International E-health Technology Transfers in Africa

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The thesis is submitted in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy of the University of Portsmouth

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The farther backward you can look the farther forward you are likely to see.

Winston Churchill

Work [innovation] is the medicine for poverty.

A Yoruba Proverb

Abstract

The sociology and economics of the conduct of international e-health technology transfers (IeTTs) is examined. Most African countries are perennial recipients with variations in their domestic e-health utilisation, development and implementation. We identify, explore, and demonstrate how complex and interlinked global, continental, national and subnational actions and institutions condition their national e-health implementations.

Multidisciplinary literatures are from national e-health implementations, national innovation system (NIS) interactive learning, international technology transfers, global development and globalisation. Methodically, a unique combination of middle-range and moderate Science and Technology Studies constructivism, NIS institutionalism and Deleuzian poststructuralist narrative is employed.

The conduct of IeTTs is characterised by technological path-dependency, history, complexity, power, politics, multiple identities, self-interests and contestations in complex global and transnational interactions. Recipients' exercises of *National Agency* mirror their varied domestic technology acquisition dynamics and trajectories.

Successful transfers are institutionally conditioned by interactions of global geopolitics, fragmented continental governance and national reticence. Agential asymmetry that results, accounts for why most recipients are variably struggling in their technology acquisitions.

The exercise of *National Agency* is paramount. National economic size and maturity of extant national innovation capacity can determine if a recipient can acquire domestic e-health innovation and industrial competences. Actions taken by National governments, can strategically determine if technologies are accumulated and technical knowledge assimilated, for addressing the challenges of technology inappropriateness, incompatibilities and obsolescence encountered during subnational utilisations.

We contend that implementing a national e-health infrastructure is a long-term and large-scale *institutional engineering* endeavour. *Cumulative advantage* explains difference between Schumpeter and Schumacher on e-health technology design and production. A Schumpeterian domestic *industrial* model of hi-tech e-health technology development, rather than a cosmopolitan Schumacher *consumerist* one, is proposed.

Whilst, appreciating that Schumacher on incremental accumulation and assimilation from small-scale technological implementations can be instrumental.

Uniquely, we identify that global geopolitical contention between global west and east economies and competitive global markets and global technoeconomic changes can either *condition* scale and depth of domestic acquisition. Nevertheless, these conditions and events have historically and contemporaneously shaped global e-health innovations.

In a Schumpeterian evolutionary sense, Satcom technologies that powered e-health services in the past are now being substituted by mobile ones. This technological transition is bringing about a convergence of consumer electronics (i.e. Smartphones) and lifesciences industries, driven by a combinatorial biomedical, telecommunication and computing e-health innovations.

With these findings, an *innovation*-based macro-societal perspective is proposed for studying e-health implementation, as opposed to the prevalent *information*-based micro-behavioural studies. Further contributions to academia and policy are made to ICT4D, Global Health and m-health practices.

Policy recommendations are made to national, continental and global institutions on how to foster national technology acquisitions. Recipients are encouraged to *learn* from incremental domestic e-health implementations in global technology frontiers. Their share in intellectual property rights accruing from global-subnational e-health co-innovations must be repatriated.

We conclude by proposing a global collaboration framework to guide and to foster cooperation amongst those involved in the conduct of IeTTs. *Symmetry* – an alignment of vertical hierarchical and diffuse horizontal complex sociotechnical interactions, though, not as the implied flat, circumscribed and cyclical dynamics of actor network theory, is proposed. So, an alignment of the constitutive diverse and competing interests and identities, is deemed strategic, to foster domestic accumulations and assimilations.

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Declaration

Whilst registered as a candidate for the above degree, I have not been registered for any other research award. The results and conclusions embodied in this thesis are the work of the named candidate and have not been submitted for any other academic award.

Adesina Iluyemi

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Abbreviations

ADF- Africa Development Forum

AfDB- African Development Bank

AIS- African Innovation System

ANDI- African Network of Drug and Diagnostic Innovation

ANT- Actor Network Theory

AU-African Union

DFID- Department for International Development

DSF- Digital Solidarity Fund

EC- European Commission

ECOWAS- Economic Community of West African States

EHR- Electronic Healthcare Record

EU- European Union

HITECH- Health Information Technology for economic and Clinical Health

ICT4D- Information and Communication Technology for Development

ICTs- Information and Communication Technologies

IDO-International Development Organisation

IeTT-International e-health technology transfer

IGO-International Governmental Organisation

iNGO- International non-Governmental Organisation

IS- Information System

ISO- International Standard Organization

ITT – International Technology Transfer

ITU- International Telecommunication Union

MDGs- Millennium Development Goals

NEPAD- New Partnerships for Africa's Development

NIS- National Innovation System

NPFiT- National Programme for Health IT

OECD- Organisation for Economic Co-operation and Development

RASCOM- Regional African Satellite Communications Organization

SADC- Southern African Development Community

SCOT- Social Construction of Technology

STI- Science Technology and Innovation

STS- Science and Technology Studies

UN- United Nations

UNDP- United Nations Development Programme

UNECA- United Nations Economic Council for Africa

WHO- World Health Organization

WTO- World Trade Organisation

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Dissemination

The following is a list of publications and presentations made by the author of this thesis during the course of the work described here.

Publications

Journal Papers

1. A. Iluyemi & V. Androuchko, Building the African Union Continental-wide eHealth Network: Making the case for Broadband Wireless/Mobile Networks. Journal of eHealth Technology and Application Vol. 6, No 1 July 2008.

Book Chapters

1. Iluyemi A. Community based health workers in developing countries and the role of mHealth. Published in "Telehealth in Developing World" Royal Society of Medicine, England 2009: ISBN 978-1-85315-784-4.
2. eHealth and Global Health: Investments Opportunities and Challenges for Industry in Developing Countries, Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering Springer Berlin Heidelberg 2008 ISSN 1867-8211.

Conference Papers

1. **Adesina Iluyemi** & Jakob Rasmussen. Innovation and Entrepreneurship for eHealth in Africa: A Conceptual Framework. Presented and published by Science with Africa, United Nations Economic Council for Africa. Addis Ababa, Ethiopia. August 2010.
2. Simon Adebola & **Adesina Iluyemi**. Space Policy for Public Health Innovations in Africa. Presented and published by Science with Africa, United Nations Economic Council for Africa. Addis Ababa, Ethiopia. August 2010.
3. Julius Mugwagwa, Rebecca Hanlin, **Iluyemi Adesina**, Joanna Chataway, David Wield and James Smith. Systems of Health Innovation in Africa: Policy Lessons from Home and Abroad. Presented and published by Science with Africa, United Nations Economic Council for Africa. Addis Ababa, Ethiopia. August 2010.

4. Phillip Olla & **Adesina Iluyemi**. People centeredness in Disaster and Emergency Management: Proposing the African Early Warning Information Network. Presented and published by Science with Africa, United Nations Economic Council for Africa. Addis Ababa, Ethiopia. August 2010.
5. Ensuring Sustainable Internet Access for Development in Africa: Insights from mHealth Innovations, M4D 2008, Karlstad 2008.
6. Iluyemi A. Murdoch I. Developing a successful Global eHealth Partnerships: Lessons from a decade experience. RSM, Telemed & eHealth 2008, London.
7. Iluyemi A. eHealth and Global Health: Investments Opportunities and Challenges for Industry in Developing Countries. eHealth 2008, London.
8. Iluyemi A., Briggs J. Policy and Change Management Implications in Building a Continental-wide eHealth Network in Africa: What Can We Learn From the NEPAD e-Schools Programme? Abstract and paper from EU-IST Africa conference, 7-9 May 2008, Windhoek Namibia. Full paper to be published in the conference proceedings.
9. Iluyemi A., Briggs J. Access and Connectivity for Community Based Health Workers in Developing Countries: Employing Wireless Technologies. Abstract and paper from "The International Educational and Networking Forum for eHealth, Telemedicine and Health ICT: Med-e-Tel 2008", 16-18 April 2008, Luxembourg. Full paper to be published in the conference proceedings.
10. Iluyemi A., Parry D., Fitch T., Briggs J. Mobile/Wireless for e-Health Provision in Africa: Opportunities for GSM-based Patient-Centric Services. Abstract and paper from "The International Educational and Networking Forum for eHealth, Telemedicine and Health ICT: Med-e-Tel 2007", 17-20 April 2007, Luxembourg. Full paper in the conference proceedings. ISSN: 1818-9334.
11. Exploiting EU-IST Mobile eHealth Programmes for Developing Health System and Human Resources in Africa: A Short Compendium and Policy Implications. Abstract and paper from "eChallenges 2007: Expanding the Knowledge Economy-Issues, Applications, Case Studies, 24-26 October 2007, The Hague, Netherlands. Full paper in the conference proceedings ISSN 1574-1230.

12. Iluyemi A. Fitch T., Parry D., Briggs J. Health Information System for Community Based Health Workers: A Case for Mobile and Wireless Technologies. Abstract and paper from EU-IST Africa conference, 9-11 May 2007, Maputo Mozambique. Full paper published in the conference proceedings. ISBN: 1-905824-04-1.

13. Iluyemi A. Briggs J., Adams C. Mobile Information System, Health Work and Community Health Workers in Less Developed Countries. Abstract and paper from The 5th International Workshop on Distributed and Mobile Collaboration, DMC 2007. 19 June 2007, Paris France. Full paper published in the conference proceedings. ISBN 0-7695-2879-1.

14. Iluyemi A. Briggs J., Fitch T. Electronic Health Records in Developing Countries, integrating with Mobile Technology and Legacy Systems for Community Based Health Workers: Organisational and End-Users' Issues. Abstract and paper submitted for The European Conference on Information Management and Evaluation. In ECIME 2007, France 20-21 September, Montpellier. Full paper published in the conference proceedings.

Published Articles

1. Adesina Iluyemi, Teleradiology and Telepathology: Applications in Clinical Dentistry, UK Health Informatics Today Newsletter of the UK Health Informatics Society. No 53, Spring 2007.

2. Adesina Iluyemi, Ambient mobile/wireless networks for health system development in Africa. Article submitted for the eHealth Magazine (http://www.ehealthonline.org/) for publication in June 2007.

3. Adesina Iluyemi, A policy rethink for the impending UK-developing countries eHealth technology transfer, BCSHIF, HINOW 2008.

4. Adesina Iluyemi, Application of Mobile Computers and Wireless Technologies in Clinical Dentistry, UK Health Informatics today Issue 57, 2008.

5. Adesina Iluyemi, eHealth Strategy Roadmap for Africa, eStrategies Africa February 2009.

Conference Presentations

1. **Speaker and Panellist**, eHealth - Panacea or placebo Telecom-Finance Conference January 2011. London, UK.
2. **Speaker and Panellist**, Adesina Iluyemi, mHealth in Developing Countries Past, Present and Future: Introducing MoDiSe. MC ThinkCamp June 2011. London, UK.
3. **Speaker and Panellist**, eHealth to mHealth: The State of Play, Mobile Device Management, June 2011. M2M Insights Maidenhead, UK.
4. **Speaker**, mHealth and Medical Devices Convergence: The State of Play, Wireless World Research Forum (WWRF #26) April 2011. Doha, Qatar.
5. **Speaker** at the GovTech 2009 Conference: The '5Is' Perspective for Sustaining eHealth at the National Level in Africa. ICC Durban, South Africa September 2009.
6. **Speaker** at the Health Commission, WITFOR 2009: eHealth/Telemedicine Sustainability in Developing Countries: Issues for Policy Development; The 5Is Perspective. Hanoi, Vietnam August 2009.
7. **Speaker and Panellist**, Mobile Healthcare Industry Summit, December 2009 & 2010. Informa London.
8. **Speaker** at the mWatch Mediterranean Summit: mHealth Services & Technologies: Players, Value Chain & Proposition. Global Living Labs, Zurich Switzerland, April 2009.
9. **Speaker** at the Europe-Africa ICT Summit 2009: Refocusing Europe-Africa Strategy: Strategic Importance of eHealth. European Commission Brussels, Belgium March 2009.
10. **Presenter & Workshop Chair at** eHealth Sustainability in Developing Countries Workshop, March 2009 KTH Stockholm, Sweden.
11. **Speaker,** Financing sustainable mHealth projects in Africa @ Health Informatics in Africa (HELINA) 2009, Abidjan Cote d' Ivoire.
12. **Speaker,** Analysis of the UN/Vodafone Foundation Report on mHealth in Developing Countries @ WWRF #22, Paris, April 2009.

13. **Speaker,** Universal Health Service Delivery in Nigeria: Leveraging The Emerging Telecom Infrastructure for an Integrated eHealth Network @ PACTe/NICTe September 2008 Abuja, Nigeria.
14. **Keynote Speaker** at the GovTech 2008 Conference: at the GovTech 2008 Conference: Africa eReadiness: opportunities, challenges and future. ICC Durban, South Africa July 2008.
15. **Speaker**, Building the African Union Continental eHealth Network: Making the case for Low Cost Wireless Broadband Infrastructure. Presented at the ICT-Africa 2008. 13-14 February 2008 UNECA, Addis Ababa Ethiopia.
16. **Chair e**-Applications session: Novatech ICT Africa Market Place 2008. 13-14 February 2008 UNECA, Addis Ababa Ethiopia.
17. **Speaker,** BEANISH: Europe – Africa Synergies on ICT Strengthening Collaborative Networks. 9th March 2007 European Commission - Brussels.
18. **Speaker**, The role of telemedicine against diseases and in health promotion, International Conference. November 30, 2007 Senato della Repubblica, Rome Italy.
19. **Speaker,** eMobility Mobile Communications &Technology Platform Staying ahead! 2nd Workshop on Shaping the Future of Mobile and Wireless Communications Rome, Italy. September 25 2007.
20. Global Health Enterprise Architecture, Jan B.M. Goossenaerts, **Adesina Iluyemi**, Kaushalesh Lal @ 21st International CODATA Conference, Kyiv, Ukraine, October 2008.
21. **Iluyemi A**. Building Capacity for Health Workers in Developing Countries: M-Libraries concept/proposal. Presented at The First International m-libraries Conference 13th -14th November 2007 at the Open University, Milton Keynes, UK.
22. **Iluyemi A.** Roland A. Burger, The low cost technology paradigm shift. Outlooks on the potential of low cost laptop computers and wireless network infrastructure towards health workers and health system development in Africa. Presented at The role of telemedicine against diseases and in health promotion,

International Conference. November 30, 2007 Senato della Repubblica, Rome Italy.

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25. **Iluyemi A.** Mobile eHealth for health workers in developing countries: impacts on organisational process and users' behaviour: Research in progress. Presented at the Mobiles and Development: infrastructure, poverty, enterprise and social development UK Development Studies Association "Information, Technology and Development" Study Group**.** 16 May 2007. University of Manchester, UK.

26. **Iluyemi A.** Mobile/Wireless solutions, end-users' and organisational issues. Presented at the OpenMRS Implementers Group Meeting, 22-26 April 2007 - Monkey Valley Resort, Cape Town, South Africa.

27. **Iluyemi A**. Internationalisation of EU mobile/wireless e-Health IST Projects to Africa for health professionals and patient care support BEANISH: Europe – Africa Synergies on ICT Strengthening Collaborative Networks. 9th March 2007 European Commission – Brussels.

Dedication

To the memory of my Father

1 Introduction

1.1 Background

Globally and nationally, the rapid diffusion of telecommunication, computing and biomedical technologies in health systems is transforming how care is delivered. Together with technologies from genomics, mobile computing, antibiotics and vaccines, e-health technologies provide exciting and potential tools for providing innovative medical care in the 21st century. Inspired by global technology optimism, countries from around the world are formulating national e-health policies and are implementing national e-health initiatives. This is a welcome development, and African countries are not being left out of this trend of globalisation.

For most African countries, e-health provides a technological platform for providing and extending quality and efficient healthcare to its teeming and geographically dispersed population. E-health[1] is needed as one of the tools for addressing the myriad challenges facing healthcare delivery in Africa. Most of the countries have also formulated national e-health policies and are aspiring to implement national e-health initiatives, and are dependent on international e-health technology transfers (IeTTs). Not least because, being a recipient of technology transfers is needed for and contributes to domestic innovation capacity acquisition. However, little research has been conducted on the depth, scale and variation of such African countries' acquisitions from IeTTs.

This study is underpinned by four years collecting multiple and messy qualitative data during fieldwork and in participating in fora and meetings in Africa at national and international levels on e-health innovation (design, invention and production) and utilisation. Our immersion in the policy and technical spaces of eHealth, science and technology, Global Health, and international development meetings, conferences and fora, and in contributing to e-health policy-making at national and international levels, is evident in the thesis. The immersion has revealed an inherent complexity, ambiguity and uncertainty in the conduct of IeTTs in Africa. It has made our appreciation of how the development and utilisation of e-health technologies can be re-interpreted as an

[1] The author's view of e-health use and development was partly shaped by attending series of meetings and conferences organised by the *Telemedicine and eHealth* section of the Royal Society of Medicine. These have been useful in the appreciation of the scope, scale, benefits and risks of e-health use and development.

innovation system cutting across subnational, national, continental and global institutions.

1.2 Defining e-health

There are many definitions of e-health in the health informatics literature. A systematic review carried out by (Oh, Rizo, Enkin, & Jadad, 2005) identifies 51 different meanings of e-health as defined by different actors, academic institutions, professional bodies, and funding organizations, with no single and accepted definition. With multiple definitions of e-health come different meanings ascribed to it by plural actors and organizations from various and diverse perspectives, geographies and contexts that are involved in its development and utilisation.

The preferred definition is provided by the World Health Organisation. The World Health Organization (WHO) defines eHealth as *the secure and cost-effective transmission and exchange of health data and information either locally or at a distance* (World Health Organisation, 2004). According to the WHO, e-health is made up of different functional sub-sets such as telemedicine, electronic health record (EHR), m-health (World Health Organisation, 2011). This definition captures the functional element of e-health but it does not demonstrate the social, cultural and political impact of networks of actors and organisations in the development and utilisation of e-health technologies from the context of international technology transfers (ITTs). Even if 'at a distance' implies that an exchange of health data occurs trans-nationally and internationally, it does not also explicitly highlight the relevance of e-health technologies in the transfer process.

The following definition from (Eysenbach, 2001) provides a holistic conceptualization of e-health from the context of international technology transfers:

"eHealth is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology"

This definition appreciates and captures the scope and scale of the complex interactions that occur in the development and utilisation of e-health from an international and transnational context. It implies the conduct of an international e-health technology transfer involving multiple stakeholders in a global space (involving actors and organisations across different geographical and organisational boundaries). As such, it draws attention to the commercial, economic, social, cultural and political aspects of e-health. However, the definition is narrowly focussed on utilising the Internet for transferring e-health services and not the transfers of material e-health technologies. In addition, it does not explicitly show the trend of converging computing, telecommunication and biomedical or health technologies (Viziteu, 2008) in the way that (Kaplan, 1987) demonstrated in historical narrative of national e-health implementations in the USA.

For the thesis, we define e-health by combining these different views.

E-health is defined as the use of computing, telecommunication and biomedical technologies for the transfer of health information and data and for the delivery of e-health services either from one point to another or within geographically dispersed and culturally, socially and politically diverse networks of actors and organisations involved in their implementation, development and utilisation.

1.3 Global state of National e-health implementations

Countries from around the world are implementing their national e-health initiatives (mostly focussed on EHRs), and are underpinned by a health information-based strategy of capturing, gathering, storing, sharing and personalising health data (Castro, 2009). In general, it can be observed that *innovation* -based strategy is marginalised in these debates. Little or no attention has been paid in both policy and academia, in a Schumpeterian industrial sense as in (Kaplinsky, 2011; Lundvall, 2007; Mazzucato, 2011; Muchie, 2008; Nelson & Nelson, 2002; Sharif, 2006; Windrum & García-Goñi, 2008), to system and product innovations.

Current policy debates in technology frontier countries are on the safety, effectiveness and efficiency of the utilising e-health technologies, in order to ensure positive patient outcomes and optimal health system performance (impacts). A common observation in these debates is that of the complexity and risks entailed in successfully aligning the interests and preferences of involved multiple and diverse actors, organisations and

technologies. A need for consultation and consensus before and during implementation, were unforeseen by governments, policymakers, regulators and managers – this has been costly and causes of uncertainty. Genuine public and academic interests in the security and privacy of health data are also dominating the policy spaces. The translation of policy into implementation has been dogged by public and political concerns of data protection and security in England (Trisha Greenhalgh, Russell, Ashcroft, & Parsons, 2011; Sheikh et al., 2011). A parliamentary review (Jolly, 2011) on the implementation of Australia's ambitious national e-health initiative is also another prominent example.

In the USA, just four years after the introduction of its national technoeconomic growth stimulant: the Health Information Technology for Economic and Clinical Health act (HITECH) (Buntin, Jain, & Blumenthal, 2010; Kaplan & Harris-Salamone, 2009), its healthcare impacts is coming under critical policy appraisal (Kellermann & Jones, 2013). In England, the debate has been dominated by politics and economics. The incumbent conservative government has reformed the hitherto creaky *National Programme for Health IT in NHS* (NPFiT), partly because of the prevalent austere macro-economic environment. In addition, partly due to a critical and probing policy reviews of the implementation has received from the academia and the public, for example by (W. L. Currie & Finnegan, 2011; Trisha Greenhalgh, et al., 2011; T Greenhalgh & Stones, 2010; Klecun, 2011; Takian & Cornford, 2012). However, in England, a new policy debate is emerging. This is about a contested, political and economical debate that is surrounding the evaluation of the *Whole System Demonstrator* project, a large-scale of e-health (telehealth and telecare) services experimentation[2] .

In these global technology leading countries, the raging policy debates have split academia, industry and policymakers into opposing camps on the right choices of national e-health infrastructural and spatial scales. Generally, debates have dichotomously centred on either the choice of 'large-scale' or 'small scale' implementation. A 'middle way out' approach (Coiera, 2009) acknowledges that

[2] The author's perception of *Whole System Demonstrator* project was partly shaped by and attending *Telemedicine & eHealth 2012 - 3 million and rising: Integrating care, mainstreaming technology* conference by the *Telemedicine and eHealth* section of the Royal Society of Medicine.

building a national e-health infrastructure, is an incremental and modular technology accumulation process (Heeks, 2006). The jury is still nevertheless undecided on how to convert ambitious national policies into large-scale national e-health implementations. Costly policy debates seem not to be evident with Asian countries such as South Korea (Lee, Min, Shin, Lee, & Kim, 2009) and Malaysia (Mohan, Omar, & Aziz, 2002), which are more pro-innovation in theirs.

Nevertheless, an optimistic picture of national e-health implementation is visible in international policy space. Continental e-health policy frameworks are being put in place to foster and encourage national and transnational cooperation in the European Union (Karopka, Frank, & Blank, 2012; A. Lang & Mertes, 2011). An international cooperation between the USA and the European Union (EU) is also being put in place to foster bilateral trans-Atlantic e-health technology transfers, trade and innovation (Friedman, Iakovidis, Debenedetti, & Lorenzi, 2009). Even the World Health Organisation, has published a *National eHealth Strategy Toolkit* (World Health Organisation, 2012) to guide its member states in formulating their national e-health policies and action plans.

The literature on national e-health implementation in health informatics is still emerging. Studies such as on Denmark and Norway (Aanestad & Jensen, 2011; Bergmo & Johannessen, 2006; Ellingsen & Monteiro, 2012), US (Coiera, 2009; Kaplan & Harris-Salamone, 2009), and on England (W. Currie, 2009; W. L. Currie & Finnegan, 2011; Klecun, 2011; Sheikh, et al., 2011; Takian & Cornford, 2012) have conservatively examine e-health technology development and utilisation from an information society and healthcare service utilisation perspectives. They have combined views from health service research, management, organisation science, work studies and information system disciplines.

The studies stress the complexity and uncertainty that characterise the building of large-scale national e-health technology infrastructures. The unique and complex combination of organisational, sociological and cultural factors is commonly highlighted. Not least, because, the dynamics of the systems cyclically and constantly work to align multiple and divergent institutional interests and needs in an actor network theory sense (Sunyoung Cho, Mathiassen, & Nilsson, 2008). As national e-health implementation dynamics occurs in dependent staggered and protracted innovation stages (W. L. Currie

& Finnegan, 2011); which requires that relevant, strategic and institutionalised interactions amongst national governments, industry and healthcare providers evolve and concretise (Coiera, 2009; Klecun, 2011; Takian & Cornford, 2012) in a medium- and long- time scale.

There has, however been a limited analytical focus on the underlying and supporting hardware and physical infrastructure from an innovation system perspective. How innovation or industrial capacity can practically solve encountered problems of technological inappropriateness and obsolescence, is not addressed. Nevertheless, the information-based analysis of e-health has provided us with an understanding of how fastidious health systems are, in the process of developing and utilising e-health technologies. For instance, issues of low utilisation of e-health technologies and organizational inertia are identified as typical barriers at hospitals and clinics. Limited reference to innovation aspect of e-health implementation is identified in health informatics – related publications such as (S. Cho & Mathiassen, 2007; Sunyoung Cho, et al., 2008; Nicolini, 2010), even though a fixation with studying software design and production predominates. These have reveal to us that e-health technologies have to be regularly invented and upgraded, in order to meet and respond to, the demanding and complex and diverse nature of clinical care.

The study of technology in health informatics is conservatively focused on EHR software design and utilisation. Analyses have narrowly examined complex and contested process of software design, its associated issues of data standards and interoperability in national implementations (Aanestad & Jensen, 2011; Coiera, 2009; Ellingsen & Monteiro, 2012; Halford, Obstfelder, & Lotherington, 2009; Johannessen, Obstfelder, & Lotherington, 2012; Kaplan & Harris-Salamone, 2009; Larsen & Ellingsen, 2012). The investigation of development and utilisation of converging biomedical, telecommunication and computing technologies, if investigated from multi-–theoretical and -levels dimensions (Frank W Geels, 2007; Wyatt & Balmer, 2007), has not received its due attention in health informatics.

The global e-health landscape we have scanned that the societal importance of, and interests in, large-scale e-health technology systems is widespread. Issues of technology complexity and uncertainty, and of policy concerns and controversies in such debates, have not been extensively covered in the health informatics literature, but this have been

a preoccupation of science and technology studies (STS) at the interface of technology and health (Lehoux & Blume, 2000; May, 2006). Such issues of public concern with e health technology choices and options, and their transnational and international transfers and utilisations, are covered in the thesis.

1.4 Introducing Africa: Innovation and Governance

The institutionalisation of science, technology and innovation (STI) in Africa is progressing, but there are rooms for improvement. According to the first published *African Innovation Outlook* report (Brundenius & Mawoko, 2010), some African countries such as South Africa and Nigeria have made considerable progress in fostering domestic innovation. Nevertheless, across the continent, the report identifies that there is a considerable room for improvements in committing more finances and developing skilled human resources in order to further institutionalised innovations. In this respect, technology pan-Africanist (Forje, 2006; Lall & Pietrobelli, 2005; Muchie, 2004; Ymele, 2011) call for 'developmental state' – that fostering or forging domestic innovation is a process of nation-building.

The African Development Bank (AfDB) African Statistical Yearbook 2010 puts Africa's population slightly over one billion people, making it almost at par with populous countries such as India and China, but occupying 15% of the global landmass. Nearly the same numbers of Africans are living on far larger landmass. The low demography-geography ratio could make e-health a cost-efficient method for delivering healthcare to the continent's dispersed and far-flung rural and urban populations. Africa is the world's largest geographically homogenous continent with 53 countries. Few are isolated small island states and many of these countries are small sparsely populated landlocked countries, which are surrounded by coastal neighbours.

The sparseness of demography and vastness of geography in Africa highlights the strategic utility and importance of employing e-health for supporting and modernising healthcare delivery. For example, telemedicine for extending and giving access to quality healthcare to disperse population or utilising EHR systems for gathering, analyzing and disseminating clinical and population health data from disperse and remote locations.

The continent is linguistically, culturally and ethnically diverse; for instance, a country like Nigeria has up to 250 diverse ethnic groups speaking almost 300 local languages.

Contemporary Africa as a whole can be classified linguistically along neo-colonial leanings. As a result, African countries are either English speaking or French speaking in their regional aggregation, international geopolitics and national political, intellectual, and societal configuration. This linguistic distinction is highlighted because there exists a pan-African e-health infrastructure for French speaking African countries (Geissbuhler, Bagayoko, & Ly, 2007). Administratively in Africa, policy directives are, ideally, consensually formulated by the cooperation of continental, regional and national political institutions.

Figure 1.1 Map of Africa showing its constituents

Continentally, the African Union (AU), supported by its independent arm, the New Partnerships for Africa's Development (NEPAD) Planning and Coordinating Agency (NPCA), provide political and technocratic impetus into socio-economic policy in Africa. The African Development Bank (AfDB) is a bank in the mould of World Bank, driving economic and financial policy formulation. In addition, the United Nations Economic Council on Africa (UNECA) plays a leadership role, in promoting the adoption of policy on STI for sustainable socioeconomic advancement in Africa. Either

collectively or individually, these institutions collaboratively formulate policies and implement developmental programmes with regional and national institutions.

Regionally, African countries are grouped into geo-economic or political aggregations. Known as Regional Economic Communities (RECs), these geopolitical aggregations are instituted to foster common developmental policies formulation amongst their member states; to ensure economy of scale for infrastructure development, innovations, attraction of investments and for trade facilitation. These aggregations occur on a geographical basis, so for example, West African countries REC is known as Economic Community of West African States (ECOWAS), while their southern African counterparts make up the Southern African Development Community (SADC). ESCA (standing for the Commonwealth Regional Health Community for East, Southern and Central Africa) is an odd example of a regional socioeconomic aggregation working to foster common responses to health challenges.

Nationally, African countries through representations to these continental and regional bodies make contributions to collective policy formulations and decisions. Commonly developed governance models tend to influence national developmental policies, and by extension international cooperation.

1.5 Africa's healthcare challenges

E-health has an enormous potential as an appropriate and timely technology for addressing health problems in African countries, according to African Ministers of Health in 2011 (African Union, 2011, Annex 1, Article 9). The Africa Health Strategy (African Union, 2007), a policy choice also reiterated in 2011 report (ibid.), has a goal to improve Africa's population health through equitable access to essential health services by the year 2015 in order to contribute to the socioeconomic advancement on the continent. To achieve this laudable policy objective, Africa's health systems need to be strengthened through global collaborations and cooperation as stated in the Africa Health Strategy for 2007-2015. The strategy recognises the role e-health can play in achieving the set goal.

MDGs (Millennium Development Goals) are social goals and targets instituted by the United Nations (UN) in September 2000 (United Nations, 2000). Three of the eight MDGs are targeted at eradicating or controlling certain diseases with high socio-economic impacts. These are:

1. To reduce child mortality from childhood diseases
2. To improve maternal health from associated causes
3. To combat HIV/AIDS, Tuberculosis (TB), and Malaria

The Africa Health Strategy 2007-2015 (African Union, 2007) developed, as response to these Global Health challenges paints the health picture of the continent in statistics. For example, the HIV/AIDS epidemic on the African continent is extremely alarming. 2.4 million Africans have died from AIDS, however an estimated 3.5 million new HIV infections was recorded in 2002 and HIV prevalence is reported to be as high as 30%. The strategy documents further reported 800,000 deaths in children under the age of five from AIDS-related diarrhoea, plus 500,000 from measles and 1.2 million from pneumonia. Further, the report cited that Malaria causes one million deaths annually, 600,000 of which are children under age five. Tuberculosis has also achieved the level of a public health problem with 300 cases per 100,000 population and 600,000 annual deaths reported in the affected population. In addition, Africa is reported to have the highest maternal mortality rate in the world with about 1000 deaths per 100,000 live births recorded.

If no urgent action is taken, it is estimated that 7.5 million new born babies will die by 2010. The burden of these diseases has a negative impact on health systems and the wider society in Africa. For example, the reports attributed 1.3% decrease of national economic growth of severely affected countries to malaria incidences. In addition, high mortality from AIDS has resulted in the loss of many qualified health personnel. The study identifies that Africa's health system's ability to cope with the consequences and effects of MDGs related diseases burdens is limited by financial and global migration - a massive brain drain that has led to the loss of its highly skilled health workers. This massive brain drain within the health systems of most African countries is also compounded by the internal rural–urban and external local-international migration of qualified health personnel (African Union, 2007). Statistically speaking, Africa is reported to have 10% of the world population but bears 25% of the global disease burden managed by only 3% of the global health workforce (African Union, 2007).

These figures presented above are to illustrate vividly the poor state of public health in Africa and to highlight the need for exploring alternative strategies for healthcare delivery in Africa. Moreover, the rising threat of chronic or non-communicable diseases

such as diabetes, cardio-vascular disorders and cancers to socio-economic growth has become a policy concern (African Union, 2011). The public health risks of underfunded and neglected tropical diseases (NTDs) on the continent must also be recognised.

The AU report admitted that limited progress has been made so far with meeting the set targets of MDGs. However, the report also documented that the poverty rate is falling, HIV/AIDS incidence is decreasing and child mortality is also reducing. Nevertheless, health-related burdens are still high, and the report concluded that Africa's survivability depends on developing, and investing in, its domestic institutions, infrastructures and innovations.

1.6 Cosmopolitanism in Global Information Society

The development and utilisation of ICT innovations as the 8th Millennium Development Goals (MDGs) (Gilhooly, 2005; United Nations, 2000) encourages technoglobalism, a term inspired by Fritsch, 2011. However, we define it as the design and production of technologies in frontier countries and their transfers to developing countries through formations of global partnerships, in the frame advocated by (Sachs, 2003). It implies that the former should support an equitable global order with regard to trade and the provision of technology to the latter. Nevertheless, the technology optimism implied in the liberalistic views of non-states – global actors and organisations and multinational companies, dominate the policy space (Fritsch, 2011, pp. 37-38). The optimism of the cosmopolitan stems from the exaggerated impacts of technology, in national survival and prosperity, in human progress, and in the globalisation of socioeconomic interactions, are just too simplistic. The contention that a possession of domestic innovation capacity can determine national utilisation of ICTs (James, 2002; Oyelaran-Oyeyinka, 2006), is alien to the cosmopolitans; and, the inherent political and techno-economic complexity of globalisation is wished away. Similar optimism is found with cosmopolitan e-health implementations in Africa.

Numerous ingenious and life-saving e-health (including EHR, telemedicine and m-health) inventions have been developed for tackling these MDG diseases and are predominantly funded by and designed by research centres outside the continent, and manufactured by companies outside the continent. M-health technologies are currently the main preoccupations of the cosmopolitans in the conduct of IeTTs in African countries. M-health experimental initiatives conceived on the back of explosive growth

in mobile telephony; and, they usually equip health workers with mobile phones for health data collection and access to clinical decision support information (Mechael, 2009). Mostly 1st generation mobile phones and to a lesser extent, Smartphones are being utilised. Accordingly, implementations in Africa have been dominated by a proliferation of small-scale initiatives. A recently published meta-evaluation (Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013), has however highlighted the knotty challenge of functionally and spatially scaling up of such small-scale experimentations.

The 'doing it all for me' being promoted for developing e-health technologies in the context of global development, is exemplified by (Allen et al., 2007; Asamoah-Odei et al., 2007; Blum, 2002; J. Braa, Monteiro, & Sahay, 2004; Cartwright, 2000; Fleishman et al., 2010; Gerber, Olazabal, Brown, & Pablos-Mendez, 2010). Their implied inherent cosmopolitan agency, stresses the imperative to study domestic technology acquisition dynamics, variations and trajectories in recipient African countries. E-health hardware and software invented by well-meaning global actors are being implemented in many African countries, for health data collection, remote clinical diagnosis and for delivering virtual e-health services, for example in (Fleishman, et al., 2010). A major problem that has been identified with these technologies is that they have not diffused widely within the national health systems of the recipient countries, strongly because of certain technological and societal constraints (Kifle, Mbarika, Tsuma, Wilkerson, & Tan, 2008; Meso, Mbarika, & Sood, 2009; Ouma & Herselman, 2009).

A study of why and how these technologies are struggling to diffuse nationally is what this thesis is all about. Most of the papers cited in this section, mostly adopted an information-based approach in their studies. None had addressed e-health implementation in Africa from an innovation/industrial and international technology transfer perspectives, as national innovation theory (NIS) theory (Arocena & Sutz, 2003; Forje, 2006; Freeman, 2002; Lall & Pietrobelli, 2005; Lundvall, 2007; Mazzucato, 2011; Muchie, 2008; Sharif, 2006) inform. That nations must imperatively become entrepreneurial and activist in the spirit of NIS, so as to survive, succeed and prosper in the age of technoglobalism, was well articulated by these authors.

1.7 International e-health technology transfer

Globalisation has different meanings to different people. Some favour economic or financial integration, others are enamoured by its political convergence and uniformity, while some see the benefits of social or cultural proximity and affinity as a canvas for a 'new world order' (Cerny, 2000). A cosmopolitan constitution of globalisation[3], is identified by Cerny (also identified by Fritsch, 2011, pp. 37-38) – its dynamics are characterized by complexity and multiplicity of disproportionate and rapidly changing actions of global and national state and non-state actors and organisations. The way globalisation works, when it comes to who benefits, is akin to 'fortune favours the brave'. It tends to favour those seen as more strategically predisposed and positioned, i.e. global technology leading nations and the multinationals that produce and utilise the technologies.

The role ICT plays in the globalisation of virtual e-health services over the Internet and other telecommunication technologies cannot be disputed (Blum, 2002; Cartwright, 2000; Edworthy, 2001; Frenk, 2005; Mandil, 1998; Rigby, Birch, & Roberts, 2000; Sinha, 2000). The utilisation of transferred e-health technologies must not be narrowly limited for exchanging health information or data trans-nationally, but essentially for delivering diagnostic and therapeutic services in developing countries, (Blum, 2002) advocated.

[3] The author's view of the development and use of e-health technologies in the age of globalisation was shaped partly by attending series of policy meetings at the Royal Institute of International Affairs (Chatham House) Global Health Security and Governance between 2008 and 2011. A classical case to illustrate the manifestation of geopolitics in the global development landscape was during the last global influenza pandemics in 2009. This case gives an insight into 'global-national' divide in the global development landscape. As the world was gripped in the fear of a potential global economic and security threatening pandemic, a request was sent from the World Health Organisation to the Indonesia national government to share viral specimens for global science and for the production of vaccines (The author was present at the Global Health Security conference at the Chatham House in 2010, when the Minister of Health from Indonesia presented and defended her country's ethical position). However, the Indonesian government ethically declined; on the basis that a global mechanism should be instituted to ensure that economically less fortunate developing countries have access to the vaccines to be developed from the specimen at affordable prices. Whether Indonesia had the right to decline in the face of a global crisis is a matter for a different debate, but it is important to point out that geopolitics and self-interest manifest in the conduct of international biomedical technology transfers. The Indonesian government national action was a negotiation for an affordable and fair transfer of global health technologies in the face of international diplomatic, altruistic, corporatist and mercantilist self-interests (Irwin, 2010).

Several international e-health initiatives have been implemented in the last two decades by global actors to improve healthcare in developing countries. Back in 1995, the international governmental organisation (IGO) G8, made up of the eight biggest economic and technology superpowers, initiated the now defunct G-8 Global Healthcare Applications Subproject-4 (G-8 GHAP-SP-4) (Lacroix et al., 2002). There is no evidence to indicate that the G-8 project was ever implemented. International Telecommunication Union (ITU), another IGO, also has a history of implementing e-health in Africa (International Telecommunication Union, 2007; Trotter & Kawasumi, 2004). In 2008, the American Telemedicine Association instituted a Global Forum on Telemedicine (Pak et al., 2008) for mobilizing USA efforts, aimed at tackling Global Health challenges.

The authors identified different social, economic, ethical workforce, political, cultural and infrastructural factors that can either hinder or enable the transfers of virtual e-health services to developing countries. However, with the exception of (Blum, 2002; Mandil, 1998), the authors have primarily focussed on studying international transfer of e-health *services*; and have largely neglected the international trade implications i.e. the regulation of the transnational transfers of software and hardware.

Most of the above cited authors, narrowly focussed on the issue of 'digital divide' to explain that infrastructural differences between developed and developing countries will hinder the latter in the conduct of virtual IeTTs. This thesis, however, is focussed more on the transfers of material e-health technologies, mostly on the development and utilisation of computing and telecommunication technologies. In addition, this thesis also addresses constraints to and conditions against domestic technology acquisition, a strategic topic largely ignored in this body of literature.

1.7.1 International e-health technology transfers in Africa

The conduct of IeTTs in African countries is emerging in different forms. IeTTs have emerged in the forms of North-South and South-South e-health partnerships, employing e-health as a global development tool in Africa. Such partnerships are being formed by governmental and non-governmental, public and private actors and organisations from developed and emerging economies, usually with African national and continental governmental organisations. For example in Africa, the European Space Agency (ESA) sponsored pan-African e-health initiative (Asamoah-Odei, et al., 2007) is employing

telemedicine, a subset of e-health, as a means of contributing to the eradication of Global Health problems in Africa. Likewise, the emerging global south economic power, India, has followed suit (Telecommunications Consultants India Limited, 2007). The Digital Solidarity Fund (DSF), an international digital divide alliance, planned to implement an ambitious '1000 Telemedicine Units for Africa'.

The conduct of an IeTT embodies economic, cultural, political, infrastructural and organizational factors (Blum, 2002; Cartwright, 2000; Frenk, 2005; International Space University, 1994; Meso, et al., 2009; Sinha, 2000). As such, transferred e-health technologies can disrupt existing local practices, because they transcend international geographical, economic, social and cultural boundaries. Such embodiments can make domestic acquisition difficult for recipient countries. By their nature, the conduct usually involves the endorsement of actors and organisations at the continental level and those of recipient African countries.

The influx of transferred e-health technologies into Africa is a welcome development, as it provides an opportunity for acquiring domestic technical knowledge and for accumulating technologies. However, because of the complex interactions that the involvements of multiple actors bring to the conduct, it is recognised that it is paramount for African countries to exercise their national agency.

The exercise of national agency[4] is defined from the context of a national innovation system (Arocena & Sutz, 2003; Freeman, 1995, 2002; Lundvall, 2007; Muchie, 2008; Sharif, 2006). African countries and their national governments must put in place measures (policies, institutions, resources) to ensure that transferred e-health technologies are accumulated, and at the same time they assimilate the required technical knowledge. With no reference to e-health, (Chataway et al., 2009; Quaye,

[4] The author's view of the exercise of national agency in the implementation of national e-health programme was shaped partly by attending series of policy meetings organised by the Commonwealth Secretariat in Asia and Africa between 2009 and 2011. The opportunity presented itself to compare progress on national e-health implementation amongst African countries and their Asian counterparts. It was observed that Asian countries such as India and Malaysia were more advanced in their implementation when compared with African countries such as Nigeria and Uganda. There are two main insights we gained to explain the difference between Asian and African countries. The first is that the leadership role of the national governments of the Asian countries is evident both in policy development and in programme implementation. The second is a striking observation that these Asian countries in contrast with their African counterparts are less dependent on international technology transfers. They possess and are still acquiring domestic e-health technology competence.

1996) pointed out that a disjoint between health and industrial policies is making African countries passively dependent on importation of biomedical devices and instruments. The authors of the paper implored African countries to build their domestic innovation capacities and institutions so as to develop biomedical technologies, appropriate for serving and meeting their local needs.

This assertion is backed by the review of an evaluation report, financed by the World Bank, carried out on a problematic internationally-sponsored e-Learning initiative, politically endorsed at continental level and implemented in 16 African countries (Farrell, Issacs, & Trucano, 2007). The authors discovered that the proactive role of national governments recipient countries, in the process of domestic implementations, could have ensured that the projects did not struggle to be sustained, which is what they observed. For instance, they identified that national governments could have fostered multi-sectoral collaboration amongst the diverse national ministries that were involved in their domestic implementations. How African countries can acquire e-health innovation competence, in the wake of globalisation[5] could be a daunting task, as most are 'technology laggards' (Forje, 2006; Lall & Pietrobelli, 2005; Ymele, 2011).

1.7.2 Policy perspective on e-health in Africa

Limited progress has been made in the implementation of national e-health initiatives in African countries. Only one country, South Africa, can be said to have made some progress in this regard, especially in the area of implementing e-health (including telemedicine, m-health and EHR) projects (Gulube & Wynchank, 2002; Kachienga, 2008; Mars, 2009; Ruxwana, Herselman, & Conradie, 2010). This is despite the importance of e-health technologies for addressing health problems in Africa having long been recognised. At the African Development Forum (ADF) of the United Nations Economic Commission for Africa (UNECA) conference in 1999, e-health was identified as essential for meeting Africa's health and other socio-economic goals (Economic Commission for Africa, 2004). Recently, continental policy directives from

[5] The author's view of African countries' limited agency in international global agenda was shaped partly by attending series of policy meetings at the Royal Institute of International Affairs (Chatham House) meetings on African Affairs between 2008 and 2011. We gained insight into the complexity, politics and power relations in the debates on global aid, diplomacy, trade and national development in Africa. We observed that limited mention is made of technology transfer in these debates.

the African Union (African Union, 2009, 2011), reiterated this policy and encouraged its member states to employ e-health technologies for addressing their national health needs. However, the impacts of the implementation of e-health initiatives in African countries have not been encouraging so far.

A report AFR/RC60/5 (World Health Organisation, 2010a) on the state of e-health implementation in African countries released by the WHO Regional Office for Africa, gives insights into why this has been the case. The report laments the fragmented, small scale and experimental nature of existing e-health initiatives in African countries. The report identifies challenges that militate against successful national scale-up of transferred e-health technologies. Those that are of relevance to this thesis are:

1. Uninspiring national leadership and poor organizational coordination which threatens large-scale adoption of technology transfers.
2. Difficulties in keeping up with rapid global technoeconomic changes.
3. Financial constraints at the national level that limit the procurement of technology from the global markets.

The aim of these continental policy directives is to create incentives for African countries to start shifting away from passive dependence on IeTTs and to start scaling up small scale subnational pilots by mobilising domestic resources and expertise. To transit from being dependents of transferred e-health technologies to a sustainable national implementation, another document AFR/RC60/R3 (World Health Organisation, 2010b) from the WHO African regional office recommends that transformation is required in economic, political and social spheres of the countries. African countries are also encouraged to exercise national agency in acquiring technologies from IeTTs. In addition, the countries are encouraged to mobilise domestic finances to build smart international partnerships and to formulate appropriate national e-health policies.

The goals set by these continental governmental bodies are at odds with the realities of most African countries' limited technological innovation capabilities (Forje, 2006; Lall & Pietrobelli, 2005; Muchie, 2004; Oyelaran-Oyeyinka, 2006). Most African countries do not consider domestic innovation strategy in the implementation of their national e-health initiatives. For instance, a review of national e-health policies of African countries (Ministry of Health Rwanda, 2009; Ministry of Health Zambia, 2006;

Ministry of Medical Services & Ministry of Public Health Services Kenya, 2009) reveals that no such strategy is being considered.

1.8 Technology in e-health implementation in Africa

Historically in Africa, national scale-up of small-scale implementations have been a policy and technical challenge in African countries. An explanation is that they were driven by cosmopolitan actors and organisations and are predominantly built on international technology transfers. Past and present cosmopolitan e-health initiatives in Africa range from small to large-scale implementations. Small-scale ones are usually subnational implementations at rural and urban clinics and hospitals in African countries. Whilst, large scale ones are often pan-African in space and reach; and, are either the development and utilisation of open–source software such as Open MRS (Allen, et al., 2007) or DHIS (J Braa, Hanseth, Heywood, Mohammed, & Shaw, 2007; J. Braa, et al., 2004) or intra-continental (Asamoah-Odei, et al., 2007; Telecommunications Consultants India Limited, 2007), and national (Geissbuhler, et al., 2007; Geissbuhler, Ly, Lovis, & L'Haire, 2003; Mars, 2009; Nchise, Boateng, Mbarika, Saiba, & Johnson, 2012), telemedicine initiatives.

Long before the advent of mobile phones and GSM, telemedicine services either based on fixed satellite or ISDN telecommunication infrastructure (Aloo, 1988; Asamoah-Odei, et al., 2007; Crump, 2006; Demerliac & Metzger, 1984; Gulube & Wynchank, 2002; Habib-Sy, 1992; House et al., 1987; Howell, 1988; Pfister, 1999; Yesufu, 1990) has long dominated e-health implementations in Africa. In most of these instances, Africa's clinics or hospitals are usually digitally connected to international telemedicine infrastructures, either located in Europe or in North America. In recent times, international e-health implementations in Africa are moving beyond mere participations in virtual teleconsultation, to the transfers of connected biomedical technologies such as the inventions of e-health enabled medical devices and equipments. For instance, this project (Fleishman, et al., 2010) implemented in Kenya and Tanzania.

In general, the fate of most of these implementations was uncertain. Perhaps essential contextual social, process, input, organisational, market, and environmental factors, were neglected. Evaluations carried out in Kenya (Ouma & Herselman, 2009), Rwanda (Ministry of Health Rwanda, 2009; Nchise, et al., 2012), Mali (African Union, 2011; Geissbuhler, et al., 2007; Geissbuhler, et al., 2003) and South Africa (Gulube &

Wynchank, 2002; Kachienga, 2008; Mars, 2009; Ruxwana, et al., 2010) highlighted the various challenges being faced in both sustaining and scaling e-health initiatives in these countries. Together, they commonly identify technological, economic, social, financial and infrastructural challenges as causes of uncertainty. Yet, an econometric analysis of determinants of e-health sustainability in Africa (Kirigia, Seddoh, Gatwiri, Muthuri, & Seddoh, 2005) , highlighted the strategic need of national and continental leaderships.

Previous information-based quantitative studies (Kifle, et al., 2008; Meso, et al., 2009) have identified certain factors that can either constrain or enable national e-health (particularly focused on telemedicine, an e-health subset) implementation in Africa. Both studies identify that the presence and depth of National ICT and e-health policies, sophistication and distribution of telecommunication infrastructure, and the receptivity of national healthcare systems, can influence sustainable national e-health implementations in African countries.

Areas for reforming national ICT policies in African countries in order to speed up e-health adoption in African countries are also suggested by (Meso, et al., 2009). These include improvement to national regulatory frameworks, encouraging local manufacturing and maintenance of telemedicine equipments, and openness to international trade and partnerships.

These areas are pertinent to the study of IeTTs in African countries. However, these studies take a narrow positivist approach to identifying predetermined national factors, and not on examining conditions that can constrain domestic e-health technology production and acquisition. In both studies, a careful reading suggests that only certain domestic factors that can constrain national adoption are identified; despite, the impression that the studies assessed e-health technology transfer. The studies do not identify or assess actions, events and conditions at national and international levels that can constrain acquiring domestic e-health innovation capacity. Moreover, the studies do not identify and examine factors and actions at national, continental and global levels that can cause such.

1.9 National e-health implementation in Africa

Certain factors that can contribute to successful implementations of e-health in Africa countries have been identified by (Bowman, Bell Jr, & Nyambura Ndung'u, 2009) from

an Information Society policy perspective, in a chapter from a book titled *Science, Technology and Innovation for Public Health in Africa*. The book chapter (pp. 123-144), interrogates the states of national e-health implementations by reviewing national ICT policies and by interviewing government officials from national ministries of selected African countries. By identifying certain deficiencies of national capacities, the authors share similar views to those expressed from the perspective of national innovation system in Information and Communication Technology for Development (ICT4D) in Africa (Kraemer-Mbula & Muchie, 2006; Oyelaran-Oyeyinka, 2006).

The authors identify that e-health utilisation is a strategic investment for African countries to make to ensure that their populations have access to quality, effective and affordable healthcare services. Most of the e-health services (mostly telemedicine and m-health), identified were implemented by national governments (public sector), both local and global private sectors and by well-meaning non-governmental organisations and donors. However, the authors identify that most of the African countries only give e-health a mere mention in their national ICT policies.

To rectify this anomaly, national governments and their public and private sectors must work together with continental (referred to as 'regional' in the book, and given a passing mention) organisations, to ensure that sustainable e-health services are delivered. National governments in particular, in the view of their economic growth strategies, must make considerable investments to upgrade domestic ICT infrastructure and industry, so that the adoption of e-health can increase in their countries. Moreover, fostering of South-South and North-South partnerships is also recommended for acquiring technologies and expertise.

Bowman et al., (2009), reports that few African countries have translated their e-health policy ambition into reality, because most are hindered by deficiencies in certain national capacities. Deficiencies in telecommunication and energy infrastructures, low national income per capita, technology regulation, and lack of skilled human resources are identified as hindering national scale-up.

There are three gaps that this thesis will attempt to fill from the perspectives of national innovation system (NIS) and the role of technology in global development. We take the view that global digital technology divide is a reflection of the lack or immaturity of

domestic innovation capacities in developing and African countries (Freeman, 2000; James, 2002; Oyelaran-Oyeyinka, 2006).

1. The authors highlight and recognise that a technological gap exists between industrialised and African countries (Bowman et. al., 2009, pp. 124-125), which can constrain sustainable national e-health adoption in the latter. However, they fall short of explicitly encouraging African countries to foster domestic e-health innovation capacity acquisition in the manner implied in NIS perspective, for example by (Forje, 2006; Juma, 2006). They assume that a possession of a domestic ICT industry will occur, without inevitable and conscious national technology accumulation and assimilation actions.

   An encouraging sign that domestic industry in biotechnology (that shares similar technological complexity with e-health), is emerging in some African countries (Chataway, et al., 2009; Juma, 2010), demonstrates that African national governments should strategically start considering the same approach with e-health innovations. African policymakers are being encouraged to foster and forge domestic biomedical and biotechnology innovations and industries (Chataway, et al., 2009).

2. The authors recommend that African national governments should adopt an incremental approach for implementing their national e-health initiatives, even in the face of the passive consumption of technologies provided by dependence on international technology transfers. They neglect to identify how passive dependence on IeTTs can hinder the translation of set national policy ambition into reality in their countries, in the face of the realities of African countries' limited technological innovation capabilities (Forje, 2006; Lall & Pietrobelli, 2005; Ymele, 2011).

3. Bowman et al., 2009, could not appreciate the complexity inherent in dealing with diverse actors and organisations at global, continental, national and subnational levels in the conduct of IeTTs. They were not exposed to the e-health policy landscapes at national and international levels and did not have the privilege of the amount of data we have at our disposal. The authors did not explicitly identify and state how instrumental the institutional actions of actors and organisations at global, continental and subnational levels, can be.

We have experienced policy debates on e-health development and utilisation with influential international governmental organisations (IGOs) such as the World Health Organization, the United Nations, the International Telecommunication Union, the European Commission, the Africa Union (AU), United Nations Economic Council on Africa, and the Commonwealth Secretariat, as listed in Appendix A and others referenced in the body of the thesis. We noticed that in these policy debates, discussions pertaining to national technology acquisition in recipient countries were not always entertained.

On this basis, the thesis will make academic and policy contributions to national e-health technology development and utilisation in African countries.

1.10 STS, Narrative, National Innovation and Globalisation

The thesis is inspired by the moderate and middle-range Science and Technology Studies (STS)[6] constructivist view on the role of technology in global development (Sismondo, 2010, pp. 195-201) and the role of technology in the complex global geopolitical interactions (Fritsch, 2011). Middle-range in that a multi-level and multi-theoretical perspectives are combined together to address complex society and technology problems (Frank W Geels, 2007; Roberts, 2012; Wyatt & Balmer, 2007). It is moderate in that technology exercises agency in complex transnational interactions (Fritsch, 2011, p. 38-39).

[6] The author's view of Science, Technology and Innovation studies was developed partly by attending a series of research meetings in the UK. These presented an opportunity to understand how STS theory can be used for studying complexity and uncertainty in the use and development of technology in the context of globalisation. Academic discussions at Economic and Social Research Council (ESRC) workshops such as *Technology for Health Systems Strengthening – Product Development Partnerships* research consortium in 2009 and 2010 at the Open University, and the Social, Technological and Environmental Pathways to Sustainability (STEPS) launch of the '*Innovation, Sustainability and Development: A New Manifesto'* at the Royal Society, London, were very useful. Also useful was to attend '*Beyond Scaling Up: Pathways to Universal Access*' (organised by the group "Future Health System Innovations for Equity") in the 2010 workshop organised by International Development Studies, University of Sussex and also attending the *International Workshop on Users, Innovation and Healthcare Technologies* at the Freeman Centre for Research and Innovation Management, SPRU, University of Brighton.

Both Fritsch and Sismondo (ibid.) share the view on the instrumental roles of technologies in a society's socio-economic advancement in the wake of globalisation. Sismondo explicitly mentions that the utility of national innovation system (NIS) theory (Baskaran, 2005; Forje, 2006; Freeman, 2002; Lundvall, 2007; Mazzucato, 2011; Muchie, 2004, 2008; Sharif, 2006) for conceptualising and understanding national technology acquisition in developing countries; even though, he suggested STS constructivism for micro-studies. Rather, Fritsch (2011, p. 36) investigated complex macro-interactions as global technoeconomic advancement contributes to the prosperity and survival of countries and peoples.

STS research according to (Sismondo, 2010), investigates how scientific knowledge and technological artefacts are constructed – *how scientists and technologists build socially situated knowledges and things*. It is about studying the conduct and process of techno-science. STS can trace its origin to the social construction of technology (SCOT) and actor network theory (ANT) (Sismondo, 2010, pp 98-103). SCOT for example, has been employed for studying the trajectory and consequences of the development and utilisation of computerised systems and their associated infrastructures and institutions (Kling, 1992).

The cyclical nature of interactions implied in both theories is evident in health informatics literature, for example (Chiasson, Reddy, Kaplan, & Davidson, 2006; Sunyoung Cho, et al., 2008; T Greenhalgh & Stones, 2010; Kaplan & Harris-Salamone, 2009); however, are unsuitable for understanding the institutional structures in interactions of collectives that are either competing or cooperating in the invention and production of technologies. In addition, both are limitedly suitable for micro- case study method; and, are not capable of generalising findings and engaging fully with complexity of a subject matter, in a way that middle-range STS (Frank W Geels, 2007; Wyatt & Balmer, 2007) will do.

SCOT, because of its utility for studying the transfer of a technological artefact, will be improper for investigating the agential asymmetry that exists between national technology producers and consumers (Klein & Kleinman, 2002, p. 38). Such agential asymmetry can be difficult to identify and study, if either SCOT or other STS theory such as how actor-network theory (ANT) is used. They are presented by (Geels, 2007, pp. 630-635) as descriptive and not analytical, mostly suitable for micro-level, localised

and action-oriented study of complex sociotechnical interactions driving an innovation systems. Similar deficiencies was found with ANT by (Robert, 2012, pp. 39-44) making it not too suitable for identifying and studying complexity and hidden or invincible agencies of the events and actions of technoglobalism. Both are not suitable for studying complex national innovation system in the face of confounding technological complexities and controversies (De Laet & Mol, 2000, pp. 225-227). Therefore, their suitability for investigating innovation policy is weak.

Our use of STS constructivism is broader than what Fritsch and Sismondo advocated. We combine moderate and middle-range STS constructivism and NIS institutionalism (Klein & Kleinman, 2002; Nelson, 2008; Nelson & Nelson, 2002) and Deleuzian poststructuralist narratives (Sikes & Gale, 2006 and Gale, 2010) to study the transnational development and utilisation of e-health technologies. Such combination was advocated by (Juma, et al., 2001) for using social theories to inquire into policy issues of socioeconomic relevance and import in Africa.

Thus, we investigate similar complex sociotechnical interactions of those that occur at a 'macro-societal/institutional' level (Avgerou, 2003; Corea, 2000; W. Currie, 2009; F.W. Geels, 2004; Roberts, 2012), so as to identify and explain the hidden 'institutional structures' (Nelson & Nelson, 2002) that underpins distributed and globalised interactions of the conduct of IeTTs in Africa. The combination of methods and theories is suitable for studying the implications of complex, dynamic and uncertainty social, economic and technological issues in society.

The study investigates institutional structures of the interactions between producers and consumers of technologies in the age of technoglobalism, when national technology acquisition is of interest. Principles articulated in the sociology and economics of dynamic and evolutionary theory of sociotechnical nature and process of innovation, are adopted. Whether a technology is implemented in a nation or service sector, the principles of NIS address the dynamic and uncertain process of innovation in and across, geographies and organisations. The objectives are to identify and explore institutional manifestations of forms, identities and arrangements that underpin the actions of the constitutive actors and organisations involved in the conduct of IeTTs, and which, can either constrain or condition domestic e-health technology acquisition.

Following Deleuzian poststructuralist narrative method, the thesis is presented as a 'continuous process of creative evolution' (Gale, 2010), this implies that the constructing narratives is akin to the process of innovation itself. The use of narrative, not necessarily Deleuzian in nature, is a longstanding method for studying policy concerns of technological controversies (Jasanoff, 1996; Kling, 1992; Lehoux & Blume, 2000; May, 2006). This is a qualitative, expressive and interpretative method – that engages with and embraces and connects the complexity and multiplicity of the technological controversies; in the way of middle-range STS constructivism.

A narrator/ethnographer, just as innovators and entrepreneurs employ creativity to deal with, and overcome, uncertainties and risks in the course of an *innovation* or an *engineering* process. A narrator constructs new/non-traditional knowledge about a complex subject (i.e. the conduct of IeTTs) and a novel object (i.e. e-health technologies) by organising, connecting and re-presenting previously unrelated multiple data in new format.

1.10.1 Research aim and objectives

The aim of this research is to identify, explore, and demonstrate how actions taken by global, continental, national and subnational actors can constrain, and how exercising National Agency can condition African countries' domestic e-health innovation capacity acquisition. The research objectives are:

1. To argue that a history of technological path-dependency on IeTTs is associated with the current immature state of an African country's domestic e-health innovation capacity;
2. To demonstrate and explore how the actions of global actors and organisations can condition a recipient's national e-health technology acquisition dynamics and trajectory;
3. To demonstrate and explore how the actions of continental actors and organisations can condition a recipient's national e-health technology acquisition dynamics and trajectory;
4. To demonstrate and explore how the actions of national actors and organisations can condition domestic e-health technology accumulation and assimilation depth and scale;
5. To demonstrate and explore that a National government exercise of National Agency is imperative for national e-health technology acquisition;

6. To propose and elaborate a global collaboration framework for re-conceptualising international cooperation so as to foster a successful national e-health technology acquisition.

1.10.2 Organisation of thesis

A conceptual framework that underlines the research focus is presented in Chapter 2. This research is presented on two levels.

The first is descriptive and exploratory in nature and addresses objectives 1-4. It is presented in Chapters 3-6. We employ the STS concept of 'symmetry' to give a balanced view of identifying and demonstrating how the institutional actions of actors and organisations at global, continental and national levels can constrain or condition domestic e-health innovation capacity acquisition in the conduct of IeTTs. Deleuzian poststructuralist narrative method as informed by (Sikes & Gale, 2006) is employed as most appropriate means of organising or ordering the messy and multiple qualitative data that we have collected. The organisation of data employs a structure of generating 'narrative themes' in the process of ordering messy data.

The second level, in Chapter 7, addresses objective 5 and discusses and highlights findings from the narrative themes from sections and sub-sections of Chapters 3-6. As Sikes & Gale 2006 do not specify a definitive approach for analysing narrative themes, the discussions highlight how institutional actions of actors and organisations at global, continental and national levels can constrain (and also enable) national e-health technology acquisition . It introduces a framework to conceptualise the complexity, power and politics in the interactions among multiple actors and organisations in the conduct of IeTTs. An argument is put forward that if African governments aim to successfully implement their national e-health initiatives, they must learn from what global technology leaders are doing.

We employ an African adage to describe what is on offer in the rest of the thesis. It goes this way. *If you point an accusing finger at someone, you must remember that three fingers are pointing back at you!* If African countries had and are struggling to acquire e-health innovation capacity from IeTTs, a teasing question to ask is, 'Who is to blame?' Is it correct to point accusatory fingers at global universities and companies that invent or manufacture technologies, or at continental bureaucrats and policymakers? Are passive national governments implicated in the struggle? This thesis provides the answer.

2 Conceptual Framework

2.1 Introduction

This chapter presents the conceptual framework for this thesis. The conceptual framework presents the literatures, theories and methods that informs why and how the research study is conducted. It sets out how the study explores and examines the institutional structures in the interactions at global, continental and national levels in the conduct of IeTTs. How we identify and examine their constraining or conditioning influences on national e-health technology acquisition variations and dynamics in Africa.

2.2 Technology and Globalisation

In technoglobalism, interactions between technology and institutional structures occur in the complex interactions among state and non-state actors. According to (Fritsch, 2011, pp. 35-36), countries negotiate the highly politicised, power-driven, competitive and complex nature of globalisation in their technology acquisition quests. A similar view is shared by Cerny, 2000 in the context of 'liberal or cosmopolitan interactions' (Fritsch, 2011, pp. 37-38). What this implies is that, the efforts of a global technology laggard on its national technology acquisition is not only dependent on the exercise of its Agency, but on how it can strategically interact with the complex configuration of state and non-state actors in the wake of globalisation.

From a globalisation perspective, a transnational transfer of a technological artefact or knowledge as either enabled or constrained by the manifestations of the complex interplay of constitutive social, infrastructural, political, cultural, economical factors (Fritsch, 2011, pp. 38-39). According to (Sismondo, 2010, p. 201), 'the conduct of technoscience should be viewed in terms of context-specific forms of knowledge and practice that interact in a set of globally distributed social interests'. Moreover, a technology transfer embodies 'tacit or implicit knowledge which are not readily available or shared' (ibid. p. 202). This view is in contrast to the neoliberal assumption implied in the international technology transfer (ITT) literature, for example in (Aloo, 1988; Cartwright, 2000; Christol, 1974; Colino, 1968; Contractor & Sagafi-Nejad, 1981; Cowhey, 1990; Crump, 2006; Goldsby & Boyd, 2001; Holmes, 1995; Howell, 1988; Lambright, 1994; Nogueira, 1998; Reddy & Zhao, 1990). A cosmopolitan

exercise of innovation agency noted in these transfers, is in the mould that (Kaplinsky, 2011; Schumacher, 1972; Toye, 2012) Fritz Schumacher advocated.

The neoliberal assumption stems from the position taken that the exchange of technology in a global system is restricted to countries that are in contention with each other and that exclude other non-state actors such as International Governmental Organisations (IGOs) and multinationals. In addition, neoliberalism takes for granted the essentiality of innovation, learning and competence building in recipient countries of ITTs that occurs in dependent relationships of globalised interactions (Arocena & Sutz, 2003, pp. 176-178; Kaplinsky, 2011, pp. 194-195; Lundvall, 2007, pp. 109-110; and Sharif, 2006, pp. 753-757).

It is generally taken for granted that technology acquisition can occur without an exercise of National Agency or by forging a functional Schumpeterian National Innovation System (NIS). A neoliberal assumption that forging a domestic innovation capacity by recipients is a linear process is, rather; challenged in the thesis. Our contention is that national technology acquisition can be constrained by the cosmopolitan, complex and uncertain globalised and transnational nature of IeTTs' conduct.

An innovative combination of middle-range STS constructivism (Wyatt & Balmer, 2007) in combination with NIS institutionalism (Nelson, 2008; Nelson & Nelson, 2002) and poststructuralist narrative (Sikes & Gale, 2006) provide an alternative ontology to challenge the implied neoliberalism. There are two areas of contention inspired by (Blum, 2002). Blum, 2002, pp. 102-107, argued Blum, 2002, pp. 102-107 that a smooth transfer of e-health technologies to these countries can be hindered by geopolitical contentions and geo-economic arrangements, international power relations, strict global patent regimes, technoeconomic upheavals, and unpredictable global funding mechanisms. The first is that the process of national e-health technology acquisition in Africa is a linear, non-complex and apolitical one. The second is that the relationships in the conduct are vertical and hierarchical.

We are taking the view that the interactions in the conduct of IeTTs are diffuse and horizontal in configuration –a constitution of multiple and diverse actors and organisations. By studying institutional structures of the interactions between producers and consumers of technologies, as suggested by (Avgerou, 2003; F.W. Geels, 2004;

Klein & Kleinman, 2002; Lundvall, 2007; Nelson & Nelson, 2002). Investigating how past institutional actions and events at multiple national and international levels are historically and institutionally path-dependent to the present poor state of national e-health technology capacities in African countries. The institutional focus examines how different collectives – each constituting actors and organisations at global, continental and national level, co-negotiate the development and utilisation of technologies during complex interactions.

National acquisition can be shaped by prevalent technoeconomic and geopolitical contexts of technoglobalism (Sharif, 2006, p. 760-761 and Arocena & Sutz, 2006, pp. 172-174). Accordingly, contestations, conflicts, competition, power asymmetry, compromise, politics, cooperation arise during complex interactions between producers and consumers. In such interactions, the material nature of technologies can determine a country's domestic innovation capacity acquisition dynamics and trajectory.

2.3 Technology transfers and National Innovation System

From the perspective of global development, domestic technoscience is viewed as a national action (Sismondo, 2010, box 17.1, p 191). Furthermore, in the wake of globalisation, the proactive role of a national government is the tested means of ensuring technology acquisition certainty (Fritsch, 2011). Contributing to a long-standing policy debate on developing countries' domestic innovation dynamics, (Kaplinsky, 2011) noted an instrumentality of a endogenous Schumpeterian engine in the rapid technoeconomic growth of emerging global East economies such as China and India. A remarkable feat, given it is occurring in the face of an enshrined global development redistributive policy preferred by cosmopolitans.

The Schumpeterian engine explained by the NIS theory, instructs that the possession of endogenous innovation capacity is essential for fostering domestic invention, engineering and manufacturing (Baskaran, 2005; Bauer, Lang, & Schneider, 2012; Freeman, 1995, 2002; Juma, 2006; Juma & Bell Jr, 2006; Achim Lang, Schneider, & Bauer, 2012; Lundvall, 2007; Mazzucato, 2011; Mohan, et al., 2002; Muchie, 2008; Nelson, 2008; Pavitt, 1998). It represents the conduct of national technoscience and a codification of how the United Kingdom in the early 19th century, became the most industrialised nation in the world and in the process, a global technology leader (Freeman, 1995 & 2002). *Learning* how to innovate and industrialise is what NIS is

about and it is captured in the concept of developmental state. This conceptualises in historical and contemporaneous term, how hitherto technology lagging countries such as Germany and South Korea, have become technology frontiers or leaders. Therefore, learning for an innovation lagging country is to acquire domestic technology competence from compressed and received experiences of the leaders. That is to accumulate and assimilate technoscientific knowledge through rapid creation of institutions and infrastructures of domestic innovation. Such accumulation and assimilation are made possible by mixing acquisitions from ITTs with domestic fostering and forging of innovations and enterprises (Forje, 2006; Fu, Pietrobelli, & Soete, 2011; Lall & Pietrobelli, 2005).

Fostering domestic innovation is implied in the concept of 'entrepreneurial state' (Mazzucato, 2011, pp. 63-70); which, emphasises and highlights the role of public sector in stimulating, organising, regulating and steering state investments into prioritised domestic technosciences. This aligns with the concept of developmental state (Forje, 2006; Muchie, 2008; Ymele, 2011), but with a slight difference in agential orientation. Whilst, with developmental states, as a policy imperative, technology lagging countries are encouraged to learn innovation; with an entrepreneurial state, the *emphasis* is for national governments in frontier countries to become innovation stewards, domestic ethical financiers and markets organisers. The former, foregrounds technology creation and accumulation; whereas, the latter is about the state taking innovation risks by reforming extant NIS institutions. Therefore, both can be seen as policy and practical articulations of Schumpeterian innovation. What developmental state concept explains, though, is the instrumentality of ITTs in forging domestic innovation assimilation and accumulation.

The catalytic instruments, is emphasised by (Freeman, 2002; Perez & Soete, 1988). For instance, Sachs (2003, p. 138-139) observes how the adoption of this model ensured that South Korea's long-term participations in varied ITTs translated into successful national technology acquisition. Same can also be said of India (Baskaran, 2006) in how it incrementally developed its domestic Satcom technology industry.

As past conduct of IeTTs in Africa were dominated by Satcom technology, for example (Crump, 2006; Geissbuhler, et al., 2003; House, et al., 1987; Howell, 1988; International Space University, 1994). Hence, it is informative to point out that the birth

of its global industry came on the back of a East-West geopolitical contention (Cold War rivalry) between the USA and the former Soviet Union (Christol, 1974; Colino, 1968; Cowhey, 1990; Lambright, 1994; Levy, 1975; Peter, 2006). This birth accelerated and contributed to the successive emergence of semiconductor-based innovations. Subsequent computing and telecommunication technologies such as mobile phones became increasingly affordable and miniaturised, following a path earlier set by the emergence of mini and micro-satellites (Goldsby & Boyd, 2001; Irish, Paul, Shaumeyer, Gaither III, & Borden, 1999; Nogueira, 1998; Sweeting, 2000). Contemporary e-health technologies such as in m-health implementations (Briggs, Adams, Fallahkhair, Iluyemi, & Prytherch, 2012) reflect these historical but incremental technoeconomic changes.

NIS views national technology acquisition as a long-term domestic process, underpinned by a country's innovative educational and research system, productive industries and technically competent human resources. This is in contrast to the well-meaning, but cosmopolitan, short-term experimental nature of technology development, for example in (Fleishman, et al., 2010; Geissbuhler, et al., 2003) that characterises the conduct of IeTTs in African countries.

Sismondo (2010) argues that the role of a 'nation-state as a scientific state' is a feature of modernity (globalisation) and that 'the state takes on the task of administering life itself', (ibid. p. 191, box 17.1). The conduct of national techno-science is what separates such global technology leaders such as USA, UK, South Korea, Japan and Norway from others, i.e. from technology laggard African countries. Sachs (2003, p.138) describes the acquisition process in countries like South Korea and Malaysia as a 'kind of self-conscious drive towards scientific and technological capacity ...' To point out, these technology frontier countries are also global leaders in national electronic health record (EHR) implementation and industry (Aanestad & Jensen, 2011; Castro, 2009; Coiera, 2009; Ellingsen & Monteiro, 2012; Johannessen, et al., 2012; Larsen & Ellingsen, 2012; Sheikh, et al., 2011). As global technology laggards, African countries are technologically less competent than these countries (Forje, 2006; Ymele, 2011), and this can make their national e-health innovation acquisitions very difficult to achieve.

Such countries, according to (F.W. Geels, 2004) must develop regulative and normative institutions to finance and undertake domestic R&Ds, and develop technical standards

so as to foster domestic industrial growth. Moreover, their national governments must institute pro-innovation public sector behaviours, in order to ensure that regulative and normative institutions are properly promoted and implemented. This stresses the proactive roles of their national governments in ensuring 'win-win' participations in ITTs, by mobilizing domestic and foreign finances into infrastructural and industrial investments (ibid. pp. 138-139). Fittingly, this view aligns with a policy view (Forje, 2006; Juma, 2006, 2010; Juma & Bell Jr, 2006; Muchie, 2004, 2008; Ymele, 2011) on how African countries must acquire domestic technology capacities through the combined leadership and agency of their continental and national governments.

The fundamental premise of this developmental state policy is how African countries can acquire and build domestic technology competence through both endogenous, and international, technology transfers. In the wake of globalisation, African countries are urged African countries to embrace and practise the principles of national techno-science. Thus, these lagging countries must invest into civil, mechanical and electrical *engineering* capacities (Juma, 2006), urgently needed to build and repair its deficient and decaying physical infrastructures, such as their telecommunications and health system.

The narrative of an engineering of public water provision infrastructure in an African country, Zimbabwe is associated with national building (De Laet & Mol, 2000). An incremental design and production of water -pumping devices, enabled by a catalytic combination of cosmopolitan and national agencies and possession of domestic manufacturing capacity, became a driver for a nation-wide infrastructural implementation. The influences of regulative and normative institutions in its immature NIS were transformative (ibid. pp. 235-256), for example, domestic technical skills and craftsmanship were reportedly improved. For example, the authors noted a domestic engineering that went into ensuring a temporally successful implementation of the country's public water infrastructure. Hence, this made the collective enterprise a matter of national pride and a contributor to the country's public health goals.

2.4 Technology transfers and Globalisation

Technology pervades our society and is instrumental and intrinsic for creating wealth for nations and ensuring the wellbeing of their citizens (Freeman, 2002; Fritsch, 2011; Juma, 2006; Lundvall, 2007; Mazzucato, 2011; Pavitt, 1998; Ymele, 2011). With such a

foregrounding context of globalisation, international political contentions and complexity in the conduct of ITTs are inevitable, because of the plural interests and influences of the constitutive global networks of national and international state and non-state actors and organisations, asserts (Fritsch 2011, pp. 29-33). Such is evident in the literature on satellite technology transfers (Christol, 1974; Colino, 1968; Cowhey, 1990; Demerliac & Metzger, 1984; Goldsby & Boyd, 2001; Häusler & Simonis, 1985; Holmes, 1995; Howell, 1988; Lambright, 1994; Nogueira, 1998; Peter, 2006; Zuzek & Bhasin, 1996) to developing countries. Though ITTs are the strategic means for aspiring developmental or entrepreneurial developing countries' domestic innovation capacity acquisitions, such highly complex and pluralistic nature create structural constraints for them, argues (Contractor & Sagafi-Nejad, 1981; Reddy & Zhao, 1990).

The constitutive complex interactions are also detailed in NIS literature such as (Arocena & Sutz, 2003; Chataway, Hanlin, Mugwagwa, & Muraguri, 2010; Freeman, 2002; Juma, et al., 2001; Lundvall, 2007; Perez & Soete, 1988; Sharif, 2006) support this claim. Though traditionally limited to the study of institutional forms and identities, such as the mercantilist and industrialist[7] nature of ITTs, (Sachs, 2003) has in addition, however drawn attention to the altruistic and diplomatic nature of the conduct in global development. These four institutional forms are evident in the conduct of IeTTs and other technology transfers in Global Health and ICT4D practises. The reality is a complex and contested interactions of diverse range of nations, IGOs, multinationals, international non-governmental organisations (iNGOs) and international development organisations (IDOs).

The bodies of literature that capture global development conducts are from three broad disciplines (information system (IS) and science, technology and innovation (STI) related in parts to e-health and ICT4D and biomedical technologies transfers). Not least, because that the co-evolutionary history of computing, telecommunication and biomedicine technosciences in the US (Kaplan, 1987). They converge in investigating policy contexts of global development and technoglobalism and demonstrated that

[7] The ITT and NIS literature have focussed on commercial and international trade relationships in ITTs. They parochially focussed on the relationships of states, firms and multinationals to the neglect of non-state actors such as individuals, international governmental organisations and non-governmental organisations.

tensions exist in the interactions of multiple and diverse institutions and technologies in the conduct of ITTs. That politics, asymmetric power relations, contentions, and complexity mediate in the interactions.

2.4.1 ITTs and Global Health

The cosmopolitan conduct of IeTTs shares similarity with the current conduct of biomedical ITTs (Chataway, et al., 2010; Free, 2004; Howitt et al., 2012; Malkin, 2007). The transfers of connected medical devices such as point-of-care diagnostics largely designed and produced in technology frontier countries, are gaining prominence in global development policy. Global biomedical techno-scientific efforts and expertise are being directed at inventing technologies for addressing global health problems in developing countries, especially those in Africa. Though much needed and potentially life-saving public health interventions, such efforts have yet to yield tangible benefits in African countries; partly because of the inherent complexity and multi-agency intensiveness of the process (Ngoasong, 2010). Also as a result of an immature but steadily improving domestic innovation capacities of African countries in biomedicine and biotechnology (Al-Bader, Masum, Simiyu, Daar, & Singer, 2010; Chataway, et al., 2009; Frew, Sammut, Siu, & Daar, 2006; Juma, 2010). If the well-intentioned and optimistic goal is making such technologies affordable and appropriate in the recipients (Howitt et al., 2012, pp. 509-510), then, the protagonists' preference for a Schumacher model of technology development hasn't been sensitive to the immature states of their domestic competence and industry.

It must be taken into consideration that past conduct of biomedical technology transfers to developing and African countries, has been critiqued for breeding dependency on the donors and multinationals in terms of unsustainable technical and financial supports (Donald, 1999; Quaye, 1996). The institutional politics and power evident in the conduct can either constrain or condition successful technology transfers. For example, (Chataway, et al., 2010; Feldbaum & Michaud, 2010; King, 2002; Malkin, 2007; Ngoasong, 2010) have articulated that, geopolitical and geo-economic concerns and institutions of global mercantilism and diplomacy loom large in the interactions.

2.4.2 ITTs and Information technology

Uncertainty and complexity is observed in the interactions of the conduct of IeTTs in Africa. Similar findings are documented in the ICT4D literature, in which, agency is

similarly cosmopolitan as in the trans-national transfers of virtual e-Services and utilisation is narrowly that of digital services at subnational levels. The development and utilisation of the underlying software and hardware that powers virtual services in a Schumpeterian sense, is not typically a common topic in this literature.

Perhaps taken for granted, the ICT4D literature, taking an *Information Society* perspective (Avgerou, 2003; Bowman, et al., 2009; Corea, 2000; Gilhooly, 2005; Heeks, 2008; Kifle, et al., 2008; Mbarika, Okoli, Byrd, & Datta, 2005; Meso, et al., 2009; Pfister, 1999; M. Thompson, 2004; M Thompson & Walsham, 2010; Ya'u, 2005) have omitted to give due notice to Schumpeterian innovation. Similar omission is noted with, those on e(m)-health utilisation (J Braa, et al., 2007; J. Braa, et al., 2004; Cartwright, 2000; Edworthy, 2001; Fleishman, et al., 2010; Geissbuhler, et al., 2007; Gerber, et al., 2010; Mechael, 2009; Ouma & Herselman, 2009; Rigby, et al., 2000; Ruxwana, et al., 2010; Sinha, 2000; Tomlinson, et al., 2013). Whilst, collectively, these authors have highlighted the problem of a 'global imbalance in the utilisation of ICTs' ala Freeman, 2000 and James, 2003; their analyses are by and large, *information*-based, action-oriented, managerial and micro-individual in orientation.

The ICT4D authors have fleetingly mentioned the need for national technology acquisition in recipient developing countries. Strikingly, the exercise of agency is more tilted towards cosmopolitanism. Notwithstanding, Thompson & Walsham, 2010 have made a clarion to recognise the imperative of economic productivity and entrepreneurship to Africa's socio-economic advancement. In general, the literature has not treated the transfers of ICTs from a Schumpeterian innovation view. They have been shy to emphasise the instrumentality of domestic innovation assimilation and accumulation in the cosmopolitan conduct of ITTs.

Nevertheless, few of this orientation, for example, (Avgerou, 2003; Corea, 2000; Pippin & Qureshi, 2011) have taken an *innovation*-based perspective; but, not completely embracing Schumpeterian notion of innovation as in national innovation system. As an immaturity or a lack of industrial capacity is a structural constraint in African countries. Avgerou (ibid.) from a macro-societal/institutional view inquired about a managerial conduct of an N-S IeTT; and, concluded that marked relative difference in innovation capacity between the technology donor/producer and the recipient/consumer, ultimately accounted for an uncertain implementation in the latter. Corea (ibid.) in contrast took a

micro-individual, behavioural view; and, presented national technology acquisition as a sociotechnical process – which can be hindered by stable cognitive/behavioural institutions of innovation. However, no mention was made of normative and regulative institutions cited by (F.W. Geels, 2004) as necessary for fostering sustainable technological and systemic innovations.

Similarly, but with a globalisation slant, Pippin & Qureshi, 2012 is closer to completely embracing Schumpeter. They employed a combination of Schumpeterian 'creative destruction' and Schumacher 'intermediate technology', to study how the utilisation of (not invention and production of), mobile phones is creating new technoeconomic opportunities for entrepreneurs and small enterprises in developing a country. The combination of the two models of technology development and utilisation is closer to the approach we are adopting in the thesis (Chapter 7).

2.4.3 National agency and Global techno-development

In both the policy spaces of Global Health and ICT4D, the idea of a Schumpeterian national innovation system (NIS) is a foreign one. A possession of domestic innovation capacity for accumulating and adapting transferred technologies is not well accounted for in their respective global policies. Recipient countries are merely consumers of externally produced technologies in a Schumacher cosmopolitan sense a la (Kaplinsky, 2011; Schumacher, 1972; Toye, 2012). The economics is consumerist not industrial in the recipients.

Research of their conducts typically references and subscribes to Amartya Sen's model of socio-economic development that emphasises investments into upgrading human capital. With his preference for capability-based approach to development, it can explain how individuals' entrepreneurial spirit and learning can be acquired in a Schumpeterian sense (Lundvall, 2007, p. 114). Nevertheless, this is, not about fostering national innovation. By focussing narrowly on ICTs as inputs, Sen omits the other four Schumpeterian process, organisation, market and product innovations that NIS theory advances. It is also unsuitable for explaining the structural and dynamic nature of national innovation acquisition trajectory (Muchie, 2008, pp. 13-14).

The global redistribution policy, that Sen's model (Kaplinsky, 2011, p. 193) informs, is prominent in of Global Health and ICT4D policies. In this sense, Schumacher once advocated for a large-scale redistributive consumption of global resources (Toye, 2012,

p. 395), as opposed to Schumpeterian notion of NIS. Emphasis in research and practice is un-developmentally tilted towards promoting consumption of transferred ICT and biomedical technologies a la Sachs, 2003; in a Schumacher sense. Largely omitted in the policy were imperatives of domestic innovation capacities in Africa needed to foster transformative biomedical (Al-Bader, et al., 2010; Chataway, et al., 2009; Frew, et al., 2006; Juma, 2010) and ICTs innovations (Kraemer-Mbula & Muchie, 2006, 2009; Oyelaran-Oyeyinka, 2006). A surprising omission it is, because a country's national development's trajectory is closely interwoven with innovations in its health and ICTs sectors.

The Global Health movement is keen to emphasise that investment into human capital development will automatically translate into long-term technoeconomic growth and progress. However, the relationship between a country's socioeconomic status and health is more complex than the implied linearity – it is a 'chicken and egg' situation. The economic strength of a nation measured in gross domestic product (GDP) positively correlates with and dialectically co-determines its public health (Howitt, 2005; van Zon & Muysken, 2007). Investments and innovations in a nation's health sector can build and equip its human resource capacities, which might in turn powers its technoeconomic progress, collective learning and creativity, productivity and economic growth. The instrumental co-determining relationship roles of domestic innovation capacity and health in a nation's developmental trajectory (van Zon & Muysken, 2007, p. 10-11), is explicitly missing in current Global Health policy.

The instrumental role of ICTs as both a driver of and a foundation for an African nation's socioeconomic advancement is well documented (Bowman, et al., 2009; Kraemer-Mbula & Muchie, 2006, 2009; Oyelaran-Oyeyinka, 2006; Ymele, 2011). However in mainstream global ICT4D policy, the dialectic and co-determining relationship between domestic innovation capacities and how these technologies are invented and combined to produce novel and upgraded products and services, were just as noted in Global Health policy, omitted. Not least, technology frontier countries are concomitantly global innovation and information leaders. As those posses established industrial capacities in semiconductor and consumer electronics R&D and manufacturing (Bauer, et al., 2012; Freeman, 2002; Achim Lang, et al., 2012; Macher, Mowery, & Di Minin, 2007; Mazzucato, 2011).

To theorise how industrialisation can occur in African countries, Sen might be unsuitable; because, building individual capabilities alone is not sufficient to leapfrog from technology lagging state to that of leading or following (Muchie, 2008, p. 17). Capability approach seems not sufficient to make the countries entrepreneurial or developmental states.

In general, in these Global Health and ICT4D literatures, it is taken for granted that the recipients possess or share a universal domestic innovation capacity standard as the donor. Given that such capacity is essential for making feasible a successful technology acquisition. Rather, we need to stress particularism in the face of implied universalism. For instance, differences in ecology and geographical location between a technology leading country and a lagging African one that could potentially make domestic innovation acquisition difficult (Sachs 2003, pg. 136), stress the need to challenge such implied universalism. In this regard, it is expected that the responsibility to acquire lies with the recipient country in a global system: i.e. where institutional arrangements such as multilateralism, regionalism and bilateralism act as mediators in international cooperation (Contractor & Sagafi-Nejad 1981, pp. 126-127). Such arrangements could be a strategic choice made by a country (Contractor & Sagafi-Nejad, 1981; Lall & Pietrobelli, 2005; Reddy & Zhao, 1990). It is the proactive efforts of the national governments that ensure that technology acquisition materialises and is not taken for granted during participations in the institutional arrangements of international cooperation, (Juma, et al., 2001) advocated.

Proactivity is line with the concept of national entrepreneurship or developmentalism. In this instance, the recipient countries, through the formulation of an active policy, must assimilate tacit knowledge from ITTs to be able to adapt transferred technologies to national needs and usage, asserts (Reddy & Zhao 1990, pp. 292-294). It is this process of assimilation and adaptation, beyond the mere or passive adoption of transferred technologies, which determines successful acquisition. What contributes to such successful acquisition is the ability of African countries to overcome specific institutional structures constraints at international and national levels, assert (Forje, 2006; Lall & Pietrobelli, 2005; Muchie, 2004; Ymele, 2011). To identify the scope of such constraints, the exploration by (Freeman, 2002) of how national technology acquisition comes from interactions within a global innovation system, is informative. Within which, such acquisition comes into being through complex interactions of

global, continental, national and subnational actors and organisations. Cross-linking institutionalised structures of these cross-interactions, can make assimilation and accumulation, difficult.

2.5 National e-health technology development

The sophistication of a country's extant domestic innovation capacity, for instance its medical invention and manufacturing strengths, correlates with its ability to provide quality healthcare to its citizens, observes (Chataway, et al., 2009; Juma, 2010; Pavitt, 1998). Countries such as the UK, USA, Norway, and Denmark are global technology leaders in the implementations of national EHR infrastructure (Castro, 2009). The key role played by the national governments of these countries in their implementations resonates with what was previously identified with Asian tigers (Holliday & Tam, 2004). The authors noticed that investments made by the tigers' national government into their domestic telecommunication and IT industries, which produced the computing and telecommunication technologies utilised for implementing their e- health infrastructures. Nevertheless, both (Holliday & Tam, 2004) and (Castro, 2009) did not associate national e-health implementation with the possession of a mature extant domestic innovation capacity and high national economic strength. Maybe these were taken for granted.

Even though the frontier countries are yet to fully build their national e-health infrastructures, it is noted that, by virtue of their domestic innovation capacities (Bergmo & Johannessen, 2006; Fujimoto & Miyazaki, 2000; Johnston, Staveley, Olfert, & Jennett, 2000; Kaplan, 1987; A. Lang & Mertes, 2012; Lee, et al., 2009; Spivack, 2005), an evolutionary approach is being taken for their designs and implementation of national e-health infrastructures (Aanestad & Jensen, 2011; W. L. Currie & Finnegan, 2011; Ellingsen & Monteiro, 2012). The same can also be observed with the emerging global technology leaders such as India in its national telemedicine implementations (Mishra, Kapoor, & Singh, 2009), reportedly underpinned by a long-term process of domestic innovation acquisition (Baskaran, 2005). Malaysia, an emerging Asian economy included the implementation of e-health projects in its ambitious national ICT blueprint drawn from the perspective of NIS (Mohan, et al., 2002).

The acquisition and possession of such specific industries and infrastructures is what identifies as 'specific state agencies, corporations, and the academic institutions – and

their linkages that contribute to technological growth' (Sismondo, 2010, p. 200). Instructively, most of these countries were at one time or the other participants and beneficiaries of IeTTs. For instance, a country such as South Korea has a history of co-production of e-health technology in forms of North-South with Austria and China (Jongman, Jung, & Kim, 2005) and south-south with China and Japan (Nakashima et al., 2004) research collaborations. Even Norway is opening up its domestic e-health market to foreign competition (promoting the conduct of IeTTs), in order to drive further innovation in its national implementation (Ellingsen & Monteiro, 2012). Meaning that implementation requires a Schumpeterian industrial model of technology development and utilisation.

2.6 Industrial model of e-health implementation

The global e-health leading countries are entrepreneurial states (Mazzucato, 2011). They have established high-technology (hi-tech) companies and multinationals and are also global leaders in the development and utilisation of mobile technologies. For example, South Korea has Samsung, the USA has Apple and Google and the UK has ARM and Imagination. Their prowess in semiconductor inventions and manufacturing (Bauer, et al., 2012; Freeman, 2002; Achim Lang, et al., 2012; Macher, et al., 2007; Pavitt, 1998; Perez & Soete, 1988) have made them global powerhouses in Smartphones' and microchips' design and manufacturing.

Samsung is a global pacesetter in this regard. Its industrial role in the accumulation and assimilation of e-health technologies, that are going into building South Korea's national e-health infrastructure, is documented (Briggs et al., 2001; Holliday & Tam, 2004). The origin of both Samsung and ARM has something to do with the exercise of National Agency of the governments in their respective host countries. Public sector stewardship, finances and market stimulation and organisation were evident in these accumulations. For example, ARM's creation took root from a publicly funded R&D programme carried out by the British Broadcasting Corporation (BBC) in the 80s[8].

A model of national e-health technology implementation we identified with the global e-health leaders can be termed as *industrial*, according to the way they utilise technologies that are domestically developed for building their national e-health

[8] History – http://en.wikipedia.org/wiki/ARM_architecture

infrastructures. By following a Schumpeterian innovation model, they have, over a long period, acquired specific national technology capacities in computing, telecommunication and biomedical industries and infrastructures, underpinned by domestic competence in electronics and semiconductor innovation and manufacturing.

The relevance of these specific capacities in the development of their national e-health technologies is clearly evident with these identified global technology leaders. They have acquired the specific domestic innovation capacities that are instrumental and intrinsic for an incremental national e-health technology invention and production. Moreover, most have also articulated policy of investing into e-health technology development and implementation as technoeconomic growth drivers.

The Health Information Technology for Economic and Clinical Health act (HITECH) in the USA (Buntin, et al., 2010; Kaplan & Harris-Salamone, 2009; Kellermann & Jones, 2013) is an example of such e-health technoeconomic driver. The European Union (EU) through the institution of similar initiatives has coordinated e-health (mostly on EHR and telemedicine) implementations in its member states with continental and national socio-economic advancement and growth (Karopka, Frank & Blank, 2012 and Lang & Mertes, 2011). For instance, initiatives such as e-health Action Plan, i2010, The Lead Market Initiatives, Joint Technology Initiatives and the EU Economic Recovery Plan were co-ordinately implemented. Germany (Lang & Mertes, 2012, p. 294), for example coordinates its healthcare and technology innovations as part of its German Hi-Tech Strategy for the implementation of its national e-health smartcard infrastructure.

2.6.1 National e-health technosciences

The e-health technology frontier countries have a long history of fostering domestic e-health technosciences through national regulative and normative institutions. Germany for example has two normative coordinating research institutions: Council for Innovation and Growth and the Industry-Science Research Alliance are created to coordinate R&D and commercialisation amongst domestic companies, universities, consumer groups and multinationals (Lang & Mertes, 2012, 290-291). The Technology Strategy Board under the Small Business Research Initiative (SBRI) in England plays similar role in coordinating R&D on e-health innovation. Initiatives such as Assisted

Living Innovation Platform (ALIP)[9] and Delivering Assisted Living Lifestyles at Scale (DALLAS)[10] were designed to stimulate innovation, investments and interoperability in the telecare and telehealth.

An impetus provided by these initiatives has resulted in a 'triple-helix' (Johnston, et al., 2000; Spivack, 2005)-like Government-Industry-National Health Service (NHS) partnership – the creation of still an unimplemented *3 million lives*[11] initiative. Nevertheless, similar innovation initiatives have not been launched in the case of England's national EHR implementation, as the USA is doing with HITECH. The long established conduct of combinatorial biomedical and computing technosciences by state-funded US National Institute of Health (NIH) laboratories (Kaplan, 1987), may be historically influential in creating HITECH.

Two types of national innovation strategies are identified with these global leaders: federalist and centralist based on a diversity of their healthcare provision. The first, federalist type, where providers are mixture of public, private and community organisations, is found with the USA (Buntin, et al., 2010; Kellermann & Jones, 2013) and Germany (Lang & Mertes, 2012). In both countries, the federal government formulate and implement innovation strategies that dictate plans for e-health technology development, financing and regulation, while implementation is delegated to subnational (state or provincial) entities. The second, centralist type is noted with England's implementation (Trisha Greenhalgh, et al., 2011; Sheikh, et al., 2011; Takian & Cornford, 2012).

The central government dictate similar plans, but also with power of implementation (at least the case was with the defunct NPFiT). The provision is predominantly through a public organisation. Both types may suit different African countries. Regardless of such configurational difference, national implementation in both types is driven by and built on possessing an extant domestic innovation capacity.

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[9] Technology Strategy Board: Assisted Living Innovation Platform – http://www.innovateuk.org/_assets/pdf/assistedlivingip.pdf.

[10] Technology Strategy Board: Delivering Assisted Living Lifestyles at Scale – http://www.innovateuk.org/_assets/0511/sbri_comp_dallas.pdf.

[11] 3 million lives News Release – http://3millionlives.co.uk//wp-content/uploads/2012/03/3millionlives-News-Release.pdf.

2.6.2 Domestic e-health innovation dynamics

The possession of such specific domestic technology capacities (i.e. R&D institutes and companies) has set these global leaders apart from laggards. What is also evident in these countries are the proactive efforts of their national governments in instituting policies and providing finances for fostering domestic e-health innovation by setting national standards, stimulating local industry, encouraging private and public sector entrepreneurships, for example in Norway (Bergmo & Johannessen, 2006) and Germany (A. Lang & Mertes, 2012). There exists a kind of domestic innovation feedback loop in these countries, similar to what (Caniëls & Romijn, 2009; F.W. Geels, 2004) has identified with global technology leaders – that act as a 'conveyor belt' between subnational e-health experimentations they have instituted and the accumulation of technologies and assimilations of technical knowledge at the national level.

The cases of national e-health implementations in Norway (Bergmo & Johannessen, 2006; Ellingsen & Monteiro, 2012; Halford, et al., 2009; Johannessen, et al., 2012) and Germany (Bauer, et al., 2012; A. Lang & Mertes, 2012; Achim Lang, et al., 2012), demonstrate that a connection between e-health technologies developed in subnational experimentations, utilised for healthcare service delivery in their hospitals and clinics, are underlined by such a feedback loop. In both countries, it is evident that the possession of an extant domestic innovation capacity doesn't necessarily translate into large-scale national e-health implementation. Underlining what is a well documented uncertain and complex nature of such an endeavour.

A domestic dispute erupted amongst the involved multiple private and public stakeholders from healthcare, management and technology sectors, in Germany, is an example. This subsequently resulted in a reported fragmented governance of the national scale-up of the electronic health card implementation. An institutional misalignment among the funding public sector and contracted EHR Software Companies in Norway during implementation is noted by (Halford, et al., 2009; Johannessen, et al., 2012; Larsen & Ellingsen, 2012). Though large-scale implementation was reportedly not yet evident in Norway, the authors, nevertheless, reported an increase in national e-health innovations and economic activity through the entrepreneurial efforts of its domestic private and not-for-profit companies.

The presence of such a *feedback loop* that links together the national and subnational innovation systems, in the conduct of IeTTs, can make feasible an acquisition of domestic e-health innovation capacity in recipient African countries. An evaluation study carried out on an international transfer of green technologies in Tanzania (Caniëls & Romijn, 2009), identified that the subnational experimentations struggled to nationally scale-up. The authors identified that the immaturity of its NIS, and the passivity of its National government in fostering domestic innovation and industrial capacities, accounted for the reported setback.

In general, it is not a sole or passive dependence of the global e-health leaders on IeTTs that is driving their national e-health implementations, but their possessions of advanced domestic innovation capacities. Except in South Africa, regarded as the most technologically advanced country in Africa (Kraemer-Mbula & Muchie, 2006, 2009), where they have started thinking about practising domestic e-health innovations (Van Dyk, Groenewald, & Abrahams, 2010), it is difficult to identify any other African country that has a national innovation system that is mature enough to acquire e-health technologies, of the kind identified with countries with an industrial model.

South Africa as an exception has a home-grown m-health company- Cell-Life (http://www.cell-life.org/projects/health-care-and-testing/) which emerged on the back of a domestic triple-helix-like partnership. Even so, the country rated as the most innovative on the continent as measured by its R&D intensity (Brundenius & Mawoko, 2010), is still struggling to ensure that subnational e-health (i.e. in EHR and telemedicine) experimentations (Kachienga, 2008; Ruxwana, et al., 2010) translate into large-scale national implementation.

2.7 Global e-health technology divides

The focus of the study here is such that the complex interactions in the conduct of IeTTs are treated as occurring within a 'global innovation system', as inspired by the preferred STS constructivist view. The system reflects the density of the interrelationships amongst the constitutive diverse and multiple actors and organisations in the contextual interactions, as e-health technologies diffuse along global, continental and national levels. In such a system, the technology acquisition capability of an African country can depend on the exercise of its Agency in Schumpeterian national innovation sense, in the process of interacting and negotiating with others (Klein 2002, pp. 41-43). An

interpretation is that the more a country is integrated into the system, the more likely it possesses similar capacity as others in the system. The converse is also true.

The less integrated a country is, the less likely it will possess similar capacity as the others. What this implies is that a country is more likely to assimilate knowledge from IeTTs if that country possesses similar domestic innovation capacity as the others in the global innovation system.

The view being presented here is akin to what has previously been highlighted in the seminal paper by (Juma, et al., 2001), that the possession of domestic technology capacities in developing countries that grapple with digital divide and Global Health challenges, must not be taken for granted. Especially when an 'international technological dualism' exists in the global information and communication technologies (ICT) industry, where extant domestic technology capacities portend that the 'haves' will acquire more and the 'have-nots' will acquire less (Freeman, 2000; James, 2002). Meaning that digital divide is a manifest of domestic innovation deficiencies in semiconductor and electronics industry and engineering. More so, when structural differences in institutions of innovation between developed and developing countries in the conduct of IeTTs (Avgerou, 2003; Blum, 2002; Edworthy, 2001; Heeks, 2006), may condition if transferred technologies can be sustainably acquired in the latter.

In technology frontier countries, the presence and maturity of extant institutions of innovation (Bauer, et al., 2012; F.W. Geels, 2004; Achim Lang, et al., 2012; Nelson & Nelson, 2002; Sharif, 2006), makes possible, a predictable and stable identification of, and oftentimes rapid and appropriate response to, technological uncertainties. Conversely, such institutions, such as manufacturing are still relatively immature in technology lagging African countries (Caniëls & Romijn, 2009; Forje, 2006; Juma, 2006; Juma & Bell Jr, 2006; Muchie, 2004, 2008). Africa's contribution to the global technology value-chain measured as its share of the world's manufacturing output is 'miniscule and has fallen' (Kaplinsky, 2011, p. 198) considerably in the last two decades.

Therefore, in the wake of globalisation, a country without such capacity would be constrained in its acquisition quest. Addressing this global 'technological divide' might require that the enforcement of intellectual property rights are relaxed for developing countries (Juma et al., 2001, p. 635). This implies that if such a country is only a passive

consumer of transferred e-health technologies and at the same time not a producer of them, its domestic innovation capacity acquisition can be structurally constrained. Contributions to academic and policy debates on national e-health implementations in African countries and globally are made on this ground.

As earlier identified in this chapter with global technology leaders, an *industrial* model underpins their national e-health initiatives. What implication does this finding have for e-health technologies in recipient African countries, who have limited domestic innovation capacity? Sismondo, 2010, p. 201, employs 'cumulative advantage hypothesis' to alert researchers to see that being at the periphery of global technology centres shouldn't be a permanent state.

Cumulative advantage – 'large differences in status can be the result of many small differences'- is employed to interpret that the *industrial* model identified with the global e-health leaders, can explain their technological advantage over most recipient African countries. It may also help to explain differences between African countries in how they exercise national agency in the conduct of IeTTs. They have incrementally acquired and are still acquiring domestic e-health innovation capacities from nationally funded and designed subnational experimentations and utilisations. In the process, they have accumulated and assimilated technologies and technical knowledge and competence in telecommunications, biomedical and computing industries.

Lundvall,2007, p. 117 recommends to developing countries, especially African ones, that they must overcome organisational inertia to learn how to innovate from others. Seen in the light that African countries are struggling with their national e-health implementations, there is an argument to be made that they should learn from the industrial model of more successful countries. An assertion made by Fritsch,2011, p. 41, that countries 'will most likely continue to play relevant role in the development and utilisation of new technologies', resonates. This implies that the exercise of national agency is not a replacement for a 'cosmopolitan' (Lundvall 2007, p. 113) approach to technology development that STS constructivism (Fritsch 2011, pp. 38-39) advocates in the context of technoglobalism.

2.8 National e-health technology development and utilisation

The *innovation* approach to study the development and utilisation of e-health technologies is meagre and limited to clinical-level, information-based, action-oriented

and managerial-focussed leanings. Even so, few have studied e-health technology at national and international levels in this way. However, studies on national implementation such as (Aanestad & Jensen, 2011; Ellingsen & Monteiro, 2012; Johannessen, et al., 2012; Larsen & Ellingsen, 2012) have pointed out with the implementation of large-scale EHR infrastructure is an incremental *engineering* of software in bits and pieces and in leaps and bounds.

Publications by (S. Cho & Mathiassen, 2007; W. L. Currie & Finnegan, 2011; Nicolini, 2010) on the development and utilisation of e-health technologies, are examples of the few that we have identified with an innovation slant. Following a Schumpeterian model of innovation, insights into the evolution of computer industry (W. Currie, 2009; Hwang & Christensen, 2008), suggest how the introduction of computing technologies can drive performance of, and improve, the impacts of clinical services, only if an optimal alignment between healthcare service and business practises, is strategically employed. Requiring that all the five types of Schumpeterian innovation – industrial: process and product and service: organisational, input and market are needed for fostering both incremental and radical technological and system changes (Windrum & García-Goñi, 2008).

How these five innovation types co-act in the development and utilisation of an e-health technology is demonstrated by Kaplan, 1987, in the case of domestic transfer of CT-Scan (a biomedical device) in the US. Cho, et al., 2007 too, studied how innovation in industrial, service and business systems can foster an incremental accumulation of e-health technologies in healthcare settings. By contrast, Currie, 2009 and Currie & Finnegan, 2011 studied from an innovation perspective, the utilisation of e-health technologies in healthcare settings in the context of a national implementation. Yet, Currie & Finnegan, 2011 recognises that institutional market forces, political and economic ideologies, history, governmental and non-governmental actions and behaviours, can condition or cause the directionality and impact of a large-scale e-health innovation.

The exercise of agency – labelled as a practise of 'institutional entrepreneurship' by (Currie, 2009, p. 76) is nevertheless limited to sectoral organisational actors and groups interacting in a cyclical mode of actor network theory (Sunyoung Cho, et al., 2008; T Greenhalgh & Stones, 2010). Their institutional view of innovation, are rather narrowly

focussed on clinical-level, information-based, action-oriented and managerial-focussed leanings. Not as taking a far-reaching approach that foregrounds the exercising of 'state entrepreneurship or developmentalism' in a way of instituting of a NIS in complex interactions of technoglobalism. For example, it articulated by (De Laet & Mol, 2000, pp. 288-231) in the case of a national innovation of water pumps in Zimbabwe. Where, it was evident that evolutionary combinations of technologies and expertise underpinned a collective engineering of its public water infrastructure.

The implementation a large-scale national e-health initiative is, however characterised by an incremental long-term, socio-technical innovation process of engineering (Geels, 2004, p. 898). In and during protracted implementation (Aanestad & Jensen, 2011; Bergmo & Johannessen, 2006; S. Cho & Mathiassen, 2007; Coiera, 2009; Ellingsen & Monteiro, 2012; Gulube & Wynchank, 2002; Heeks, 2006; Johannessen, et al., 2012; Kachienga, 2008; Larsen & Ellingsen, 2012; Sheikh, et al., 2011), suggested that the demanding and fastidious nature of healthcare system and of diverse healthcare professionals' needs and preferences, deserves that e-health technologies have to be regularly invented, and constantly upgraded. Thus, it elicits a structural comparison with the dynamic nature of Schumpeterian engine (Hwang & Christensen, 2008; Pippin & Qureshi, 2011; Windrum & García-Goñi, 2008) of creative destructionism.

We hence, posit that a national e-health implementation is similar to engineering large-scale technology project. It is akin to building an infrastructure by assembling and combining together diverse and multiple institutions and technologies in bits, parts pieces. In the manner of a long-term and large-scale technoeconomic (Freeman, 2000; Perez, 2010; Perez & Soete, 1988) change, such engineering process will pan out as a long wave of concurrently accumulating material or physical technologies and assimilating technical knowledge and skills. Of course such process is buoyed and supported by an extant possession of a domestic innovation capacity.

Schumacher provides a counterfoil to Schumpeter in how technologies are acquired and accumulated in the sphere of international development. Both Schumpeter and Schumacher theories on the development and utilisation of technologies were conceived as critical policy challenges to established neoliberalism (Kaplinsky, 2011, pp. 194-195). The former's work on 'intermediate technology' (Kaplinsky, 2011; Schumacher, 1972; Toye, 2012) insights a practical view of a 'doing it all for me', consumerist and

cosmopolitan approach that underpins the development of most of the e-health technologies that are being transferred to Africa. Whilst Schumpeter model of adapting, accumulating and assimilating of transferred knowledge and technologies can be seen as an alternative.

2.8.1 Schumacher

Schumacher is widely noted for his quixotic ideas on green, open, affordable, modular and people-centred technologies as espoused in a book *Small is beautiful*. The title of which, was chosen more for its evocativeness and 'has clouded his (Schumacher's) message' (Toye, 2012, p. 387). These ideas codified in a cosmopolitan intermediate technology model, are noted in the conduct of e-health, m-health and biomedical technologies transfers to African countries.

The Schumacher idea of 'intermediate technology came into fashion in the 70s, as articulated in this report (Schumacher, 1972), and is observed in the conduct of past and present conduct of international technology transfers in Africa. Implicit in the idea, was that African countries could only be passive recipients of dated and non-modern equipments and devices designed and manufactured by global technology leaders. Such technology is produced by small-scale village industry are typically subnational and non-commercialised inventions and for communal utilisation. Frugal innovation that it represents, reads as a dated and environmentally suitable equipment or device that is in low capital and high labour-intensive to produce and operate.

The report (ibid.) showcased examples of environmentally appropriate, low-capital and high-labour intensive technologies. For example, a case of a Nigerian teaching hospital's efforts of inventing and producing an intermediate health device; which was only for a localised subnational utilisation at the host hospital and with no reported intention any national-scale-up, was cited (p.87). A path-dependency between this past innovation is noted in the current cosmopolitan global health efforts, for example in (Chataway, et al., 2009; Chataway, et al., 2010; Howitt, et al., 2012; Malkin, 2007).

The narrative of water pump invention in Zimbabwe by (De Laet & Mol, 2000), is a past example of an intermediate technology production in Africa. Similar approach was taken in past cosmopolitan transfer of Satcom devices in several African countries (Yesufu, 1990, Goldsby & Boyd, 2001 and Nogueira, 1998). Yet, despite the uncertainty surrounding the model's success (Free, 2004), a current global health policy

on developing frugal biomedical technologies for developing countries (Howitt, et al., 2012, p. 509) is adopting it.

A policy concern with cosmopolitan agency is that innovation learning – the acquisition and assimilation of techno-scientific knowledge by the recipient is passive. Whilst, the cosmopolitan agency conditions consumerist technology development trajectory in the recipients, in the Schumpeterian industrial model, the agency is national. Rather than the active learning and interaction with technology producers, which is deem foundational for acquiring domestic innovation capacity in NIS theory. Moreover, with Schumacher, there is no accounting for the explicit nature of tacit knowledge that is required for acquiring industrial competence. Schumpeter is about active learning, while in contrast, learning in Schumacher's model learning is passive. Not least because that cosmopolitanism can be at odds with, proactive national actions (De Laet & Mol, 2000, pp. 242-243), and with individualism (ibid. pp. 248-252) that often characterises global actors' inventions.

On technological scales, whereas, Schumpeter is concerned with large spatial, geographical and functional factors, Schumacher is more concerned with minimal numbers of users. Schumacher concern with large-scale technology infrastructure is about its 'appropriateness'. 'Bigness' – an optimal number of consumers or users an infrastructure can serve, as appropriate to a country's economic capability. The inclination is descriptively minimal technological institution and infrastructure as opposed to large-scale ones implied in the Schumpeterian industrial model. Schumacher is also quiet on how technology comes into being. Though, innovating to produce durable devices and to minimise technology obsolescence is credited to Schumacher (Kaplinsky, 2011, p. 195). The Schumpeterian creative destruction model of combinatorial and incremental technology production is not evident.

2.8.2 Schumpeter

The NIS theory of agency and learning presented in the preceding sections informed about Schumpeterian engine of innovation and the hi-tech nature of e-health industry. Though in healthcare innovation, a service-based approach is the typical, for example (Hwang & Christensen, 2008), innovations in manufacturing and consumer markets are usually and practically overlooked (Windrum & García-Goñi, 2008).

The incremental and radical nature of e-health technology development, essentially and instrumentally requires product and market innovations, to translate experimentations or inventions to viable and large-scale systems. Organisational, process and inputs innovations are also essential at the service, sectoral or subnational level, however. For example, input innovation such as the platform provided by semiconductor-based industries (computing and telecommunications), and emerging biomedical (lifesciences) one, provides raw or basic materials for a burgeoning global e-health enterprise.

The convergence of these technologies will drive their (re-)combinations and will be powered by the ubiquity and consumer-focussed nature of mobile /technologies, as articulated in (Briggs, et al., 2012). The industrial capacity that is required for combining, engineering and implementing these converging technologies are also needed for fostering national acquisition and accumulation. Such capacity is instrumental for addressing a country's public health goals; for example, as (De Laet & Mol, 2000, pp 231-233 & 238-242) noted in the case of a challenging incremental domestic technosciences and engineering of water pump devices and infrastructure in Zimbabwe.

The health of a nation is tightly coupled with its industrial and innovation capacities in a Schumpeterian sense (Howitt, 2005; van Zon & Muysken, 2007). Moreover, Pavitt, 1998 argued that a nation's biomedical innovation sophistication strongly reflects its state of extant domestic innovation capacity and determines the depth of its health service sector's technology utilisation. Domestically, health service utilisation is determined by the quality and appropriateness of produced technologies and the consumer markets of an innovation system (Windrum & García-Goñi, 2008). Service utilisation is in turn, structurally determined by: the maturity and innovativeness of a system's (i.e. a country's) industrial capacity; the agency of its public and private care providers and policymakers; sectoral technical competence; and the receptiveness of consumers (ibid., p. 652). In short, national innovation capacity produces technologies for sectoral health service utilisation.

The instrumental role of consumerism (not consumerist model) is pivotal for acquiring a domestic industrial capacity (Windrum & García-Goñi, 2008). Consumerism of biomedical products/technologies is on the rise, hence, suitable types of service and market innovations (ibid., p. 657-659), are needed. In e-health, such consumerism is

now being driven by the ubiquity of mobile phones (Briggs, et al., 2012). In global term, consumerism and mutlinationalism appears to be a driving force behind the production of affordable technologies such as mobile phones buoyed by the rising innovation power of global East economies and rapidly expanding international markets (Kaplinsky, 2011). From the ICT4D literature, Pippin & Qureshi (2012) presented mobile phones as an appropriate technology in the sense that they are less-capital intensive for a user or consumer to own; but, omitted to mention that their invention and manufacturing are not.

The implementation of m-health innovations in Africa is benefiting from the positive trend of consumer adoption of mobile phones and in the process are yielding 'reverse innovation' (Immelt & Govindarajan, 2009) to global value chain. Product innovations being carried out by multinationals in developing countries create values for international markets (Kaplinsky, 2011. p. 201). So far such conduct of reverse innovations, un-developmentally limits African countries as 'outsourced R&D labs', the passive learning that transpires in our opinion, will not translate into national e-health technology acquisition. The dynamism of domestic market and consumerism necessary to drive e-health scale and industrialisation, will also struggle to emerge and evolve. On this note, we contend with Schumacher typified by (Kaplinsky, 2011, pp. 201-202) that African countries will benefit from the global production of less capital- and high-labour –intensive devices produced by multinationals and global East economies. No consideration was given to recipients' domestic innovation assimilation and accumulation and a likely concern of technology dependency.

To sum up, both Schumpeter and Schumacher models apply to technology utilisation and implementation, but differ on how innovations are acquired and accumulated. The former is consumerist – inclined towards technology consumption and on low-technology design and not production. In contrast, the latter is distinctly industrial – about the creation and production of both low- and high technologies. Schumpeter is concerned about technoeconomic changes, spaces and infrastructures; Schumacher is concerned with spatial, infrastructural and sectoral minimalism. However, both value participating in ITTs, but differ on the locus of agency and mode of learning.

We have identified certain areas of contention by comparing Schumpeter with Schumacher in satisfactorily explaining how e-health technologies can be acquired and

accumulated. The contention stem from the ambiguity and looseness of interpreting and applying Schumacher's idea, for example, as (Toye, 2012) tried to explain in his mini-biography. Not least that the Schumacher model might not realistically addresses the dynamism and challenges of technology development and utilisation in the current age of globalisation (Kaplinsky, 2011). The areas of contention are innovation learning, exercise of national agency and the nature of technology are fully discussed in Chapter 7.

2.9 STS constructivism, institutionalism and narrative

In health informatics, the notion that the creation and interpretation of knowledge is pragmatically determined (Scott & Briggs, 2009) connects well with constructivism and poststructuralism. The multidisciplinary of health informatics discipline, call for a pragmatic mixed method approach. Our combination of theories and methods is in line with such methodical pragmatism and pluralism. Our pragmatic combination of plural methods or theories is line with STS policy-making for studying complex interactions of innovation systems (Geels, 2007, pp. 631-635).

The thesis studies the conduct of IeTTs in African countries by combining moderate STS constructivism, NIS institutionalism and poststructuralist narrative. Such combination of methods or theories is synonymous with middle-range STS – making connections between multiple theories, audiences, levels and data through 'multisited ethnographies' (Wyatt & Balmer, 2007). The objective is to overcome limitation of conservative micro- case study methods. This combination is employed to attend to the five research objectives listed in section 1.9.

The study asserts that an exercise of national agency (or a lack of it) should not be subsumed in the clatter of competing structural mechanisms, forms, identities and arrangements. The study in a pragmatic manner foregrounds in a Schumpeterian sense, the importance of national agency in the acquisition of domestic technology capacity, against the backdrop of structures of technoglobalism. NIS institutionalism (Geels, 2007, Nelson & Nelson, 2002 and Nelson, 2008) study the co-evolution of 'social technologies' (i.e. regulative and normative rules) and 'physical (material) technologies' (i.e. material biomedical, telecommunication and computing ones).

The debate whether NIS is neither an academic nor policy theory (Sharif, 2006) is irrelevant – as its policy concern is with practical issues of national e-health technology

development, implementation and utilisation. Not only concerned with studying managerial or social aspects of an innovation system, but also demonstrate the developmentalist or entrepreneurial interests of nations to acquire and accumulate technologies for domestic utilisations.

The identification, description and exploration of the institutional structures are presented as Deleuzian poststructuralist narrative, as informed by (Gale, 2010; Sikes & Gale, 2006). The focus is to identify and demonstrate how such structures can condition national technology acquisition. The thesis explains *interactions* of multiple actors and organisations, for identifying and demonstrating the manifestations of structural constraints. It demonstrates domestic acquisition can be conditioned by both vertical hierarchical and horizontal diffuse complex globalised interactions embodied in the conduct of IeTTs. Thus two threads run through the narratives:

1. The process of national e-health technology acquisition is not linear but rather a complex interaction of multiple and diverse actors and organisations;
2. The constraints of the complex nature of the interactions on the exercise of National Agency by National governments in such acquisitions.

The intention is to identify how National Agency can be exercised in *a complex web of interactions among a range of different subjects and institutions* (Fritsch, 2011, p. 34) as they occur along a global-national continuum. Freeman (2002) has plotted how such interactions manifest in such transnational continuum. As a negotiation of interlinked and diverse institutional global, continental, national and subnational forms and identities and their manifested consequences in the complex conduct of IeTTs in the face of prevailing and contravening events and circumstances. A global technoeconomic event, for example can open up a 'window of opportunity' (Perez & Soete, 1988) for a recipient to accumulate and assimilate technologies and knowledges. Such as the current global credit crunch occurring in a backdrop of exponential growth in mobile technology performance, provides a recipe for fostering innovations and entrepreneurships.

The identification of such structural constraints is derived from the actions of the constitutive actors and organisations, who share common meanings (Klein 2002, pp. 37-38). That is, they act as collectives, not as an individual entity. For instance, 'national

reticence' is employed to capture how recipient African countries have not been proactive in forging domestic e-health innovation assimilation and accumulation.

2.10 Narrative study design

The chosen narrative method is inspired by Deleuzian poststructuralist method of 'rhizome' – 'becoming 'and 'fold', as informed by (Gale, 2010; Gale & Wyatt, 2007; Sikes & Gale, 2006). In addition, it also directs the researcher's attention to what solution (i.e. policy change) can be recommended for effecting change. A narrative is *grounded stories that raise the level of debate and help to resolve key social problems* (Kling, 1992, p.353).

The method is adopted for ordering, organising and presenting the messy and multiple qualitative data collected through immersion in the conduct of IeTTs in the way middle-range STS theory does (Geels, 2007 and Wyatt & Balmer, 2007). Similar in a way Currie, 2009, pp. 75-76, suggested that ethnographic, multi-level, multi-theory and longitudinal studies of national e-health implementation should be investigated. As the ontology of STS constructivism dictates, narrative sees all knowledge as socially *constructed* (Fritsch, 2011, Sismondo, 2010, Wyatt & Balmer, 2007). Meaning that both the actions of data collection (production) and interpretation (writing) of knowledge are 'creatively' and *narratively constructed*, hence poststructuralists in orientation, with no distinction made between ontology and epistemology. Both data collection and writing are rhizomatic – based on actual lived experience that enables a researcher to make sense of the world.

Rhizomatic narrative employs rhetoric, contingency and reflexivity to articulate and stress 'subjectivities and contextual circumstances and the way in which events are casually linked and given meaning by their connections', in time and space. Both the creation and interpretation of knowledge in poststructuralist narrative draw together diverse events, happenings and actions of human lives, and provide links, connections, coherence, meaning and sense amongst the diversity. Narrative is suitable for studying the consequences of the development and utilisation of e-health technologies as they are diffusing trans-nationally in Africa.

The existing use of narrative for studying e-health implementation takes a managerial and information-based approach, and is very limited and emerging. For example, in their narrative inquiries (Trisha Greenhalgh, et al., 2011; Klecun, 2011; Nicolini, 2010)

employed discourse analysis method. In the same vein, Greenhalgh, et al. (2011), ethnographic work, employed Wittgensteinian approach to narrative (Sikes & Gales, 2006), to offer a policy critique of the national e-health implementation in England.

Such discourse analysis is often an action-oriented, micro-individual narrative inquiry. Narrowly focuses on investigating institutions and often parochially foregrounds techno-pessimism and relegates innovation. Wittgenstein's is different from Deleuzian narrative.

The contrast between the two forms of narrative approaches is starkly presented in (Gale, 2010 & Sikes & Gales, 2006). Deleuzian poststructuralist narrative inquiry's orientation is towards the creation of 'concepts' that critically challenges institutional structures in complex macro-societal interactions. Wittgenstein, in contrast, privileges action-oriented micro-individual inquiry – it foregrounds in the interpretation of large-scale e-health implementation (i.e. as in Greenhalgh, et. al., 2011).

Deleuzian poststructuralist narrative subscribes to ontology that the world is labile, unpredictable and dynamic and it is constructed by a researcher becoming part of this world, and its interpretation written in the researcher's unique, reflexive and creative style. In contrast, Wittgenstein ontology subscribes to a world that is fixed, contextual, stable and predictable where interpretation is narrowly a symbolic representation of human actions and often without a critical examination. The former inquires from macro- societal perspective, while the latter is at the micro-individual.

Deleuzian rhizome as a data presentation strategy, presents a researcher with an opportunity to engage with STS tenets of complexity, multiplicity and connections. STS makes accessible to a researcher, the creative revealing and interpretation of the underlying causes of a historical or structural problem or challenge (Sismondo, 2010, pp. 190, 197-8). Deleuzian poststructuralism and middle-range STS constructivism opens up to scrutiny, the taken-for-granted or hidden nature (invincible agencies) of technologies and practices. Thus, opening up the black boxes of complex process of globalisation; rather than narrowly studying stable and routine behaviours in an organisational context (Roberts, 2102, p. 40-47).

Poststructuralist narrative shares with STS constructivism the need to unpack complexity and to interpret hidden meanings in organisational actions and behaviours, events and interactions, which take place at multiple levels of interactions during the

development and utilisation of technologies (Geels, 2007 and Wyatt & Balmer, 2007). In combination with poststructuralist narrative, inform how a researcher or an ethnographer collects data in the field and how the data are interpreted and presented to an audience, i.e. policymakers or epistemic communities. The construction of knowledge aligns with NIS institutionalism. An innovation system becomes a complex sociotechnical network, when institutional structural interaction is diffuse and horizontal. Not of a linear, vertical interaction in the conduct of ITTs – where hierarchical relationship amongst nation-states result in agential asymmetry typical of technoglobalism.

Discourse analysis method to study national e-health implementation is at the level of organisations. Ours is at a higher level of technoeconomic changes of globalisation (Robert, 2012, pp. 40-44). In the age of rapid and converging technoglobalism, where multiple interacting and contending institutions mediate the exercise of national agency, such narrative inquiry will not suffice.

2.10.1 Justification & Limitation

The justification is premised on the reflexivity of the researcher. Reflexivity is through a combinatorial use of Deleuzian poststructuralist narrative and STS constructivism. They share in common that the relations between cause and effect are not linear, but complex, political, contentious/contested and heterogeneous, and difficult to attribute to a single factor (Jasanoff, 1996). To determine the nature of causes, conditions and effects of the institutional structures by going beyond just identifying concrete sociotechnical interactions; and, also inquire about the largely hidden contingent, contradicting, multiple, and heterogeneous causes and effects, embodied in cosmopolitan socio-historical formations .

Determining causality from messy and multiple qualitative data is a difficult task, because, ‘causes are heterogeneous and are hard to pin-down’ (Jasanoff, 1996, p. 413). For example, if we argue that geopolitics constrains African countries’ e-health technology acquisition, then we also need to accept that there are other heterogeneous conditions. National reticence as well as global and continental geopolitics can shape exercise of National Agency or domestic innovation activities.

Reflexivity is based on Deleuzian rhizomatic narrative figures of ‘becoming’ and ‘fold’ – engaging in a nomadic inquiry. Moving across multiple labile, unpredictable and

dynamic spaces, both in the process of collecting data and writing through paying 'reflexive attention to diversity, contradiction, and complexity' (Gale, 2010, p. 304). Through nomadic becoming, the author became immersed in different and diverse geographies, epistemic communities and structural spaces of e-health technology policy, development and utilisation. In the process, a reflexive ethnographer assumes multiple identities, and in this regard; the author becomes a policy and technology advocate, a learner and researcher. For instance, the author's immersion in policy geographies and epistemic communities in Africa and Europe brought about, a 'narrative turn' (Sikes & Gale, 2006). The learning from these policy and intellectual spaces in turn influences the contents and context of the thesis.

Reflexivity is about immersion in a field of study. By having conversations with or interviewing different actors, and interacting with multiple documents that embody the contrasting and conflicting geographies, ideologies and cultures of the conduct of IeTTs. Reflexivity is also about challenging the status quo of established policy and epistemic orders by creating a new way of thinking of, or viewing an object or a subject (Jasanoff, 1996, Gale, 2010). For example, challenging the agential asymmetry of technology divide of globalisation and dualism of techno-globalism, between technology frontiers and laggards.

Immersion and learning from, and participations in, policy and academic spaces and debates: formulation of national and continental eHealth policies in Africa; Africa's and international development; Global Health; and Science, Technology & Innovation (Appendix A and Publications), have all contributed to the reflexivity in the thesis. For example, participation and learning from the European Union-Africa cooperation process. The process, which culminated in the formulation of a Euro-Africa ICT Manifesto and the commencement of an EU-Africa ICT Forum, was influential in opening the author's intellect to the role of technology in international development. The author's advocacy for the inclusion of eHealth in this process was highlighted by a keynote presentation titled: *Refocusing Europe-Africa Strategy: Strategic Importance of eHealth* at the first edition of this forum held at the European Union Secretariat in Brussels in 2008. A similar participation was to the United Nations-World Health Organization ministerial and high-level process in 2009. In addition since 2009, the author has through the Commonwealth Secretariat being providing technical assistance

to its developing member states in Africa and Asia on national e-health policy formulation.

The narrative from these policy and intellectual spaces is the nature of national agency in international cooperation and development and in global partnerships. In the process, our learned worldview has insightfully enlightened our knowledge of the pervasive influence of the complex interplay of institutions of politics, interests, trade, commerce, diplomacy and aid. We have come to question, how well-intentioned global partnerships or international development plans, are oftentimes counter-productive to national socioeconomic advancement aspirations of recipient developing countries. Our focus is on variation in the dynamics, depth and scale of African countries' national e-health technology acquisition trajectories in the context of complex interlinked globalised interactions.

Becoming and fold brings creativity to the writing. It is performed by 'telling' the policy and epistemic audiences in the writing – 'each telling and retelling sets up will serve to reconfigure preconceptions, established interpretations, and practices' (Gale & Wyatt, 2007, p. 794). In this thesis, *knowing* is to counter-balance and enrich a predetermined world-view (Sismondo, 2010, pp. 58, 64). The predetermined world-view is that in an increasingly globalizing world, that IeTTs are not free from contentions, politics and power and interests. They are rather driven by a complex political economy that is historically, socially and structurally *constructed* (Sismondo, 2010, pp. 195-201, Fritsch, 2011).

A technology embodies tacit or implicit knowledge that is not readily accessible or shared in a transfer process (Sismondo, 2010, p. 202). Such nature, typical of technoglobalism, conditions the consumers (recipients) to be dependent on the producers (developers or donors); for example, for newer technologies, or for technical knowledge to carry out repairs, and even for finances to implement projects.

Reflexivity informs the writing of the thesis in a creative way of connecting multiplicities in disparate and messy qualitative data. That is 'fold' – the revealing of thoughts and feelings that encourage different ones to unfold in narrative themes. Each institutional entity (i.e. involved actors and organisations) in the globalised conduct of IeTTs in Africa generate texts in their narrative accounts, which are in turn reflexively and creatively folded in the themes.

2.10.2 Data collection

The data for narrative are collected from privileged access to diverse sources, in different and various geographies and policy spaces and at various times, over a four-year period. The data employed are from multiple sources and mostly refer to telemedicine implementations at subnational, national and continental levels in Africa. There are also, to a lesser extent, data on electronic health records implementations at national level. Data sources are, for example, informants, interviews (structured and unstructured), participant observations, literature, transcribed field notes, ethnographic accounts, personal reflections and documentary evidence (reports of different forms and types). In all, 18 structured and unstructured interviews were conducted, 40 participant observations in policy meetings and technical conferences and 76 policy, programme and project documents were reviewed and analysed.

2.10.3 Data analysis and interpretation

The data analysis is through becoming and fold. It is about – reflexivity, while writing by making connections with, and working with, multiplicities of texts from different data sources. The goal is to capture the complexity, politics, history, contestations (conflicts), power and interests in the conduct of IeTTs in Africa. The intricacy and complexity of the conduct of international e-health technology transfer (IeTTs) and the messy nature of the data we have collected, means that the structure of the narrative follows Deleuzian rhizome. According to Sikes & Gales, 2006, a rhizomatic approach to narrative is a complex, non-hierarchical and non-linear, structural configuration which is defined by movement, multiplicity and states of becoming.

The Deleuzian structural form permits the organisation of messy textual data fragments through ‘folding in’ and ‘folding out’ in the narrative writing, especially when interviews and conversations took place in real-life settings. Likewise, STS constructivism *constructs* knowledge from messy data as a process of improvisation and contingency (Sismondo, 2010, p. 133). It enables the unravelling of the complexity of a subject, by exploring and exploiting the richness and the interconnectedness of multiple qualitative data. The interpretation of data is fluid and mobile, suitable for capturing the emergence of multiple and diverse material technologies, actions and events. The narrative is not in the form of a structured emplotment – ‘providing a specific sequence and structure’; but, to ‘explain the twists and turns, the layers and dimensions’ (Sikes & Gale, 2006), that messy qualitative texts present.

The interpretation goes from the way Deleuze represent the world by inventing his own words and writing style. A narrative inquiry uncovers, challenges and questions hidden and established ideologies and institutional structures of complex sociotechnical interactions. Such as we are identifying and critically analysing the nature and impacts of structural constraints on domestic e-health innovation capacity acquisition in the contexts of global development and technoglobalism.

Interpretations in the narrative chapters are presented in 'narrative themes' – to organise the sense-making of, and give meaning to, the constraints or conditions and the presentation of key points into sections and sub-sections. Themes are more general than plots, because they '....relate to concepts and theories' (Sikes & Gale, 2006). They do not present data in a specific order or structure, but equips a reflexive researcher to organise and make meanings of messy qualitative data in the narrative.

In the sections and sub-sections of the narrative chapters, the use of concepts and theories underpin a creativity that goes into the writing of the narrative themes. It is about 'logic of sense and not a logic of reason', argues Sikes & Gale, 2006. The interpretation in the narratives, following Deleuzian notion, sense-making – the process of folding and unfolding of the texts in the narrative, is a continuous process of creative evolution (Gale & Wyatt, 2007 and Gale, 2010). It is a creative process of inventing new concepts that have not been previously developed by relaying lived experience. In the process being reflexive, challenging that the structural territories of global, continental, national and subnational are not fixed, but rather are mobile and fluid, flux. By intensively connecting and multiplying rich and diverse messy texts, alternative accounts are thus, elaborated; for instance, by challenging that the cosmopolitan/consumerist conduct of IeTTs in Africa, requires a national industrial model for technology accumulation.

2.10.4 Organisation of narratives

Narrative is employed for organising data in Chapters 3-6, as set out in the research objectives in Chapter 1. Each chapter is a narrative that identifies and demonstrates how a structural mechanism manifests as structural constraints in the conduct of IeTTs. A symmetrical presentation helps in aligning heterogeneous views interests and causes of (Sismondo, 2010, pp. 132-133) technological controversies. Nevertheless, the narratives

in all the chapters are inter-linked, as each focuses on constraints to national e-health technology acquisition in Africa.

The STS concept of *symmetry* is employed so that evenness is given to each macro-structural mechanism in the conduct, in each narrative chapter. We employ symmetry in sense of concrete socio-technical interactions of actors, organisations and technologies in the conduct of IeTTs, and, also with an aim to reveal hidden influences of history, politics and power that mediate in such interactions (Robert, 2012, pp. 37-39).

The focus of the narrative in each chapter is on the transfers of material e-health technologies such as devices and equipment, but each with a focus on a different condition. Each narrative chapter is stand-alone in this regard, also in that the sources, scope and scale of data employed for the narrative are presented at the beginning of each chapter. At the end of each chapter, a summary of the themes, and the key points from the narrative, are presented in a table.

In Chapter 7, a discussion of how the constraints or conditions are inter-linked or inter-woven is presented. The discussion explores how they co-act to constrain the acquisition of national e-health technology capacities in Africa. The STS concept of *cumulative advantage* is employed to discuss how the exercise of national agency can be exercised by African governments in the conduct of IeTTs. This concept helps to explain differences in productivity among parties in situations where capacities or competences are unevenly distributed (Sismondo, 2010, pp. 38-39). The discussion forms the basis for making our main contribution to knowledge – a collaboration model for fostering the acquisition of e-health technology competence in African countries.

The concept of symmetry is employed in developing the model. Symmetry in an institutional sense is that interaction in an innovation system is ‘shared habits of patterned actions and behaviours’ (Nelson & Nelson, 2002, p. 267). We are stating that each global, continental, national and subnational structure, in a socio-technical interaction, has a role to play as a collective in supporting the exercise of national agency. By drawing inspiration from Geels, 2007, our goal is to create an alignment amongst the multiple and contending institutional interests of globalised interactions of the conduct of IeTTs in Africa, and to make instrumental policy contributions.

Collective action is needed when new or innovative combination of technologies is brought into use, and that requires the assimilation of new knowledge or the

development of new institutions of innovation (Nelson & Nelson, 2002, p. 269), by a leaning developing country. Symmetry, however, is not in the sense of actor network theory of a stable, predictable network, but of uncertain and labile interactions of technoeconomic globalisation (Robert, 2012, pp. 39-40).

As technology learning in the age of globalisation, occurs amongst cooperating an ever competing nations in vertical relationships of IeTTs, an alignment with the complex horizontal interactions of multiple and diverse interests of institutional actors and organisations, can make active learning to happen and to be transformative.

3 Technological path-dependency

3.1 Introduction

This chapter presents the first of the four narrative chapters and addresses objective 1.It demonstrates and argues that a history of technological path-dependency exists in the cosmopolitan conduct of IeTTs in Africa. The narrative foregrounds those in the succeeding three chapters. It traces a perennial recipient's (AB) national e-health technology acquisition, has been institutionally constrained by a historical combination of global and domestic technological, social, economic and political changes and conditions.

African countries are encouraged to become developmental states by acquiring domestic innovation and industrial capacities from participating in international trade and diplomacy (Forje, 2006; Juma & Bell Jr, 2006; Lall & Pietrobelli, 2005; Ymele, 2011). However, it is often taken for granted, that the reticence of a recipient National government can create a situation where the process of technology acquisition becomes static. Such stasis is noted in the historical and contemporaneous conduct of IeTTs in African countries, exemplified by AB.

AB's exercise of National Agency has been historically conditioned by global geopolitical and technoeconomic events that took place in the 1980s, 1990s and 2000s, and leading to the present time. These historical events are still having a conditioning effect on this country's current immature state of domestic e-health innovation capacity. Telling, as this country is still struggling to implement its national e-health initiative.

Given that a technological path-dependency is noted in the continuum of past-present conduct, we thus argue that the dynamism of exercising National Agency as entrepreneurial states (Mazzucato, 2011) or developmental states (Forje, 2006), is a policy choice for addressing such structural stasis.

The data employed in this chapter are qualitative in nature collected over four years of research and field work. The data sources include different structured and unstructured interviews conducted with e-health policymakers and programme managers and key stakeholders at different national meetings and workshops. The interviews with some the actors are continued for a long period through e-mails for getting updates and

clarifications on the e-health projects they were involved in. Documental analyses of policy documents, evaluation reports and meeting reports, obtained by privileged accesses granted by these actors, are carried out. Other sources of data are transcription of notes taken from policy meetings.

The references for the data sources are presented in Appendix B. In total, four interviews (two structured and two unstructured) were conducted, there were participations in two policy meetings, one meeting report was reviewed, twenty four project documents analysed, three policy documents reviewed, and the literature explored.

The structure of the narratives is divided into eight sections.

1. The first section gives an overview of national e-health implementation in AB.
2. The second presents five cases of IeTTs and highlights their globalised conception, and how their diffusions in AB are shaped by global geopolitical and technoeconomic events.
3. The third presents the institutional identities of the global actors and organisations in the conduct of the IeTTs in focus.
4. The fourth presents other institutional identities of the global actors and organisations in the conduct of the IeTTs in focus.
5. The fifth presents AB's technological contributions to the global innovation system in the process of being a recipient of IeTTs.
6. The sixth lists three structural factors at the national level implicated in AB's setbacks in its domestic e-health innovation capacity acquisitions.
7. The seventh emphasises that a strategic omission to exercise its National Agency has made AB still a dependent recipient of IeTT.

At the end of each section or sub-section, a key point is included to highlight the finding from the narrative.

3.2 National e-health implementation: AB's storyline

The choice of AB is informed by the insights we have gained into a Commonwealth Secretariat's process [CM, Appendix A] that contributed to the design of AB's current efforts to implement a national e-health initiative. These insights came during a two

weeks' research visit to AB in 2011. The visit provided an invaluable opportunity to observe at first-hand the state and progress of its national e-health implementation. During the visit, several interactions took place with senior officials from its Ministry of Health (MoH) and with national and international stakeholders in two workshops on national e-health policy formulation. It became apparent that little progress had been made in the national implementation, since the last of the transfers in this study was conducted a decade ago. For instance, two different national e-health policy documents formulated in 2004 [1] and 2006 [2], were still not yet implemented in 2011, when the process for the formulation of a new one commenced. More striking was that a reference was made in the 2006 policy document to malfunctioning telemedicine equipment that had been acquired from one of the previous IeTTs, conducted a decade earlier.

The globalised nature of these past transfers was reflected in this new process of developing AB's national e-health initiative. A striking observation made at one of the workshops [3] was how the dominant influence of international actors was apparent in the policy setting process. Review of a strategic document [4], the blueprint, defines the specifications of technologies to be acquired for the country's national implementation. The extent of financial contributions made by multiple international governmental and non-governmental development organisations to the process is shown by a review of a national e-health vision document [5]. Such altruistic and diplomatic contributions are also apparent in the formulation of the previous national e-health policy documents [1 & 2]. It is also apparent in making technology choices.

We learned during an interview with a senior MoH official [6], that the specification of technologies for AB's national e-health implementation was based on a blueprint, conceived by a consortium of European based academic and multinational telecommunication organisations. Certainly, nothing has changed since the conduct of the previous IeTTs, those, as we are going to demonstrate in this narrative in this chapter, whose technologies were tested and improved in this country.

There is inherent complexity that works to constrain or condition national technology acquisition from such transfers in the wake of technoglobalism, as we have previously identified in Chapter 2. The apparent influence of multiple international actors and organisations in AB's national e-health implementation suggests that a historical

linkage exists with previous conduct of unreliable IeTTs. As the interview with the senior official from the MoH [6] revealed, such unprofitable reliance on altruistic and diplomatic transfers for implementing AB's national e-health initiative is no longer acceptable. This apparent realisation of the unreliability of previous conduct is not surprising, as three evaluation reports [7, 8 & 9] recorded. AB's first recorded attempt at a national implementation in 2000 never materialised; because a partnership that was formed with a very reputable IGO broke down soon thereafter. In addition, these three reports catalogue how a series of acquired malfunctioning and defective telecommunication, computing and medical devices, in the absence of requisite domestic innovation capacity, had frustrated any hope of a successful national adoption.

The next section thus traces a path-dependency between the globalised nature of the previous IeTTs and the current immature state of AB's domestic e-health innovation capacity.

3.3 The previous IeTTs

These previous North-South (N-S) IeTTs were five Satcom-e-health initiatives presented in Table 5.1. The first project is PS, a Satcom-telemedicine initiative in two African countries in the 1980s. The second is HEN, implemented for health data collection and management (health informatics) in several African countries, including AB in the 1990s. The third is WOD also implemented in several African countries and in AB in the 2000s, also for health informatics purposes. The fourth and fifth are EAS and TEL were both implemented in the 2000s. .The era when these IeTTs were conducted was before the current remarkable explosive diffusion of mobile phones in Africa. It was when e-health initiatives in Africa employed Satcom for communication and connectivity (Crump, 2006; Geissbuhler, et al., 2003; House, et al., 1987; Pelton, 1987). The era when the three initiatives were conceived, was also the time when state and non-state actors from the global West started implementing Satcom-e-health initiatives, for example, expressed intentions of global development in (Dario et al., 2005; Zuzek & Bhasin, 1996). Project GATES conceived by the International Space University is a notable example of such (International Space University, 1994).

Table 3.1 presents the International e-health technology transfers

Initiatives	Descriptions	Implementations in Africa

PS	PS was conceived, financed and implemented by INTELSAT for internationalising telemedicine services from global West to Africa in 1984.	The transfer and testing of teleconferencing and the transmission of physiological and imaging technologies.
HEN	HEN was conceived, financed and implemented by a consortium of global West not- for -profit organizations in 1989.	The development and launching of two micro-satellites and the massive transfers of end-user devices for health data collection.
WOD	WOD was conceived, financed and implemented by a global West Foundation owned by a private Satellite company in 1990.	The development and launching of a big satellite and the massive transfers of end-user devices for health information dissemination.
TEL	TEL was conceived, financed and implemented by a consortium of a global West public, private and academic, and international governmental organisations in 2000.	The development and testing of a new telemedicine device for remote teleconsultation.
EAS	EAS was conceived, financed and implemented by a consortium of global West public and private organisations in 2003.	The transfer and testing of a new telemedicine device for aiding remote clinical diagnosis.

The diverse international origins of these IeTTs over the last four decades are presented in Table 3.2. The table captures the representations of political, healthcare, telecommunication, financial, industrial and global development interests represented in the conduct of these transfers. The diversity reflects the multiplicity of international organisations such as IGOs, international NGOs, multinationals, academia and individuals involved in the transfers. Take for instance, the case of TEL. There were three academic institutions and one renowned research institute from three different European countries that worked together to invent and improve the technologies. There was also a device manufacturer from a different European country. Lastly, there were three IGOs that worked together to finance and design the transfer process. The inherent complexity, in the process of fostering national e-health technology acquisition, is a reflection of such multiple inputs and interests of different international actors, as it was with TEL in AB. Such multiple global/organisational interests, if uncoordinated by a recipient's national government, can act to constrain such acquisition.

Table 3.2 presents the diverse actors involved in the transfer of TEL

Organizations	**Roles**
An internationally renowned research institute from an European country	Device & Software Techno-Invention
An international governmental organisation	International Development
An international governmental organisation	Telecommunication
An European international governmental organisation	Financial Contribution and International Development
A telemedicine device manufacturing company from an European country	Industrial Manufacturing
A university from an European country	Software Techno-Science
A university from an European country	Radiology Technical Expertise
A university from an European country	Healthcare Expertise

The narratives identify and examine how global technoeconomic and geopolitical events of the previous era on AB's exercise of National Agency. The narratives go further to identify and examine how these global events that acted as institutional mechanisms constrained AB's agency to foster technology acquisition.

3.3.1 Global geopolitical events

According to (Christol, 1974; Colino, 1968), the decades just before the first conduct of these IeTTs (i.e. the conception of Project Share (PS) in the 1980s) were when information and communication technologies became an altruistic instrumental tool for international development. The employment of Satcom as an instrument of diplomacy coincided with Cold War inspired ideological and technological rivalries between the West and the old East (Soviet Union). That period was marked by intense global technoeconomic and geopolitical competition, driven by capitalism in the West and communism in the East (Colino, 1968; Lambright, 1994; Levy, 1975; Peter, 2006).

Altruistic and diplomatic international technology transfers in the shape of institutional arrangements of bilateralism and multilateralism along N-S and South-South (S-S) were also emerging in these periods (Colino, 1968; Cowhey, 1990; Levy, 1975). Several African countries were recipients of such diplomatic and altruistic technology transfers during these decades, for example from AIDSAT and INTELSAT (Christol, 1974; Colino, 1968; Holmes, 1995; Howell, 1988). At this time, but to no avail, African

governments formulated different policy instruments and conceived several initiatives to acquire Satcom infrastructures for their countries (Aloo, 1988; Demerliac & Metzger, 1984; Habib-Sy, 1992; Häusler & Simonis, 1985; Holmes, 1995; Howell, 1988; Pfister, 1999).

A key point is that geopolitical crises at the global level can act to constrain or condition African countries' national e-health technology acquisitions.

3.3.2 Global technoeconomic events

The global 'techno-economic' (Perez, 2010) events that defined the era when the IeTTs were conducted in Africa shaped the process of their national acquisition quests. The era was also a period of global rapid technological changes. The era was defined by the miniaturization of satellites and their receiving devices (Goldsby & Boyd, 2001; Nogueira, 1998). According to (Pelton, 1987), satellite technologies started evolving from fixed and big enterprise-centric receiving devices to portable and small consumer-centric ones. For example, very small aperture terminal (VSAT) emerged during this time, and reportedly, was invented with the African markets in mind (Yesufu, 1990). Behind this lay the emergence of mobile telephony (Holmes, 1995; Nogueira, 1998). The rapid technological changes were typified by INMARSAT, whose pioneering invention of portable devices for remote and mobile communication (Howell, 1988), led to their experimental utilisation for an international telemedicine service[12] between Swaziland in Africa and the UK.

Concomitant with these rapid changes were global economic events which constrained the diffusion of the IeTTs in Africa. For instance, in the case of WOD, a global economic crisis – the dotcom bubble burst of the 1990s, which resulted in a global 'credit crunch' as documented by (Goldsby & Boyd, 2001) - was a constraint to the successful acquisition of the technologies in those countries. Similarly, the oil price crisis of the 1980s was also implicated in African countries setback to acquire a pan-Africa Satcom infrastructure during this era, as documented in a report (Habib-Sy, 1992). The impact of these global technoeconomic events was truly disruptive to

[12] Roy Howell (2008) cited a pilot carried out by INMARSAT in Swaziland, a southern African country, to demonstrate its technological prowess. The highlight of this was an instance where the UK based doctors were able to remotely diagnose and prescribe treatment for a child suffering from a rare, life-threatening ailment in the absence of a local and resident specialist.

Satcom technology acquisition in Africa, laments Habib-Sy. International investors were reluctant to commit their finances to African countries that had become indebted after being unfairly exposed to the global economic crises (Christol, 1974; Howell, 1988). In the case of a certain mineral resource-rich African country, her quest to acquire a national Satcom infrastructure suffered a fatal blow, as her hitherto secured access to foreign capital suddenly vaporised.

Key point: global economic crashes and crises can act to constrain or condition African countries' national e-health technology acquisition.

3.4 Global corporatism

The employment of altruism and diplomacy in the previous IeTTs, as vehicles for facilitating the provision of financial and technical assistance by well meaning IGOs or international NGOs, did not enable AB to acquire domestic e-health innovation capacity. Analysis of the evaluation reports on the implementation of TEL in AB has revealed the reasons why these well intentioned acts were not successful, - specifically, politics and weak leadership.

Political contestations that arose between one IGO that financed the IeTT, and another that facilitated the transfer process to AB were evident. It is documented in [10 &11] that power struggles between these two resulted because there was no agreement reached on a protocol to coordinate their partnership. This weak coordination led to a reported difficulty to secure long-term finances for the e-health technology transfers, as one of the IGOs that had previously committed, defaulted. A different IGO that had also previously committed to install a telecommunication infrastructure also defaulted.

Weak leadership on the part of the IGOs was also evident. The lack of clear leadership led to poor accountability and coordination of activities during implementation. As can be deduced from this report [11], it was evident that the IGOs could not effectively govern and align the divergent interests of the multiple partners involved in the IeTT. The lack of a clear line of authority in the allocation and execution of tasks was also evident.

The impacts of political contestations and weak leadership on national acquisition were negative. As documented in [10, 11, 12 & 13], it can be deduced that the IGOs omitted to enlist the cooperation of relevant national governmental agencies in the design and implementation of the IeTT. Even when the MoH was involved, it seemed a symbolic

involvement only, as it was bypassed during the transfer of the technologies to the hospitals where they were implemented. The import of this institutional neglect was apparent in the exasperated reaction of an AB government official, as documented in [11]. The official, from one of the agencies that were bypassed, expressed concern that the process was not aligned with the extant national plans for e-health implementation.

Key point: corporate actions by global actors that manifest as political contestations amongst them, and weak leadership in the coordination of their actions, can either constrain or enable African countries' national e-health technology acquisitions.

3.5 Global industrialism

The global industrial partnerships that were forged by WOD and HEN to foster a development of low-capital devices for the African markets, (including in AB) never materialise. This was as a consequence of the high cost of the devices which was prohibitive for African consumers. Well-intentioned global industrialism in the case of WOD did not have impact in Africa at the time when its economy was grossly underperforming in 1990s. The industrial partnership was forged with a consortium of four major Japanese consumer electronic giants for the production of such devices, which were not affordable for potential consumers in Africa[13], because of the set high market price, according to (Goldsby & Boyd, 2001).

A partnership forged with a group of manufacturers from Asia[14] also struggled to deliver the $US10 device they had hoped for. The market prices which the devices were sold for were prohibitive for most African users, as documented in these reports [14 & 15]. A parallel can be drawn with a similar more recent event, the 'One Laptop per Child' device's story. In this case, ideological differences between the altruism of a philanthropic organization (the device inventor) and the mercantilism and industrialism of its global corporate partner, frustrated this frugal innovation. As a consequence, the former couldn't deliver on the widely publicised affordable market entry price of

[13] These Japanese consumer electronic giants Sanyo, Panasonic, Hitachi and JVC produced four different versions of the WOD devices each costing an average of $ US$300 in 1999. This amount was slightly more than the average annual individual income in AB in the same year.

[14] As deduced from [15], the minimum market entry price of $US300 for the devices produced by the Japanese was later reduced to $US150 when they were produced by an India, Indonesia and South Korea industrial complex. Nevertheless, this was not enough to reverse the uncertainty that trailed its evolution.

$US100 (Kraemer, Dedrick, & Sharma, 2009). Therefore, the promise of a laptop for each school child in developing countries never materialise.

This clash of economic ideologies also affected the transfer of WOD to Africa. According to (Goldsby & Boyd, 2001), in the search for finances from the global capital market for inventing and producing of a satellite technology solely dedicated for Africa's market, a similar ideological clash between two dissimilar potential investors arose. This ideological clash pitted the neoliberalism of the global West's companies against the state capitalism of a competing Middle-Eastern National government. As a consequence, there was a reported delay in the transfer of WOD to Africa.

The lack of a common standard between technologies produced by international companies was recorded as a constraint to a planned pan-African expansion of EAS. As documented in [7], a plan to link the telemedicine infrastructure in AB with that in another African country was scuttled, because the devices and software procured from two different international vendors were found to be incompatible. The challenge of incompatibility, as also documented in [8], was recorded as a frequent constraint encountered in implementing a national e-health initiative in AB.

The superficial integration of Africa into the global industrial network was also a constraint. For instance, it is documented in these evaluative reports [10, 12, 13, 16, 17 & 18] that there were delays to the repairs and maintenance of telemedicine devices that were being utilised in AB because the manufacturers were located in a European country. Even the simple fabrication of a spare part for a faulty device required the unreliable dependence on a complex global industrial network of manufacturers that were based in global West countries, as documented in these reports.

Well-intentioned global mercantilism in the case of HEN also struggled to gain traction in Africa at the time when its economy was grossly underperforming in the 1980s. Hence, the promise of producing low-capital devices for the African markets was broken, as we learned in an interview with the project manager [19]. This was despite a commercial partnership that was forged with a consortium made up of a global West start-up company, national space agency and a large Satcom manufacturing company, as documented in [20]. It is important to point out that the start-up company is now a commercial manufacturer of devices for oceanography (Irish, et al., 1999), which can trace their invention to domestic technosciences carried out in Africa.

In spite of the report [21 & 22] that a technology remittance agreement was signed with the start-up company, no low-capital devices were ever transferred back to the African countries that contributed to this global innovation, as we learned from the project manager [19].

A claim can be made to suggest that these domestic techno-sciences have contributed to global innovations and enterprises. As an example, the utilisation of microsatellites that HEN pioneered is now widely employed for earth monitoring and observations (Nogueira, 1998). This move from altruism to mercantilism is directly observable in the case of TEL. An improved portable telemedicine device, which came out as a product of domestic technosciences in AB, is now being offered as a commercial product by a European start-up company for military and civilian purposes in the Americas. This is as we learned from an interview with a key informant that is closely involved in the process [23].

Key point: well meaning global industrial partnerships can constrain or enable African countries' of national e-health technology acquisitions capacity in, because of expensive transferred technologies.

3.6 Globalised technosciences

It is observed that AB struggled to acquire domestic innovation capacity, despite reports to substantiate that it contributed to the improvements made to the transferred hardware and software in the process of addressing technology inappropriateness in these project documents [21, 22 & 24] and [14 & 15]. A review of the aforementioned documents on the local technosciences that took place with HEN and WOD, suggests that user-generated and technical data considerably contributed to the development of a more appropriate and miniaturised Satcom devices, later made commercially available in global markets. It was apparent that AB did not acquire any capacity or accumulate technologies from the previous IeTTs, as we observed during a research visit in 2011 [2].

For instance, a series of technosciences jointly carried out with WOD in various experiments in African countries are documented in two reports [14 & 15] produced by the Department for International Development (DFID). These domestic technosciences had in no small way contributed to the pioneering role WOD played in the miniaturisation of receiving devices. Similar joint experiments with HEN are

documented in [21, 22 & 24]. The documents detail a decade-long series of technosciences conducted in several African countries that contributed to the design, manufacturing of, and subsequent improvements made to, portable and mobile Satcom devices. For example, a newer generation of efficient antennas was developed after repeated prototyping, notably in AB (documented in [24]).

These technological improvements were not limited to receiving devices only but also the satellites themselves. The invention and improvement of the HEN technology made possible the global transition from geosynchronous earth orbit (GEO) to low earth orbit (LEO) satellites. To substantiate, as documented in [22], at the World Administrative Radio Conference in 1992, organized by the International Telecommunication Union, fervent advocacy by HEN's inventors reportedly contributed immensely to a decision to appreciate LEO's technology validity and appropriateness as a low-capital alternative for telecommunication in developing countries. This turned out to be an immense contribution to the global innovation system, according to Prof. Sir Martin Sweeting of the renowned, UK-based, Surrey Satellite Technology Limited (SSTL) (Sweeting, 2000), who linked the HEN's invention with the emergence of LEO satellites.

The contributions to global innovations were not limited to satellite technologies. It can be argued that contributions were also made to telemedicine devices. The review of TEL technical project reports [12, 13, 16, 17, 18, 23, 25, 26, 27, 28, 29, 30 & 31], reveals that a series of incremental domestic techno-sciences conducted over 2 years in AB immensely contributed to a markedly improved, usable and efficient device. The reports chronicle how a process of software and hardware prototyping resulted in the miniaturisation, improved mobility, ruggedization and greenness of the improved device that was finally produced after this period, as a contribution to global innovation.

Key point: co- developments with global actors cannot necessarily make national e-health technology acquisition happen.

3.7 National capacities

A strategic omission to accumulate technologies and assimilate technical knowledge from past conduct of IeTTs can partly be attributed to AB's reticence in exercising its National Agency. For example, its National government could have prior instituted certain national innovation capacities. There are two conditions behind this omission we have identified. The first is that certain counter-productive actions of global actors and

organisations identified in the preceding sections can be held liable. The second is limited benefit for example, from HEN and WOD had much to do with the contravening global technoeconomic and geopolitical events of the time of their conduct. In spite of the influences of these two conditions on national acquisition, we however, argue that the poor states of AB's national financial, economic and innovation capacities were more telling.

3.7.1 National financial constraint

Financial constraints impeded any wide-scale national diffusion of the transferred technologies in AB, in spite of all the domestic techno-scientific contributions to the global innovation system, as documented in the evaluation report [9]. For instance, the evaluation reports of the decade-long transfers of HEN [20 & 21] in AB and elsewhere in Africa, document national financial constraint as a major challenge to successful acquisition. This finding is also substantiated from these interviews [19] and [32] with the programme managers that were implementing the IeTTs in Africa at that time in the 1990s. In the case of HEN in AB, it is documented in this report [20, pp. 9-10] that financial constraints limited the procurement of more and newer devices required for successful national expansion. As documented in these reports [20 & 22], the prohibitive costs of procuring an end-user device rose by a multiple of four from an initial cost of $7,500 in 1993 to $30, 000 in 2000.

The same challenge was also encountered with the transfer of EAS in AB later in the 2000s. As reported in the evaluation report [7], lack of domestic financial resources made impossible the regular maintenance of telemedicine equipments and also prevented the procurement of new devices from the global market after obsolescence set-in. The report stated how an incapability to mobilise $US 9 million, the amount needed to procure a set of new equipment for its only tertiary specialist hospital, proved to be deleterious. A resort to a purchase of unreliable and malfunctioning second-hand equipments as an alternative was documented in this report [8], did not help.

Financial constraints also prevented the maintenance and repair of the existing equipment and the hiring of technical human resources. As documented in these reports [20 & 22], high financial costs constrained any attempts at domestic technological customization.

Ultimately, there was a shortage of technical expertise to carry out repairs and to adapt the technology for local utilisations. Similar circumstances also befell WOD. An evaluation sponsored by the Department for International Development (DFID) by the UK in AB in 2003, documented in [14 &15], identified the prohibitive and high unit cost of devices[15] as a major constraint to any hope of a national adoption. Nevertheless, the fact that this country struggled to acquire national technology capacities from these IeTTs had less to do with national financial constraint, and more with the small size of its economy and its immature domestic innovation capacity.

Key point: lack of national financial capability can limit domestic adaptations of transferred technologies and can cause technology obsolescence, which in turn can constrain recipients national e-health technology acquisition.

3.7.2 Small National economy

The small size of AB's economy is identified as a constraint to the successful national acquisition of technologies from the IeTTs. Having a small national economic size meant that the markets were also small in size and were less integrated into the global economic system, as was observed with the transfers of WOD and HEN.

The small market size of AB's national economy meant that an economy of scale was not possible. In the case of WOD, the price of the devices remained prohibitively high because the volume of the devices that were sold in Africa was too low to create any economies of scale, as documented in these reports [14 & 15]. Poor integration into the global economy meant, for example, dissociation from the centres of production in Asia, leading to scarcity of the devices in the domestic market. A factor that created an artificial inflation was also implicated in making the devices unaffordable. The situation was so dire that in the whole of Africa, the total number of sales veered widely from the initial market projection, according to these reports [14 &15]. Instead of a projected market of 250 million African potential buyers (a figure that represented 45% of African population in the 90s), the econometric analysis carried out by (Goldsby & Boyd, 2001) found out that only 6.4% of this projection was feasible.

[15] The report concluded that as if the minimum unit cost of $US150 price for a device was not prohibitive enough, the additional burden of an estimated $US1, 250 for computer accessories needed for Internet access and constant battery replacements, together made it unaffordable.

The superficial integration of AB into the global industrial and economic system was also a documented constraint in the case of EAS and TEL. These reports [7, 8, 13] document how the procurements of telemedicine equipment and their spare parts was hindered due to the loose connection of AB with complex, distant and overstretched global supply and value chains. The distance between AB and the global value chain also caused delay in the import of spare parts needed for the repair of telemedicine devices. For instance, in the case of EAS, it is documented in [7], that it took a whole two years to be able to procure a telemedicine device from the global market, because of AB's superficial integration into global economy.

Key point: small National economic size and superficial integration into global economy can constrain national e-health technology acquisition.

3.7.3 Immature National innovation capacity

The immaturity African countries' domestic innovation capacities also contributed to the uncertainty of acquiring technologies from the IeTTs. A lack of capability to carry out routine repairs when there were breakdowns and the failure to adapt the technologies to local conditions, for example, was shown in the case of HEN. As documented in [21, 22 & 24], there were occasions of frequent breakdown of equipment, in the absence of domestic technical capabilities to repair or fabricate spare parts. For these reasons, the continuous utilisation of the technologies was constrained, as obsolescence set in, in the absence of domestic innovation capacity to engineer any improvements that were required. Similarly, the inability to locally manufacture WOD devices in African countries including AB was identified as a constraint to making them affordable for the African markets (Goldsby & Boyd, 2001).

Similar problems with obsolescence and technology-environment misfit were prominent constraints in the cases of TEL and EAS, and resort to international manufacturing and expertise for repairs and procurements was reported. The deficient state of domestic innovation capacity in AB was identified, in the case of EAS, as a hindrance to the incremental adaptation of the transferred telemedicine devices to local needs and contingencies, as documented in these reports [7]. The same was also recorded for TEL, as documented in [18]. Some of the transferred telemedicine devices were never utilised, because the expertise to adapt the devices to local user-demands was lacking. This problem of deficient domestic innovation capacity was extremely constraining for

any e-health technology the acquisition in AB. For instance, it was documented in the evaluation report [9] that in a rare instance when a spare part was locally procured for a telemedicine device, the absence of the required domestic engineering expertise resulted in the device having to be eventually sent back to the manufacturer in a global West for the required repairs.

It can be claimed that the immature state of domestic innovation capacity accounted for the lack of assimilation of the intellectual property rights (IPRs) co-generated with international partners in AB. In the specific case of TEL, the series of domestic technosciences that took place in AB, as documented in [10, 11, 12, 13, 16 & 17], was acknowledged by the inventors as immensely useful for the re-development of a more efficient and improved device, as documented in [31]. Nevertheless, it is apparent that these IPRs were not assimilated, as the capacity to adapt the technologies to local contingencies and needs was not evident years afterward, as documented in the report [9] produced in 2010.

Key point: lack of domestic innovation capacity linked a failure to assimilate technical competence, can make local technology adaptations difficult to achieve, which in turn can constrain national e-health technology acquisition .

3.8 Uncertain National agency

The narratives in the preceding sections have demonstrated that an African country, AB as a passive recipient of IeTTs in the last three decades, hasn't acquired domestic innovation capacity. The country is still without the requisite domestic e-health innovation capacities to *engineer* its own national e-health systems. If it were possible to assign whose role it is between the national and the global in addressing these constraints, the bulk of the responsibility lies with the former. The lack of the exercise of national agency had been the norm in the past, as is documented in the meeting report [33], produced following a national stakeholder meeting in 2011 and endorsed by the country's Minister of Health. For instance, in the national e-health vision document [5] and this meeting report [33], it is documented that national leadership had been unwisely absent in the conduct of strategic relationships with global partners in previous and ongoing IeTTs.

AB's ill-fated national e-health technology acquisition can be attributed to a historical linkage between those previous IeTTs and how they have come to constrain the present

state of its e-health implementation. Despite their history of unreliability, it was observed during two field trips undertaken in 2009 [34] and 2011[2], that AB was still as heavily dependent now on transferred e-health technologies as it was in the past. During these field trips, it became apparent that the country had not acquired the domestic innovation capacity that it needs to translate its policy of building a national e-health infrastructure into concrete actions.

On a field trip in 2009 to the main national hospital, where most of the transferred e-health technologies were implemented and utilised, none of the transferred technologies from the previous IeTTs were still functioning, as was learnt in an interview with a hospital official. Moreover, the unpleasant sight of a mountain of obsolete equipment and devices dumped at the hospitals' biomedical unit demonstrates both the uncertainty of those previous technology transfers and is a testament to their unreliability.

At the stakeholder meetings [1 & 2] that we participated in, a recurrent issue that dominated the policy debates was the difficulty AB is facing to coordinate and align the various IeTTs in the country with its national e-health strategy. The current deficient state of AB's domestic innovation capacity is in sharp contrast to the aspiration expressed to implement a national e-health initiative in the immediate future [5]. There is a list of constraints identified in the strategy paper as hindrances to turn this aspiration to a reality. Most of these are sociotechnical in nature. That is a technology acquisition imperative is to be incorporated in the currently being formulated national e-health policy, as informed by key stakeholders at the meeting in 2011 [2].

The incapability of AB to assimilate technologies and competences, and its historical uncertainty to adapt transferred technologies to local needs and contingencies, can be taken as the main cause of the current state of deficient domestic e-health technology capacity. The import of this deficiency is now recognised at policy-level in AB. To sum up, it is important to emphasise that the importance of national technology acquisition for an African country such as AB, for example in the telecommunication industry, was long recognised policy at the continental and global levels. See, for instance, a Memorandum of Understanding (MoU) signed by the African Union with the United

Nations Industrial Development Organization (UNIDO) in 1981[16]. However, this policy was never translated into anything that resembled industrialisation in Africa (Aloo, 1988; Habib-Sy, 1992; Holmes, 1995; Pfister, 1999).

Key point: limited exercise of National Agency in the conduct of IeTTs is the main factor that constrains national e-health technology the acquisition.

3.9 Conclusion

This chapter has demonstrated with the case of AB that a historical linkage exists between previous IeTTs and the current absence of a mature national e-health technology capacity in recipient African countries. This is a reflection of our articulation that there is an inherent complexity in the conduct of IeTTs in Africa. This complexity reflects the diversity of the international and national actors and organisations that are involved in the process. The narrative has traced and examined how global geopolitical and technoeconomic events can constrain or condition domestic technology acquisitions capacities from previous conducts. We have also identified that the high cost of transferred technologies and political contestations among global actors can also be conditional. In addition, how national financial constraint, absent national innovation capacity and small national economic size can constrain a successful acquisition, were identified.

Table 3.3 summarises factors which are identified to account for uncertainty acquisition of national e-health technology capacity acquisitions in African countries.

Table 3.3 summarises the institutional constraints

Narrative themes	Institutional constraints
Global geopolitical events	Geopolitical crises at the global level can constrain or condition a recipient's national e-health technology acquisition.
Global technoeconomic events	Global economic crashes and crises can constrain or condition a recipient's national e-health technology acquisition.

[16] Article Volume 1590, II-1047 between the UNIDO and the Pan-African Telecommunication Union (currently know as African Telecommunication Union) expresses the wish of the latter to foster domestic Satcom industry in Africa with the support of the former.

Global corporatism	Corporate actions by global actors that manifest as political contestations amongst them, and weak leadership in the coordination of their actions, can either constrain or enable a recipient's national e-health technology acquisition.
Global industrialism	Well meaning global industrial partnerships can either constrain or enable a recipient's national e-health technology acquisition in, because of expensive transferred technologies.
Domestic technosciences	Co- developments with global actors cannot necessarily make a recipient's national e-health technology acquisition happen.
National financial constraint	Lack of national financial capacity can limit domestic technology adaptations and can cause technology obsolescence, which in turn can constrain national e-health technology acquisition.
Small National economy	Small National economic size and superficial integration into the global economy can constrain national e-health technology acquisition.
Immature national innovation capacity	Lack of domestic innovation capacity linked to an uncertain assimilation of technical competence can make difficult local technology adaptations, which in turn can constrain e-health technology acquisition.
Uncertain exercise of National Agency	Uncertain exercise of National agency in the conduct of IeTTs as a main factor that constrains national e-health technology acquisition.

We have identified and demonstrated a complex history of institutional constraints on national e-health technology acquisition. The main finding of this chapter is that the exercise of National Agency can ensure a recipient's acquisition of domestic e-health innovation capacity from IeTTs.

Further exploration of the nature of such complexity and its influence on domestic accumulation and assimilation, is presented in the succeeding three narrative chapters.

At this junction, we provide a brief account of how the narrative in this chapter link to and complement the ones in the subsequent three chapters. These subsequent narratives further build on this chapter, and identify and examine the institutional nature of the structural constraints to the exercise of National Agency in the complex interactions that characterise the process of IeTTs in African countries. Subsequent narratives identify how national, continental and global institutional actions contribute to a recipient's immature state of domestic e-health innovation capacities.

4 Global geopolitics

4.1 Introduction

The second of the four narrative chapters that addresses Objective 2. This identifies and demonstrates how institutional actions and identities, manifest as global geopolitics, in the cosmopolitan conduct of both North-South (N-S) and South-South (S-S) IeTTs. Furthermore, how national e-health technology acquisition is constrained and the inappropriateness and affordability of transferred e-health technologies are demonstrated.

Global geopolitics manifests as international commercial and ideological differences amongst involved diverse and competing actors and organisations. The contentions are underpinned by the emerging global technoeconomic events and changes, as those identified in the case of AB in Chapter 3. As rising global economic giants emerge from the East they are competing with the established global West countries for supremacy and influence in international markets and trade (Cheru & Obi, 2010). The position of many African countries as technology laggards (Forje, 2006; Lall & Pietrobelli, 2005; Ymele, 2011), despite being recipients of numerous N-S transfers from the global West, has caused some academics to see the transfers as promoting technology dependency (James, 2002; Ya'u, 2005) (See chapter 3 for detailed examples). The same judgement cannot yet be made of the emerging S-S transfers from the global East. However, (Cheru & Obi, 2010, pp. 22-23) contends that the consequence of technology dependency cannot be overlooked. Interdependency among nations is, however, essential for co-development of technologies in international cooperation (Freeman, 2002; Lall & Pietrobelli, 2005). Notwithstanding, the utility of ITTs that such cooperation brings, has limited impact on recipient developing countries' technology accumulation and assimilation.

In the context of global development there is a notable technological path-dependency between the past and the present. Despite best intentions, since the first cosmopolitan conduct of Satcom ITTs on the back of the launch of the 1st *United Nations Decade of Development* in the 1960s (Colino, 1968), and to the present conduct of IeTTs in the current MDGs practise, most recipient African countries several decades later on, are

still global Satcom technology laggards. A substantiation is that African countries are still recipients of Satcom-based IeTTs, for example the pan-African e-health initiatives.

The first global development plan did not translate into a successful transfer of Satcom technologies to recipient African countries (Aloo, 1988; Habib-Sy, 1992; Pfister, 1999). Just as it is emerging that cosmopolitan m-health transfers that predominates in the MDG practise, are struggling to scale-up in recipient countries (Tomlinson, et al., 2013). Un-developmentally, a historical linkage of uncertainty set in motion by the earlier ill-fated Satcom ITTs, are observed in contemporaneous ones directed at achieving the MDGs such as pan-African e-health initiatives (Asamoah-Odei, et al., 2007; Geissbuhler, et al., 2007; Telecommunications Consultants India Limited, 2007).

Like Domino cards, such technological path-dependency in the way we demonstrated with AB (Chapter 3), has been replicated in successive and contemporaneous conduct of IeTTs and ICT4D initiatives in Africa. This is an observation that is not lost to (Ya'u, 2005). Would for instance, these initiatives often presented in the mode of international cooperation, survive the stasis of historical linkage?

In their book, (Cheru & Obi, 2010, pp. 14-39) further identifies an emerging trend of technology transfers through various bilateral and multilateral international cooperation arrangements, as diplomatic instruments to strategically gain future commercial footholds in African markets. The tussle between two global East economic giants, as documented by (Cheru & Obi, 2010, p. 47) in acquiring Africa's biggest mobile operator in 2009, is an example of the perceived intentions of strategic mercantilism and industrialism.

The implication of these observations will be demonstrated in the ensuing narrative. It can be seen that little difference exists between N-S and S-S IeTTs, in term of their consequences for of national e-health technology acquisition in Africa. As Cheru & Obi go on to highlight, the rise of the global East state operated enterprises (SEOs) brings them into direct competition with each other and with the global West multinationals in Africa (Cheru & Obi, 2010, pp. 31, 47 & 73-75).A similar observation can be made about the recently conducted IeTTs (Satcom telemedicine initiatives) in several African countries.

The data employed in this chapter are qualitative in nature collected over four years of research and field work. The data sources include different structured and unstructured

interviews conducted with African and international policymakers and key informants at different meetings, workshops and conferences. The interviews with these actors continue for a long period through e-mails and from discussions at different fora, for getting updates and clarifications on e-health projects they were involved in. Documental analyses of policy documents, evaluation reports and meeting reports, obtained by privileged accesses granted by these actors, are carried out.

Other sources of data are from transcription of notes taken in policy meetings. In total, nine interviews (nine structured and one unstructured) were conducted, there were participations in six policy meetings, four meeting reports were reviewed, twenty project documents analysed, one national e-health policy document reviewed, and the literature surveyed. The references for the data sources are presented in Appendix B. The main source of data is from participations in the policy debates that contributed to the shaping and implementation of three pan-African e-health initiatives (Appendix C) and from data from national e-health initiatives in Africa.

The chapter is divided into four main sections.

1. The first section demonstrates, from the conduct of IeTTs, geopolitical competitions manifested in the forms of mercantilism, industrialism and diplomacy.
2. The second section presents how geopolitical contentions can result in a clash of commercial ideology between the global East and West.
3. The third section demonstrates that geopolitical contentions can result in African countries acquiring expensive and inappropriate transferred technologies from global markets.
4. The fourth examines the conduct of neoliberalism that is common to both global West and East in the conduct of IeTTs.

At the end of each section or sub-section, a key point is included to highlight the finding of the narratives.

4.2 Geopolitical competition

In the recent conduct of large-scale pan-African e-health transfers (Appendix C) in Africa, similar geopolitical competitions are observed; as we have observed in the various negotiations that took place at these meetings, amongst the multiple global, continental and national actors and organisations involved in the conduct of IeTTs in

Africa. We observed this while participating in a multi-stakeholder policy meeting on these e-health technology transfers held at an office of a pan-African organisation in 2009 [35]. The dominant presence of the global identities in the conduct is underpinned by a perception of their self-interests.

The geopolitical interests of the global actors were observed in the conducts. Geopolitical contentions between an S-S IeTT from the global East and an N-S one from a consortium of the global West were observed at a multi-stakeholder meeting [35]. Although both were presented to Africa's continental and National governments with an altruistic face, we had the opportunity to observe at firsthand how the institutional interests of international actors can constrain national e-health technology acquisition was presented at the meeting. The meeting was convened to incorporate Africa's inputs into the transfers' co-implementation plan. It included representatives from Africa's continental and regional bodies and from the partnering international organisations. At the meeting, the strategic importance of the integration of the two contending globalised transfers for the benefits of effective national acquisition was demanded by the African representatives.

"[.....], I am not against the [donor sponsored] Telemedicine project but it is the [the pan-African organisation] which has to see how best it can coordinate the two different initiatives which in some cases they have the same objectives....."

This expression from a high ranking official from a pan-African telecommunication organisation at the stakeholder meeting organised by a key pan-African governmental organisation [35], sums up the recipients' desire to integrate the competing and contending IeTTs.

However, the expressed strategic interest of the African governments to integrate the three different e-health technology transfers was met by strong opposition from those competing global actors. At this immediate aforementioned meeting, it was openly expressed by the proponents of the N-S IeTT that such integration wouldn't be in their own strategic interest. The same position was also taken by the proponents of the S-S transfer, according to an official of the key pan-African governmental organisation at the same meeting. The expression of strong opposition to integrate plausibly had something to do with their real intents for conducting the transfers in the first place. The conduct of the transfer was supposed to reside within an altruistic multilateral

international cooperation arrangement. However, from what we deduced from these concept reports [36 & 37], there is reason to suspect that their real intent was for conducting mercantilist bilateral relationships with African countries.

Nevertheless, the employment of the craft of diplomacy by the proponents for legitimising the conduct of the transfers was not appreciated by Africa's policy makers. They also feared the potential of geopolitical contentions arising as a consequence of multiple uncoordinated e-health technology transfers. Take for instance, this expression from the same high-ranking official who was present at the multi-stakeholder meeting [35].

"[Africa] will even in future be offered several other initiatives but the most important thing will be to synchronize. Now we have from [the East and West donors] next it could be the US and China"

Such occurrence of geopolitical contentions constrained the integration of the two N-S and S-S IeTTs. The intensity of the expressed reluctance to integrate the two contending globalised transfers was also documented in these meeting reports [38, 39 & 40]. Despite the diplomatic pressure applied by Africa's main continental governmental body to foster the integration of the contending transfers, organisational rivalry persisted, as the proponents of the two competing and contending transfers were ultimately reluctant to integrate, as we learned in the post-meeting report [40]. According to an official of Africa's main governmental body interviewed during a research trip a year after the meeting [41], no hope of integration ever materialised.

The interests of mercantilism and industrialism were observed as the underlying currents driving these geopolitical contentions. In the case of the N-S transfer, the quest to safeguard the commercial interests of its constituents was expressed at the meeting [35]. Demonstrably, the desire to maintain a separate organizational identity from the S-S IeTT, as expressed in this meeting report [42], was also matched by the latter's perceived desire to pursue its mercantilist interests with African countries, as we learned in an interview with a national implementation manager of the said transfer [43].

The displays of these institutional behaviours were observed in the conduct of the two contending globalised transfers. In that conduct, the interests of mercantilism and industrialism are intricately interwoven, with the untoward consequence of causing national technology dependency. In the case of the N-S transfer, a review of the

programme documents [36, 44, 45, 46 & 47], revealed that a well established global West Satcom-e-health industrial research complex was already in existence before the IeTT was conceived. The suspicion that a future mercantilist interest was in the air is evidenced in the scale and scope of the biomedical, computing and telecommunication technologies being proposed for transfers. For instance, the blueprint to build a large-scale pan-African Satcom infrastructure, presented in this document [47] was not even on the agenda for scrutiny at the meeting [35].

A suspicion of intent of industrialism was discovered from the review of the implementation plan conceived by a global consultancy firm [36]. It can be inferred from the plan that the preferred recipient countries already had in operation national e-health initiatives that could act as suitable test-beds for adapting the transferred technologies to Africa's markets. Moreover, the intention to produce technologies for African markets was not denied by their representative at the multi-stakeholder meeting [35]. We therefore suggest that the conduct of the transfer was strategically employed as a clever means of securing a commercial foothold for their products and services in African markets.

The manifestation of these institutional forms is even more strikingly observable in the S-S transfer. The observation of mercantilism and industrialism is substantiated with this micro-narrative of telemedicine software that was transferred to an African country. The software that was developed for donor country's domestic utilisation [37] was already protected by an intellectual property right, which as documented in this evaluation report [48], made the ignorant recipient immediately need to start paying for upgrades. Previously not communicated to the recipient country was that a license fee was required to carry out any domestic technology upgrading, required to make it fit for local utilisation. The strategic goal was to make African countries mercantile lock-in with the originating country. There is a reason to suspect that the transfer was conducted in order to strategically achieve this end. Take, for instance, these comments from an interview with an African expert who was involved in the international negotiation that preceded the technology transfers at a stakeholder meeting in 2009 [72] and those from an interview with the manager of national implementation of an S-S IeTT [43].

"[….] the [the donor country's] government wants to offer that service to the African Continent we will pay for the [the foreign] doctors to give the service I'm saying why

are you building capacity in [in the foreign country] to give a service to Africa, but not building capacity here? It's really buying market share" [from 72].

"[.....,] the real purpose of the network [infrastructure] was to create in road to govt [recipient government] for ICT from the [donor country] and [to] leverage the spread of [companies] business using govt support" [43].

"I have met with them and they actually offered to buy me out [...,] they look[ed] at the [...], and said we can fund this entire project and your govt (sic) will pay back in 20-30yrs [.....]" [43].

What these comments show is that the advancement of mercantilism and industrialism is the real goal of the technology transfer. The goal as these comments show is to employ the conduct of the IeTT as a strategic means of giving competitive advantage to its business and industry in African markets. To substantiate this claim, a review of an evaluation report of a national implementation in an African country [48] revealed that 'medical tourism', is the common practice. This is a business practice where rich patients examined utilising telemedicine by medical experts from another country, can travel to that country for any prescribed medical or surgical treatments. The implication of this practice of medical tourism does not augur well for economic and healthcare workforce (human capital) development in the recipient country. Economically, money paid abroad for treatments might otherwise be spent locally for the same purpose in the low-income recipient country.

In addition, 'deskilling' of its local healthcare workers might arise, because of not being exposed to the management of complex medical and surgical cases, that learning through an international telemedicine consultation infrastructure could have offered. Global self-interests can worsen the already poor state of domestic health systems and can frustrate any attempts to integrate multiple and competing e-health initiatives.

Key point: global geopolitics in the conduct of contending and competing S-S and N-S IeTTs in Africa can in the long run constrain or condition national e-health technology acquisition.

4.3 East-West contention

The employment of global diplomacy is observed in the conduct of both the N-S and S-S IeTTs in Africa. This institutional form, a manifestation of the mechanism of global geopolitics, is strategically employed to advance the interests of mercantilism and

industrialism, and can constrain or condition national technology acquisition . The term *East-West contention* is adopted to capture how diplomacy can be employed for advancing commercial gains during technology transfers. In the conduct of the S-S and N-S IeTTs in Africa, this contention manifests as two competing ideological forms of global East and West mercantilism and industrialism.

This comment from an interview with a high-ranking official of a pan-African governmental telecommunication organisation [76] sums up the intensity of global commercial competition for Africa's Satcom market.

"Intelsat will be launching a satellite [name given to the satellite]. Asian Broadcasting Services (ABS) will also be launching a satellite with coverage of [southern African countries], O3B networks, New Skies are also planning to launch a satellite to cover Africa" [76].

This demonstrates that global Satcom companies from global East and West are already competing with each other to capture the emerging e-health service market in Africa. Take for example, the procurement of bandwidths from a global West Satcom multinational for e-health service delivery by an S-S IeTT from a global East giant, reported in these reports [50, 51 & 52] that documented the implementations.

An employment of diplomacy is observed in both N-S and S-S IeTTs in order to gain undue advantage in their commercial competitions for Africa's market share. Take for instance, the conduct of the e-health technology transfers from two emerging global East countries and from a global West consortium. In the case of the former, it was discovered that the transfers were facilitated by their respective ministries of Foreign Affairs, as we discovered from reviewing the initiative documents [37, 55, 58 & 59]. In the latter; the support of a global West organisation was instrumental in enlisting Africa's continental governmental bodies' endorsement, as we learned from the presence of a high-ranking official of the organisation at a multi-stakeholder meeting [35]. Through the instruments of institutional arrangements such as bilateralism and multilateralism, diplomacy is employed by these global actors to strategically gain commercial advantage. The contestation between them mirrors two different but competing geopolitical ideologies.

Key point: commercial competitions between these contending N-S and S-S IeTTs reflect two different but competing geopolitical ideologies between the global East and West.

4.3.1 Eastern ideology

Eastern ideology is taken to capture the identities of mercantilism and industrialism in the conduct of two S-S IeTTs in Africa. In the case of one of the two global East economic giants, a review of two documents [51 & 53], which set out the conditions of international cooperation, discovered the employment of such arrangements for advancing Eastern mercantilism in the conduct of this particular transfer. First, diplomacy ensured that a multilateral memorandum of understanding (MOU) was extracted from a pan-African governmental body [53], endorsing its technology transfer. Different bilateral commercial agreements were later signed with African countries. Discussions with Ministry of Health officials from English speaking West Africa countries, at this national e-health policy formulation workshop [57], revealed that they were being pressured into signing commercial bilateral procurement agreements with their SEOs.

A review of these meeting reports [54 & 55], revealed that an IT Company, owned by this global East country's National government, was responsible for designing and implementing the transferred e-health technologies. The company was to implement a blueprint for a pan-African telecommunication infrastructure for Africa [56], which put it in direct mercantilist competition with a similar plan from the global West consortium [47].

A similar employment of diplomacy was also observed in the conduct of the other global East economic giant. In the case of the other S-S IeTT, a review of these reports [58 & 59] that documented the conduct of the technology transfer capture the diplomatic process that preceded the signing of a bilateral international cooperation agreement between this African country and the global Eastern country. Diplomacy was employed to advance the mercantilist goal of a SEO e-health technology multinational from the latter.

The diplomatic act involved a series of meetings between their ambassadors sponsored and financed by the Ministry of Foreign Affairs of this donor country. It also entailed the participation of government officials from the country's ministries of technology,

finance, industry and international development during the negotiation. In this process, diplomacy mutated to mercantilism. A commercial company, jointly owned by this country's SEO, has been incorporated in an African country, and has commenced trading in e-health equipments and services in Africa (interview with a key informant [49]).

Key point: eastern mercantile-industrial ideology can constrain or condition how African countries' national e-health technology acquisitions.

4.3.2 Western ideology

Western ideology is taken to capture the identities of mercantilism and industrialism in the conduct of an N-S IeTT in Africa by a global West industrial consortium. The perception of employing diplomacy for advancing mercantilism in this case was more subtle, as observed at an international cooperation forum in 2009. At this forum, high-profile African government officials had closed-door meetings with their counterparts. Such subtlety can also be inferred from the conduct of a technology transfer. The said consortium had earlier, before the conduct of the technology transfer in focus, procured Satcom equipment and devices and bandwidths from a global West multinational for an African country's national telemedicine initiative (interview with the project manager [60]). Such an act reveals a subtle employment of diplomacy to smooth the path for one that was to come.

Thus, the choice of a country with a mature e-health initiative to be the recipient, gives the impression that it was a ploy to pre-test the appropriateness of the consortium's technologies for African markets. Take, for instance, the procurement of Satcom equipment and devices and technical expertise from two global West multinationals by the consortium, in ongoing large-scale e-health implementations in two African countries.

Such use of a conduct of an IeTT, as an indirect means for carrying out technological prototyping, appears to be a trademark of this global West consortium in advancing its mercantilism and industrialism. An interview with a project manager [61] of a similar action by the consortium in another developing region of the world reinforces this perception. Apparently, the mercantilist activities of the industrial consortium partners went beyond the original scope of the multilateral international cooperation agreement, as they were forcing on the recipient a certain Satcom technology standard. Such

behaviour was also identified by (Habib-Sy, 1992; Häusler & Simonis, 1985), as an institutional constraint, that worked against past African countries' quest of acquiring Satcom technologies from the global markets .

In the past, similar ill-fated quests, were partly a consequence of numerous geopolitical ideological contentions between the global East and West during the Cold War, claims (Christol, 1974; Cowhey, 1990; Holmes, 1995; Howell, 1988). Technology was a diplomatic tool for enrolling members into diametrically opposed geopolitical circles of influence.

Key point: western-eastern mercantile-industrial ideological contention can constrain or condition African countries' national e-health technology acquisitions.

4.4 Inappropriateness and affordability

The manifestations of such East-West contentions observed in the conduct of IeTTs, can constrain or condition African countries' technology acquisition from ideologically divided global markets. Hence, the concerns of technology inappropriateness and affordability in the context of technoglobalism, calls for further analysis.

A manifestation of geopolitical contentions was demonstrated in the case of a bilateral commercial S-S transfer of Satcom technologies from one of the global East economic giants' SEO to an African country KL, for the purpose of building its national e-health infrastructure. As was learnt from informal interviews at these meetings [57 & 62], the geopolitical events that preceded the procurement had the dynamics of an East-West complex. Apparently, previous commercial negotiations conducted with some global West Satcom multinationals by this African country, were unsuccessful. Consequently, the difficulty in negotiating for favourable terms was cited as a reason for resorting to an alternative choice – a supposedly more favourable S-S transfer.

Generally speaking, it can be argued that neither N-S nor S-S IeTTs have been favourable for national e-health technology acquisition in Africa. In the case of the S-S transfer in KL, the satellite that was commercially procured soon thereafter became dysfunctional and had to be de-orbited as discovered in an interview with a Director of the Agency [63] that was operating the satellite[17]. The public uproar that greeted this

[17] The satellite failure was due to a solar panel defect that led to its malfunctioning and after a failed frantic rescue attempt, it was decommissioned.

setback was reported by the national newspapers in the country, and revealed that there were previously undisclosed intense competitions between the global East and West in the bidding process. Apparently, KL deemed procurement from the former as more affordable than the offers received from the latter.

As previously mentioned, the choice of an S-S technology transfer did not go down well with the public. There was a feeling that procurement from the global West could have offered a superior product to the one that was eventually procured from the competing other, which was perceived as inferior. Such dynamics of East-West contention in the conduct of IeTTs in Africa, call into question the appropriateness of transferred e-health technologies.

Hence, the narrative foregrounds the concern of affordability of e-health technologies in the midst of global geopolitical contention. This structural constraint setbacks African countries' national e-health implementations and subsequent long-term domestic innovation assimilation and accumulation.

Many African countries face the challenge of procuring affordable e-health technologies from the global markets. Take for instance, the case of another African country ZP, whose efforts to build a national e-health infrastructure [64] in the last decade from both N-S and S-S IeTTs have so far been unsuccessful. An interview with an official from the country's ministry of health in 2010 [65 & 66] informed us that limited progress had been achieved in this regard. The delay in implementation was attributed to the incapability of ZP to successfully negotiate global markets, during the conduct of both transfers.

ZP, just as we noted with AB in Chapter 3, was constrained in negotiating the complexity of global markets, because of domestic financial limitations. For the country, previous participation in similar technology transfers turned out to be unaffordable, due to the prohibitive costs of procuring e-health devices and equipments from global markets. In spite of having articulated detailed technology specifications and procurement procedures in this policy document [64], an attempt to participate in a commercial S-S IeTT with a global East country never materialised. ZP was incapable of affording a mere estimated $US 500, 000 quoted for the procurement. Hence, what

was planned as an incremental national e-health implementation suffered a massive setback; as was discovered in two separate interviews with an official from its Ministry of Health [65 & 66].

The spectre of financial constraint also manifested itself in being a recipient of an N-S IeTT (project documents [67 & 68]). It took two years of painstaking fundraising and entrepreneurial efforts of a philanthropic global West faith-based organisation, to mobilise $US 300, 000 for procuring two expensive modern digital microscopes from global markets, needed for building an urban-rural telepathology infrastructure in ZP. In the process, they had to delicately negotiate complex global markets, before affordable appropriate devices were eventually sourced.

The challenge of e-health technology affordability is a commonly encountered constraint in Africa, as this interview [69] with the founder of a pan-Africa telemedicine infrastructure informed. A planned expansion of the said N-S transfer to other African countries suffered a fatal setback, because of this structural constraint.

In a different circumstance, a planned large-scale pan-African e-health implementation by a global West altruistic-mercantilist consortium, suffered a similar setback. The mobilisation of an earmarked multi-million US dollar capital investment to procure Satcom, biomedical and computing devices from the global markets, never materialised. Again, another unfulfilled cosmopolitan promise due to geopolitical political contentions. The state (which included African, global West and East countries and non-state actors (NGOs and IGOs)) that constituted the consortium, could not arrive at a multilateral decision (interview with the organisation's senior official at that time [70]).

African countries struggle to successfully negotiate global geopolitics when procuring e-health technologies from global markets. The constraint of affordability as encountered by ZP in complex and competitive global markets, setback its national e-health implementation. An interview with a senior official from this country's Ministry of Health, during a National e-health policy formulation workshop [71], confirmed such; and ironically, that any hope of reviving it is heaped on receiving an IeTT from a global East.

Key point: neither N-S nor S-S IeTTs have made e-health technologies reliable and affordable for national e-health implementations in Africa.

4.5 Neoliberalism

We demonstrated that neither western nor eastern commercial ideology seems to have resulted in an unproblematic technology transfer in the aforementioned recipient countries. It might be that both ideologies commonly embody the identities of mercantilism and industrialism. These appear to bind them together in a shared practice of 'neoliberalism' (Fritsch 2009, pp. 35-36).

This shared ideology in the context of technoglobalism can be interpreted in a way intellectual property rights (IPRs) regime, binds cooperating countries together. Such understanding was obtained from a session on a global East country's development plan for Africa at the Chatham House African Agency programme in 2009 [73]. A very senior official of the country's Development Agency plainly stated that the country cannot altruistically transfer technologies to Africa, because most were co-developed with mostly global West countries. Both the global East and West are locked together in technology neoliberalism. A shared neoliberalism informs the practice of their multinationals and state operated enterprises (SEOs) mercantilism and industrialism in the conduct of IeTTs.

What is apparent is that transferred-health technologies will not come cheap for most African countries. Even when they domestically co-developed technologies, most might be not be able to afford them.

Reverse innovation (Immelt, Govindarajan, & Trimble, 2009) by multinationals and SEOs, might result in a situation where domestically co-developed e-health devices in African countries, become expensive and unaffordable commodities on global markets. For example, a certain e-health device invented by a global West multinational in a middle income African country [74], is now being offered at prohibitive prices in global markets. A similar act of reverse innovation is also identified with another device invented on the back of the innovations that took place in two low-income African countries [AB and ZP], but being manufactured by a global medical device manufacturer (Parati et al., 2010). Of course, an accusing finger should also be pointed at the immature state of these recipient countries' domestic innovation capacities, which might have scuttled knowledge assimilation and technology accumulation.

Key point: both eastern and western commercial ideologies commonly embody technology neoliberalism.

4.6 Conclusion

The narrative identifies and examines the constraining and conditioning impacts of global geopolitics on national e-health technology acquisition in Africa. Global diplomacy, mercantilism and industrialism, which manifested in both conduct of North-South and South-South IeTTs, can impact on the exercise of National Agency. These global institutional identities underscore the true nature of the conduct; hence, foregrounding the concern of technology affordability as an institutional constraint to domestic acquisition.

Table 4.1 summarises the institutional manifestations of global geopolitics.

Table 4.1 summarises the institutional constraints

Narrative themes	Institutional constraints
Geopolitical competitions	Global geopolitics in the conduct of contending and competing S-S and N-S IeTTs can in the long run constrain or condition of national e-health technology acquisition.
East-West contentions	Commercial competitions between these contending N-S and S-S IeTTs reflect the underlying geopolitical contestations between the global East and West.
Eastern ideology	Eastern mercantile-industrial ideology can condition recipients' national e-health technology acquisitions.
Western ideology	Western-eastern mercantile-industrial ideological contention can constrain or condition recipients' national e-health technology acquisitions.
Inappropriateness and affordability	Neither N-S nor S-S IeTTs made e-health technologies reliable and affordable for national e-health implementations.
Neoliberalism	Both eastern and western commercial ideologies commonly embody technology neoliberalism.

A key finding is that East-West contentions capture the underlying geopolitical divide in the conduct of IeTTs in Africa. We reckon that if unregulated it can constrain affordable technology acquisitions from the global markets; as the costs of procuring e-health technologies are prohibitive.

5 Continental fragmentation

5.1 Introduction

The narrative in this chapter addresses Objective 3. It identifies and demonstrates how institutional actions and identities manifest as continental fragmentation in the cosmopolitan conduct of IeTTs. Global influences in this manifestation and its constraints on national e-health technology acquisitions are highlighted.

As Freeman (Freeman, 2002) affirms, in the conducts of international technology transfers, a successful diffusion of national acquisition happens when the strategic intermediary role of continental governmental bodies is enabling for national technology acquisition. That is, the continent plays an essential intermediary role between the *global* and the *national* in the conduct of international technology transfers. Such an intermediary role, according to (Muchie, 2004), can enable an assimilation and accumulation of domestic innovation capacity, when continental governmental organisations are acting in unison, and are strategically advancing an innovation agenda.

An optimal functioning of the continental political and financial organisations is essential, and they have to be aligned with their national counterparts for a successful transfer to occur. In the conduct of S-S and N-S IeTTs in Africa, the narrative in this chapter identifies that the intermediary function is weak. Instead of enabling domestic e-health innovation capacity accumulation, we observe that the inefficiency of the continental governmental bodies in Africa is constraining the exercise of National Agency.

There are three institutional forms identified as structural constraints in acquiring domestic e-health innovation capacities in African countries. The first is the divisive influence of regionalism. The second is the influence of fragmented governance. The third is poor strategic leadership. These three define the mechanism of continental fragmentation. They constrain the exercise of National Agency, as continental institutions malfunction in the performance of their intermediation role during the conduct of IeTTs.

The first section examines the nature of continental fragmentation as geopolitical divisions in Africa. The other two examine the organisational capacities of the continental governmental organisations as they mediate in the conduct.

The data employed in this chapter are qualitative in nature collected over four years of research and field work. Data sources include different structured and unstructured interviews conducted with African and international policymakers and key informants at different meetings, workshops and conferences. Interviews with some the actors were followed up for years through e-mails and from discussions at different meetings and conferences, giving updates and clarifications on e-health projects they were involved in. Documental analyses of policy documents, evaluation reports and meeting reports, obtained by privileged accesses granted by these actors, are carried out. Other sources of data are transcription of notes taken in policy meetings. In total, five interviews (three structured and two unstructured) were conducted, there were participations in five policy meetings, seven meeting reports were reviewed, eleven project documents analysed, six policy documents reviewed and the literature reviewed.

The references for the data sources are presented in Appendix B. The main source of data is from participation in the policy debates that contributed to the implementation of three pan-African e-health initiatives (Appendix C) and from data from national e-health initiatives in Africa.

The chapter is divided into three main sections.

1. The first section presents and demonstrates how IeTTs conducted on a regional basis can fragment continental governance and make recipient countries take self-interested unilateral decisions.
2. The second section describes the underlying nature of fragmented governance as defined by complex interactions, interference and inefficiency, that limit coordination of IeTTs.
3. The third presents and demonstrates that poor strategic leadership results in poor coordination of, and limited influence in, the conduct.

At the end of each section or sub-section, a key point is included to highlight key findings.

5.2 Regionalism

Regionalism, the fragmentation of Africa into geopolitical regions by dominant international actors and organisations in the conduct of both N-S and S-S IeTTs, can constrain national technology acquisition. Regionalism, the convenient segmentation of geographically proximate African countries into groups, is evident in national implementations of pan-African initiatives (Appendix C). The fragmentations are

caused by the disruptive global dominance in the conduct of IeTTs in Africa. Insights into past conduct of Satcom technology transfers in Africa demonstrate that such regionalism might result in a weakening and disintegration of any continental multilateralism that has been put in place to enable it. Moreover, it had also resulted in African countries taking unilateral actions in opposition to such continental multilateralism.

Regionalism that is identified in the conduct, favoured one geographical sub-continent over the other. For example, countries from East Africa were explicitly picked for national implementations in two of the conduct, as reviewing these reports revealed [45, 46 & 75]. A reason that can be offered for this observed predilection was found when participating in various policy debates that took place at the Chatham House Global Health Security and Governance and African Agency programmes [73]. Countries in this African region, for example AB in Chapter 5, are noted for being long-standing dependent recipients of more financial aids from international development partners relative to other parts of the continent. However, one of the transfers was explicitly intended to be implemented in all the five geo-economic regions of the continent: namely West, East, North, South and Central, as stated in these documents [37 & 56]. So, in this example, national implementations were to be conducted on an equally distributed regional basis.

There is a correlation between regional variation and the distribution of national implementations of the technology transfers. A review of a multi-stakeholder meeting report on an S-S IeTT conduct [55] revealed a skewed distribution of national implementations in the eastern, western, southern and central part of the continent, when compared with those in its northern part.

The exclusion of the northern region can be explained by its relative regional economic strength and its geographical proximity to Europe. Perhaps the region's existing ownership of a regional Satcom system (as discovered from an interview with an executive of a pan-African telecommunication body [76]) made it unsuitable for the technology transfers' hidden agenda of commercial operations. This region and certain middle-income countries from the southern African region were also excluded as a recipient of another N-S IeTT, as discovered from a review of its technical implementation document [46].

The consequence of regionalism, however, was that unilateralism supplanted multilateralism in the conduct. The attendant outcome of such supplanting was that multilateralism became fragmented, and the intermediary role expected from the continental governmental organisations was not evident. The beneficiary became the donor, who tactically started enlisting countries into separate bilateral arrangements. As a result, the recipient countries themselves started to take unilateral decisions to break away from the collective organisation at the regional level.

5.2.1 Fragmented multilateralism

The fragmentation of continental multilateralism as a consequence of regionalism imposed by overbearing global dominance seems characteristic of IeTTs conduct. Dynamics of such characteristic became apparent in a multilateral process, in which, Africa's Continental and National governments, together with several IGOs, global West countries and multinationals, tried in vain to deliver a successful N-S Satcom technology transfer[18]. Insights from the policy debates on this ill-fated acquisition process help us to understand how such an act of national unilateralism could become an institutional constraint to technology acquisition.

Global dominance – overbearing industrialist, mercantilist and diplomatic interests of international entities in the transfer process[19], as stipulated in this policy meeting report [77] and these policy documents [78 & 79], ended up fragmenting a set pan-African Satcom technology multilateralism. How regionalism resulted in geopolitical contestations between Africa's English-speaking and French-speaking regions in the process of technology selection, is revealed in [77]. Each of the two neo-colonial separate linguistic regions represented a different technology choice. Moreover, each choice was backed and financed by competing global mercantilist, industrial and diplomatic interests, and were jostling with each other for Africa's policymakers' attentions.

[18] The idea of a Pan-African Satcom network was conceived in the 1970s as essential for socio-economic development of Africa. This plan was the first socio-economic and industrial development blueprint led by Africa's continental governmental bodies that was aimed at reversing the trend of Africa's lack of global competitiveness.

[19] The transfer was dominated by IGOs such as ITU, UNESCO and UNDP and with the financial supports of the Governments of Italy and Germany. The process of the transfer was also dominated by a 'Trans-Atlantic alliance' of private consultancy organizations from Canada, Norway, Sweden, France and the UK.

The ultimate consequence of these dominant interests was that certain African countries started competing with each other. For instance, an English speaking country that offered to host the operational headquarters of a proposed pan-African Satcom infrastructure, came up against the self-interest of a certain global West Country, who preferred it to be instead sited in a competing French-speaking one (policy meeting reports [77 & 80]).

Fragmented multilateralism thus eventually brought about a manifestation of national unilateralism. In the process, the promise of a pan-African Satcom infrastructure implementation as a spur for fostering a continent-wide digital economy, evaporated.

This conclusion might be prescient for the contemporaneous cosmopolitan implementation of these pan-African e-health initiatives (Appendix C). Just as Africa lost an opportunity in the past to successfully acquire technologies and build a planned pan-African e-health infrastructure, it is not overstretching it to state that a similar a fate might befall these initiatives.

Key point: regional linguistic differences can make the achievement of continental multilateralism difficult to attain, which in turn can constrain national technology acquisition.

5.2.2 Unilateralism

Unilateralism stemming from regionalism underlines the mechanism of continental fragmentation. This (where each individual country enters into a bilateral agreement with the international governmental partner, as found in a review of this implementation document [51]) differs from multilateralism (where implementations in each country are directed or led by a continental governmental body). In the conduct of an S-S IeTT, unilateral national implementation completely replaced the collectiveness of continental multilateralism, the documented original basis for conducting the transfer [53], as this evaluation report [48] has shown.

Unilateralism has its own consequence for a late coming recipient's national technology acquisition, as it was discovered from a stakeholder meeting [57]. Early domestic implementation in a regional hub West African country translated into delayed transfers in neighbouring countries. The early recipient had an e-health infrastructure fully operational before the latecomers, which were still waiting for the transfers, almost a year thereafter. Of course, having a pre-established regional hub for regional

coordination and organisation is essential. However, an unintended consequence is that an early recipient could gain an undue strategic advantage over the latecomers in potential future international cooperation and trade. In this conduct, the hub country became engaged in a bilateral virtual telemedicine services trade with the donor, in spite of the latecomers. Such resultant act of bilateralism, a consequence fragmented continental multilateralism, explains how unilateralism stem from regionalism.

Such unilateralism may inadvertently create a regional technology dependent relationship between an early recipient and latecomers. For example, the former privileged and pre-established innovation capacity could later make the latter dependent for their implementations. Conversely, being concurrent recipients might have given them equal shots at technology acquisition from the donor. Though, a pre-established regional leader re-transferring adapted technologies to others could in regional development sense, seen as success.

A unilateral act of abstinence is also a cause of regional fragmentation. For instance, southern and eastern African countries in comparison with others were behind the curve in national implementations of the said S-S IeTT, as we learnt from these policy setting workshops [2 & 71]. A middle-income southern African country also unilaterally decided against becoming a recipient of a bilateral contending S-S transfer (multi-stakeholder policy meeting on pan-African e-health initiatives [40] and an interview at a multi-stakeholder meeting in 2009 [72]). Such competitive nature of IeTTs' conduct belies the influence of global dominance in the emergence of these acts of unilateralism.

Key point: regionalism can lead to national unilateralism supplanting continental multilateralism in the conduct of the IeTTs.

5.2.3 Domestic action

Fragmented continental multilateralism can nudge financially capable countries towards taking a domestic action to foster a national technology acquisition. For example, an initially unsuccessful unilateral action taken by a mineral resource-rich African country to acquire its own national Satcom technology, after the said ill-fated pan-African effort (Habib-Sy, 1992). This domestic policy choice, albeit protracted, thereafter resulted in a successful Satcom technology acquisition about two decades later on.

This country initial exercise of National Agency – its willingness to finance an N-S technology transfer, came up against the self-interest of a certain global West Country

(policy meeting reports [77 & 80]). Recently, however, the country has reaped the fruit of its unilateral policy choice. A modern Satcom technology was acquired through an S-S transfer. This will provide an infrastructure upon which its unilaterally conceived national e-health initiative will be implemented. This is testament of its foresighted domestic action as this initiative is implemented separately from a globally conceived and continentally endorsed S-S IeTT (interview with the national implementation manager [43]).

A positive view of globally mediated fragmented continental multilateralism can be taken given the success of such act of unilateralism.

Key point: fragmented continental multilateralism can inadvertently spur a financially endowed recipient‘s unilateral technology acquisition.

5.3 Poor strategic leadership

Poor strategic continental leadership is an institutional constraint to the exercise of National Agency in the conduct of IeTTs in Africa. Continental governmental bodies must perform their strategic intermediary role between the global and the national; even, in the face of global diplomacy and mercantilism (see Chapter 4).

Weak strategic leadership can constrain domestic e-health innovation capacity accumulation in two ways. The first is inefficient coordination on the part of the continental governmental bodies in dealing with inherent complexity involved in negotiating with multiple and self-interested international donors or partners. The second is the limited influence of these bodies in the design and conduct of IeTTs.

5.3.1 Inefficient coordination

An inefficient coordination of the diplomatic negotiations with multiple and diverse international donors at the continental level is identifies as an institutional constraint to national e-health technology acquisition. This can partly be attributed to dominant cosmopolitanism and the complexity that comes with it.

The complex nature of negotiating and navigating diverse diplomatic, mercantilist, altruistic and industrial interests are on their own enough to make the effects of inefficient coordination, more glaring. This complexity is a reflection of the multiple global, continental and national actors involved in the conduct of IeTTs.

With such multiple organisational interests at play in negotiations, one can imagine that any attempt at coordinating would be difficult, especially if the organisational capability to do so is deficient. Inefficient coordination constrained continental oversight in national implementations (an interview with an official of the main continental political body [84]). This has a negative consequence for exercising National Agency.

We identified in the case of one of the IeTTs, that national inputs critical for fostering successful acquisition were excluded from negotiations with international donors. The technology transfer was conducted in an atmosphere of an 'information void'. This is an example of how weak strategic leadership in negotiations can prevent equitable partnerships for recipients.

It is not that a need for coordination was not recognised at the continental level. However, the inherent complex interactions coupled with self-interested push made it very difficult to achieve such. We noticed strong strategic lobbying from the international partners to advance their self-interest in their dealings with the continental governmental bodies (directly observed in a multi-stakeholder meeting [35]). These meeting reports [32, 39, 82 & 83] reveal how a transfer donor incessantly lobbied a continental governmental body in order to make its own proposal the official choice in lieu of competing others.

Inefficient coordination result in limited influence on donors. Despite the expressed intention of a main continental governmental body to forge partnerships amongst multiple donors at this multi-stakeholder meeting [35], such never materialised. A review of two stakeholders' meeting reports [40 & 55] revealed that the different sponsors instead opted to keep their implementations separate from each other.

A reason that can explain difficulty in coordinating complex interactions and negotiations is found in these meeting reports [38 & 39] on the proceedings of negotiations between a main continental body and one of the sponsors of an IeTTs. The reports reveal dissatisfaction with lack of transparency and accountability in the conduct of the IeTTs, expressed by this body.

The ultimate consequence was fragmented pan-African multilateralism – a situation where a collection of continental governmental bodies enlist and invite national inputs and cooperation in negotiations. Rather, unilateralism when separate countries enter into individual bilateral agreements with donors was an unfortunate outcome.

Key point: inefficient continental coordination of multiple and complex globalised interactions can constrain recipients' national technology acquisition.

5.3.2 Limited influence

Weak strategic leadership, in general, has also much to do with the exclusion and limited influence of continental governmental bodies in the design of IeTTs. None of the continental governmental and technocratic bodies was involved in the design of an N-S transfer until two years after its cosmopolitan conception (interview with an official of a continental political organisation [41] and review of stakeholders' meeting reports [32, 39, 82 & 83]).

Limited influence can be assessed by the extent of financial contributions made to IeTTs' conception and implementation by continental bodies. More often than not, donors are usually the sole financiers. For example, these pan-African e-health initiatives were solely conceived and financed by them (programme documents [75 & 85]). This stark reality is supported by a comment obtained from an interview with a high-ranking official of a continental telecommunication organisation [76].

"After all it is not the [pan-African organisation] which is providing funds [.....] but the donor institutions [.....]"

Neither the continental governmental bodies nor national governments contributed financially to the initiatives' design and implementations. Perhaps they were not asked to in the first place by the donors, or that they were not willing capable to do so. The latter is the more likely reason. Take, for instance, the reluctance of the continent's premier development bank to co-finance one of the pan-African initiatives, (interview with a senior official of a continental governmental body [86]). A given official explanation was that the bank's organisational policy was to only entertain and finance project requests from individual countries and not one conceived by a donor. Notwithstanding, such act of reluctance comes as another demonstration of weak strategic leadership.

A similar act of reluctance was detrimental to a successful pan-African Satcom technology acquisition in the past. Continental multilateral leadership struggled to enlist financial commitments from member states, as noted in these policy documents [80 & 87]. Notably, only three countries out of the total, (at that time African countries were 45 in number), came up with what was in fact less than 2% of the required finance for

the intended N-S technology transfer. The action taken by the continental leadership thereafter to mobilise domestic public finance, is telling. Recourse to private investments was eventually made to mobilise the financial capital required for the said acquisition (noted in this policy document [88]). Notwithstanding, the said acquisition suffered from a history of near-misses no thanks to regional neo-colonial contestations and contravening global technoeconomic and geopolitical events (refer to Chapter 4).

The history was also underscored by disruptive influences of global diplomatic, mercantilist and industrial contestations and competitions. Most pertinently, such history was also defined by a display of weak continental strategic leadership. Though, the technology has now being acquired, fully functional and operated by a technocratic continental organisation. The past setback can be found replicating itself in the present conduct of IeTTs. A historical path-dependency of the past conduct's dynamics is existentially observable, as we found out from reviewing these policy documents [78 & 79].

As it the eventual acquisition was privately financed and operated, the pan-Africa Satcom technology infrastructure, public governance of its utilisation by continental governmental organisations, is weak. Hereby is making multilateral e-Service provision nearly impossible to achieve. A consequence is a forced recourse to international procurements of bandwidths from a western multinational by countries that were recipients of transferred e-health technologies. Ironically, this multinational absurd display of mercantilism was implicated by (Habib-Sy, 1992) in the history of near-misses. This conundrum could have been avoided, had the pan-African Satcom body involved early on in global-continental negotiations.

The absence of this telecommunication infrastructure management body in the negotiations that preceded the conduct of IeTTs is identified as another display of weak strategic continental leadership. The perplexed reaction of a senior official of the Satcom organisation to this absence (interviews: [35] and [76]), was both informative and conclusive. An offence was taken to the reality that a body created for a purposive should be begging to supply bandwidths to initiatives presented as 'developmental projects' by altruistic 'international development partners'. This was hard to fathom.

After all, in the case of the pan-African e-health initiatives, continental governmental bodies' participation in and inputs into IeTTs' their conduct and implementation, was

not more than a ‘window dressing’. Their influence on national implementations in recipients is more a matter of ‘style’, less of ‘substance’. The aloofness of certain wealthy African countries towards the privately financed pan-African Satcom body sums it up. It substantiates that continental governmental bodies’ influence on recipient countries is really even weak.

Take for instance a middle-income Southern African country that declined to partake in any continental multilateral technology management. In defiance, it is going ahead with unilateral acquisition from the same implicated multinational. Though being financed by its domestic private sector is development. As the same country also opted out of a multilateral S-S IeTT, speaks to the reality that such act of unilateralism is inevitable.

Key point: not co-financing IeTTs is a reflection of weak continental strategic leadership capability.

5.4 Fragmented governance

A fragmentation of continental governance mechanism is identified in the conduct of the IeTTs in Africa. This is an ineffective functioning of continental governmental organisations’ administrative and policy making mechanisms, in their execution of intermediary or facilitating roles of ensuring that recipients are fairly and equally treated. Such fragmentation is a reflection of poor communication amongst the various departments within the main continental governmental body, and it is compounded by the deficient coordination of its relationships with other technocratic continental ones.

In addition, fragmentation also reflected the main body’s limited influence on international development partners’ objectives. Take for instance the negligence of two IGOs, whose headquarters were involved in the conduct of an N-S IeTT, neglected to brief their African regional offices of an implementation being conducted in their administrative domains (discovered from reviewing this stakeholder technical meeting report [81]). Their missing intermediary roles could have assured an engaged participation of the continental bodies and the negotiated aggregation of potential recipients into workable multilateral arrangements.

Given the density and multiplicity of involved stakeholders in the conduct of IeTTs, such institutional neglect can come as unavoidable. Such complex plurality contributes to continental governance fragmentation, and can condition how a recipient’s exercise of National Agency. To sum up, fragmented administrative and policy-making

mechanisms of continental governmental organisations can condition technology acquisition.

There are two factors we have identified that are behind the fragmentation of governance at the continental level.

5.4.1 Organisational inefficiency

The first is the inefficient coordination of administrative functions of continental governmental bodies in the conduct of the IeTTs. We noticed a fragmentation amongst those departmental units with various functions in finance, infrastructure development, healthcare, science and technology and socio-economic advancement. There were not in synergy, in the absence of an effective coordinating mechanism and leadership.

We identified two consequences of inefficient coordination.

The first is that the interfering nature of global diplomacy in the conduct of the IeTTs can partly cause fragmented continental governance. Such was closely observed at a multi-stakeholder meeting [35], involving representatives from two IGOs and those from Africa's continental governmental bodies. An IGO who was a sponsor of an N-S IeTT, that wanted to partner with another one with a similar transfer of same technological characteristics, had this request coldly rejected. Self-interested advancement of global diplomacy and mercantilism we noted in preceding sections, are also examples of constraining institutional competition. In all, we noticed that uncoordinated continental bodies were always at hand to forge global partnerships that they limited influence in.

Interference wouldn't have been possible, had the various continental governmental bodies were strategically and duly coordinated. This could have their governing of IeTTs' conduct less perfunctory rather than just issuing out political endorsements.

The second is by and large, a main consequence of fragmented governance. That continental multilateralism will struggle to materialise as African inputs into the governance of transfers, are often missing. There is a historical precedent to consider in interpreting the potential impact of this consequence on the exercise of a recipient's National Agency. As described by (Habib-Sy, 1992), a similar situation of fragmented continental governance was associated with a catalogue of setbacks in acquiring a pan-

African Satcom technology. Consequently, this made countries to start contemplating unilateral acquisitions, when pan-African multilateralism became fragmented.

Key point: organisational inefficiency can partly cause fragmented continental governance.

5.4.2 Fragmented policy-making

The second is that fragmented governance has to do with the complexity inherent in interacting with multiple and contesting National governments and international state and non-state actors involved in the conduct of the IeTTs. This manifests as intra and inter organisational contestations. Inter-organisationally, continental governmental bodies have different and competing institutional priorities, as found at this multi-stakeholder meeting [35]. For example, a continental development bank, that was supposed to co-finance the implementation of one of the transfers, already had in place a plan to bankroll a separately developed regional e-health initiative.

Intra-organisationally within a continental governmental body, competition amongst administratively distinct departments can also constrain an exercise of a recipient's National Agency.

During two research visits to this main body in 2009 and 2010, it was discovered that there were three different administrative departments with overlapping responsibilities for governing e-health policy-making. From interviews with officials from these three departments, it was further discovered that communication and coordination among them was very limited. One of the departments with a techno-centric leaning was dominant in the attendant policy deliberations (stakeholders' technical meeting reports [32, 39, 82 & 83]). This implies that essential inputs from the other two departments were not taken into consideration. For instance, the second science and innovation-oriented department, whose active inputs could have advanced national technology acquisition, was not present at all at these important meetings. Similar kind of frosty relationships are observed with the third technically relevant health-centric department.

A fragmentation of e-health policy governance is apparent. As, for such a body, partnering with international donors requires effectively navigating complex interactions, more difficult to attain, if, intra-organisational coordination and cooperation cannot be fostered.

Key point: fragmentation of continental policy-making governance can impede national e-health technology acquisition.

5.5 Conclusion

Continental fragmented governance has been identified as a structural constraint to national e-health technology acquisition from IeTTs in Africa. We identified and examined its working against continental governmental bodies' intermediary roles between the national and global in conducted transfers. Three institutional forms of this constraint are identified.

The first is regionalism. The fragmentation of the continent by the international partners based on Existing geo-economic or geopolitical segmentations are exploited by donors for advancing their self-interests in national implementation, contributed to continental fragmented governance.

The other two forms, weak continental strategic leadership and fragmented governance, are internal in origin. Deficient organizational capacities of continental governmental bodies to both coordinate and influence the design and implementation of IeTTs, is an institutional challenge.

Complexity inherent in coordinating various competing and contending national, continental and global actors, and organisational inefficiency of continental governmental bodies, fragment intended multilateralism. Thus, national unilateralism is coordinated governance of the transfers impossible.

Table 5.1 summarises institutional constraints

Narrative themes	**Institutional constraints**
Regionalism	Regionalism can lead to national unilateralism supplanting continental multilateralism in the conduct of the IeTTs.
Fragmented multilateralism	Regional linguistic differences can make the achievement of continental multilateralism difficult to attain, which in turn can constrain national technology acquisition.

Unilateralism	Regionalism can lead to national unilateralism supplanting continental multilateralism in the conduct of the IeTTs.
Domestic action	Fragmented continental multilateralism can inadvertently spur a financially endowed recipient‘s unilateral technology acquisition.
Organisational inefficiency	Organisational inefficiency can partly cause fragmented continental governance.
Inefficient coordination	Inefficient continental coordination of multiple and complex globalised interactions can constrain recipients’ national technology acquisition.
Fragmented policy-making	Fragmentation of continental policy-making governance can impede national e-health technology acquisition.
Limited influence	Not co-financing IeTTs is a reflection of weak continental strategic leadership capability.

The ultimate consequence of the structural constraint is that national e-health technology acquisition can be impeded. In response, recipients take unilateral actions away from fragmented multilateralism.

6 National reticence

6.1 Introduction

National reticence explains and demonstrates African countries' weak and lagging domestic e-health technology accumulation and assimilation. This is identified as even more telling for their national technology acquisition; notwithstanding, the other contributing and influencing conditions we identified in preceding chapters.

This chapter addresses Objective number 4 by examining institutional variation and dynamics of National Agency in the conduct of IeTTs. We associate the causality of this condition with three domestic factors. The first is primarily a weak exercise of National Agency. The second is the organisational passivity of recipient African National governments. The third is poor dynamics of domestic e-health technology adaptations and accumulations. We explore these three factors by examining variation of current state of domestic e-health innovation capacities in African countries.

We argue that immature extant domestic innovation capacity in these recipients, account for their poor history of national e-health implementations. By identifying that their domestic incremental accumulation and assimilation of e-health innovations from subnational experimentations are missing and weak. It moves beyond blaming others, by stressing a strategic imperative for exercising National Agency in face of dominant and incessant cosmopolitan conduct.

Several African countries, for example AB (Chapter 3), have expressed in their national e-health policy documents, their domestic e-health implementation ambitions. However, up to now, none has in a global comparative term been successful. A catalogue of setbacks and uncertainties has been the norm across the continent. This is because most African countries, despite being longstanding recipients of diverse IeTTs, have historically struggled to build up their domestic innovation capacities. (This is notwithstanding the fact that a recipient country such as AB has made considerable technoscientific contributions to global innovation system). Subnational e-health experimentations have hardly ever scaled up to a critical mass required for fostering domestic technology and competence accumulations.

According to the NIS literature (presented in Chapter 2), African countries are categorically global technology laggards due to their immature extant domestic innovation capacities as they historically struggled to assimilate and accumulate from international technology transfers (Forje, 2006, Lall & Pietrobelli, 2005). In contrast, global technology frontiers' possession of extant domestic innovation and industrial capacities are underpinning an incremental national e-health technology accumulation and implementation (Chapter 2).

On this account, we identify two domestic institutional actions as to why an exercise of National Agency is deemed strategic for African countries. The first is the proactive role of National government in fostering and forging domestic innovation capacity from international technology transfers. Given that with the frontiers, both an acquired and indigenously fostered domestic innovation capacities, are driving their incremental technology accumulation and knowledge assimilation from various subnational experimentations. With them, the establishment of cognitive, normative and regulative institutions (Geels, 2004) by their National governments underpins their domestic acquisitions and implementations. National agency is driven by normative proactive and collaborative behaviours of their domestic public and private sectors. They are formulating innovation policies, stimulating industrial development, promoting socioeconomic growth and providing financial resources provision.

The second action is that a frontier's possession of domestic innovation capacity drives its incremental accumulation and implementation. As already articulated in Chapter 2, such occur through long-term technology learning from subnational experimentations and voluminous utilisations at sectoral hospitals and clinics. Incrementalism is characterised by domestic technology adaptations from usually undertaken technoscientific and engineering activities in the process of addressing challenges of technology inappropriateness or obsolescence.

This explains the dynamics of domestic e-health innovation capacity acquisition. Technical competences acquired from such subnational actions and activities are in turn assimilated into their extant functional and productive national innovation systems. Assimilated knowledge then become a foundation for accumulating existing and emerging technologies. Upon which subsequent the fostering of further and novel domestic innovations and creation of domestic industries, follow. The acquired

domestic innovation capacity, then, incrementally supplies appropriate technologies for engineering national e-health the implementations.

Subsequent narrative examines that the variation this dynamics in of African countries and why its absence or immaturity account for their immature national e-health technology capacity states.

The data are qualitative in nature collected over four years of research and field work. The data sources include different structured and unstructured interviews conducted with key informants, national e-health programme managers, entrepreneurs and policy makers at different meetings, workshops and conferences. The interviews with some of the actors continue for a long period through e-mails and from discussions at different meetings and conferences, for getting updates and clarifications on e-health projects they were involved in. Documental analyses of policy documents, evaluation reports and meeting reports, obtained by privileged accesses granted by these actors, are carried out. Other sources of data are transcription of notes taken in policy meetings. In total, five interviews (four structured and one unstructured) were conducted, there were participations in seven policy meetings, seventeen project documents were analysed, two national e-health policy documents reviewed and observations made from six conferences. The references for the data sources are presented in Appendix B.

The chapter is divided into three main sections.

1. The first section presents and explores the normative behaviours of African countries' public sector that can constrain the exercise of National Agency in national e-health technology acquisition.
2. The second section demonstrates and explores how a lack of the proactive role of national governments constrains knowledge assimilation and technology accumulation, and fostering of domestic e-health innovation and industry. It explores how variations in the exercise of National Agency is explained by differences in their national economic sizes and national innovation capacities
3. The third section demonstrates and explores how immature domestic e-health innovation capacity, is associated with an uncertain incremental subnational utilisations and accumulations. It shows that low volume technology utilisation and absent domestic e-health industry as institutional barriers to domestic acquisition.

At the end of each section or sub-section, a key point is included to highlight the finding from the narratives.

6.2 Lack of National Agency

A lack of exercising National Agency in the conduct of IeTTs is identified with African countries. This refers to proactive behaviours that the public sector of recipient African countries can exhibit for ensuring national e-health technology acquisition. The uncooperative organisational behaviour of the public sector of an African country: KL, exhibited during the conduct of an S-S transfer, is employed to demonstrate how such display of National reticence can stifle domestic acquisition. For instance, as it was noted in mismanagement of its national e-health telecommunication technology acquisition.

There are two factors we associate with such lack of the exercise of National Agency in this recipient, as observed during participations in these national e-health policy making stakeholders' meetings [35 & 65]. These are implicated as responsible for the defunct state of its national e-health implementation. Their interpretations give an insight into how the working of this country's immature and unstable institutions, to the point that a technology acquisition from an S-S transfer was truncated.

6.2.1 Inter-agency rivalry

Inter-agency rivalry is the first of the two identified institutional barriers. It is a reflection of the irreconcilability of KL's National governmental agencies' divergent organisational interests. In the process of building its national e-health telecommunication infrastructure, a strategic omission to reconcile conflicting and fragmented organisational functions of the five different agencies involved led to a mismanagement of the transfer. For instance, the agencies that are responsible for healthcare policy and provision were at odds with those responsible for telecommunication (policy formulation, service provision and infrastructure development research).

Such manifestation of irreconcilability had its consequence. Instead of fostering management collective stewardship, in the form of instituting an inter-agency cooperation mechanism for the delineation and governance of responsibilities, the manifestation of inter-organisational rivalry proved to be catastrophic for a deepened

and scalar national acquisition. In this case, the irreconcilability of the divergent and conflicting bureaucracies of the different governmental agencies rendered the fostering of inter-agency cooperation and governance difficult.

Key point: domestic inter-agency rivalry can constrain a recipient's national e-health technology acquisition.

6.2.2 Organisational technocentrism

The second is parochial techno-centric interpretation of e-health deepened inter-organisational rivalry among KL's different National governmental agencies. As a consequence of irreconcilability amongst the agencies, two conflicting groups emerged along technology development and health service provision lines. A dominant techno-centric group, constituted of the three telecommunication service provision, research and policy making national agencies, made irrelevant the inputs of the sole health service provision agency that was involved. In the absence of any governance mechanism and with the health service provision agency's lukewarm attitude to e-health, the organisational techno-centrism of the dominant group, contributed to the catastrophic termination of its national e-health infrastructure implementation.

Organisational techno-centrism of this kind can constrain national e-health technology acquisition from IeTTs in African countries. When a national inter-agency governance mechanism is not instituted as a policy foresight, such institutional behaviour can manifest.

We have demonstrated that inter-agency rivalry and related organisational techno-centrism in a recipient can stifle technology acquisition. This kind of disingenuous organisational behaviour is atypical of global technology frontiers. As stressed in Chapter 3, with these leaders, the pro-activity of their national governments is evident in the ways they steer, foster and forge their domestic e-health technology capacities. Their possessions are dependent on the institutions of constructive collaboration and cooperation among their National governmental agencies. Similar pro-activity are found wanting in most African countries. It is hard to see that without such, they can successfully foster acquisitions from IeTTs.

Key point: organisational technocentrism can constrain a recipient's national e-health technology the acquisition. .

6.3 Passive National governments

The passivity of African National governments is a manifest of a lack of pro-activity in deliberately fostering national e-health technology acquisition. Global frontiers formulate and institute appropriate policies, and they also provide enabling environmental conditions for enabling domestic innovation to thrive (Chapter 2). However, in African countries (AB, KL and PE), such exercise of National Agency is found as limited, or absent on the whole. Nonetheless, this is not always the case with these countries. There are instances identified to demonstrate that African national governments are indeed capable of exercising such National Agency.

An acquisition of a hi-tech Satcom technology by KL through an institution of bilateral south-south cooperation with an emerging global East economic giant is an example. Another is the proactive behaviour exhibited by PE's National government in the process of being a recipient of an S-S IeTT (national implementation evaluation report [48] and an interview with the country's advisor on national telemedicine implementation [89]).

PE's National telecom regulatory agency and its Ministry of Health financed the implementation of the transferred e-health technologies in its hospitals and clinics, in the face of a documented uncertainty. An institution of bilateral S-S cooperation with a different emerging global East economic giant, prior to the conduct of the said transfer, is identified as instrumental for it becoming an early privileged recipient above what seemed to be other more suitable candidates in Africa. Nonetheless its National government pro-activity made it become a recipient of valuable telecommunication and computing technologies.

These two examples of exercising National Agency are however few and far in between in Africa. There are other contrary examples that buck this trend. These make us to unequivocally state that passivity on the part of African National governments stifles national e-health technology acquisition. For example, the Satcom technology acquired by KL soon became dysfunctional, a few months after it was put into orbit. As a consequence, its national telemedicine infrastructure that technology supplied bandwidth for also became defunct. Admirably in PE, domestically invented low-capital telemedicine software later became an appropriate replacement for the documented unreliable transferred one.

A manifestation of National reticence also extends to limited advocacy with relevant global bodies responsible formulating for international e-health related governance such as the World Health Organisation (WHO), International Telecommunication Union (ITU) and International Standard Organisation (ISO). This claim is backed by direct participation in technical engagements with these organisations during the course of this research study. A shocking discovery, that African countries were excluded from an European body led global e-health telecommunication standard-setting process, was made at a conference organised by the International Society for Telemedicine and E-health in 2007 (Appendix A).

Another discovery made from a conference organised by the Institution of Engineering and Technology in 2008 on biomedical technology innovation and regulation in developing countries. Following polemic debates that trailed some technical presentations on two African countries, that revealed they were not structurally and strategically positioned to advocate for their 'national-interests' in a global system. It was highlighted at the conference that there a need for creating a special governance mechanism for regulating the development of less-capital-intensive and appropriate (frugal) biomedical technologies (i.e. diagnostic medical devices). Such, much-needed for making remote diagnosis, were not of interest to these global bodies. An account of how difficult it was to get the ISO to accredit and certify a low-capital medical device, developed after a long daunting frugal engineering process, was presented as a demonstration.

There is much to be lamented about an unfavourable atmosphere of globalisation and its powerful agents. In all the examples we cited of AB, PE and KL as recipients, their exercise of National Agency was stifled by certain global corporatist and industrialist actions (Chapters 3 & 4). With PE, for instance, the withdrawal of financial and technical supports by an international donor for subnational experimentations, created an uncertain atmosphere for an expected national technology acquisition. Given that a longer term support by an international partner, can ensure that ample time was given for technology accumulation to take place, this uncertainty stifled scalability.

All in all, judging from knowledge we acquired from participating in policy debates at the Chatham House Global Health Security and Governance conferences and meetings [73], the extent to which the exercise of National Agency can have any meaningful

impact on global actions is limited. We reckon that changing or influencing global actors' behaviours, is not deemed worth pursuing as an appropriate strategy. An exercise of National Agency is advocated as paramount in the wake of technoglobalism, if domestic innovation assimilation and accumulation are to be successful, as we argued in Chapter 3. To successfully acquire technologies, an alignment of and the proper functioning of a recipient's public sector is essential and instrumental. Such is only fostered through the pro-activity of a country's National government.

Proactivity is more likely if a recipient's national innovation system is mature and capable enough for accumulating transferred e- technologies and assimilating competences. Provision of national finances, a possession of a thriving domestic private sector and the presence of certain national conditions are examples of such maturity. We identify an absence and deficiency of national e-health policies and structural weaknesses in these domestic conditions, as areas in which proactive actions of National governments can also make a difference in Africa.

Key point: how African governments can proactively engage with and influence global governance, can determine if e-health technologies are successfully acquired.

6.3.1 Deficient National e-health policy

African countries have until recently struggled to formulate and institute a National e-health policy. The few that have done so do not have an innovation strategy included in their policies. No considerable is made for fostering domestic innovation accumulation and assimilation.

In the World Health Organisation Global Observatory for eHealth 2007 report, global ranking of countries demonstrates that a country's e-health adoption progress with correlates with an institution of a national e-health policy. Not surprisingly, the countries we identified as global e-health technology leaders (Chapter 2) rank higher than any African country in this regard.

Most African countries were reported as laggards – have not instituted a national e-health policy. Out of the surveyed 39 African countries, fewer than 40% of these claimed to have in place a policy. Such a poor performance relative to global

benchmark is a demonstration of their display of National reticence. This is hardly a surprise.

Following field trips to some African countries, it was noted that most have not even formulated a national policy. Worse still, those that had were yet to implement it, for instance, by translating it into institution of e-health programmes. Generally, it was noted that almost all the countries, such as KL, PE and AB, had no policies, and none seemed to be considering including a strategy of forging domestic innovation capacity.

African national governments' reticence of not including an innovation strategy in their e-health policies by, is a pointer to why they have been historically constrained in their technology acquisitions. A similar history is noted in African countries' continued dependence on altruistic and mercantilist international biomedical technology transfers. Their reticence in failing to formulate and institute a *national health technology policy*, of an e-health kind, was identified as a barrier by a senior official of the World Health Organisation (conference organised by the Institution of Engineering and Technology (IET) [90]). Having such policy in place that takes into consideration domestic needs and capabilities, he asserted, and could have prevented them from being recipients of sub-standard and inappropriate medical devices and equipment.

The consequences of not instituting an innovation strategy, highlighted by the cases of three recipient African countries of varying economic statuses presented at this conference, were technology obsolescence and dependency. As the advocated instrumentality of a national policy is to prevent or minimise such challenges, an acquisition of engineering skills and competences for making local repairs and maintenance, couldn't have been more relevant.

In a middle-income African country, BC, lack of an innovation strategy might have hindered a nascent implementation of its national e-health initiative. This conclusion is arrived at after learning from a World Health Organisation's expert on biomedical technology in Africa at the aforementioned IET conference. In this country, almost 50% of the transferred biomedical technologies were identified as obsolete, inappropriate and impractical for utilisation, he stated. This situation was reported to be even worse in other low-income African countries with relatively weaker domestic innovation capacities.

Key point: not including an innovation strategy in their national e-health policies is a manifestation of African national governments' reticence.

6.3.2 Weak National capacities

African countries are at a disadvantage in their national e-health technology acquisition quest from IeTTs due to weakness in certain essential national capacities. Small economic size and low financial capacity are national capabilities, we identified as institutional constraints to competitively acquire technologies. AB considered in Chapter 3, brought to bear less exercise of its National Agency in the conduct of IeTTs; and as such identified as too structurally weakened to successfully acquire domestic e-health innovation capacity. The influences of these national conditions on national governments' pro-activity are thus examined.

A pointer as to how weakness in these national capacities contributes to and correlates with the display of National reticence is provided by the Global Observatory for eHealth 2007 report from the World Health Organisation (WHO). The report ranks and monitors countries worldwide on their national e-health adoption progress. It demonstrates that progress correlates with national income levels based on World Bank measures. Not surprisingly, high income countries ranked such as West European and North American countries are identified as global e-health frontiers. Conversely, most African countries ranked as low-income countries, are global technology laggards.

This suggests that a low-income country is institutionally weakened as a result of its small sized economy and low national financial capacity. Hence, in global terms will be less innovative. Moreover, these weaknesses also suggest that the capability of an African country to initiate and sustain a national e-health implementation is constrained, by virtue of the structural limitations of adapting and absorbing transferred technologies. For instance, in the way we demonstrated with AB (Chapter 3). Its passive dependence on being a mere recipient and not concurrently an innovator are hindering national e-health technology acquisition.

It is noted that countries with small economic sizes struggle to accumulate technologies. In contrast, though, high, middle-income and mineral resource-rich countries might fare better, by the virtue of their relatively stronger national financial capacities (Brundenius & Mawoko, 2010). Acquisition by the formers is hindered by such weak national conditions. Notwithstanding, their impacts on the exercise of National Agency vary.

Middle-income and mineral resource-rich African countries can be more strategically placed to acquire domestic e-health innovation capacities. Having a bigger economic size, conventionally, confers an advantage on these countries, not least because of their stronger financial capacities.

This strength is noted in BC, a middle-income African country, and KL, a mineral resource-rich one, in the conduct of two different S-S IeTTs. BC's national economic strength, as we discovered from a review of these evaluation reports [58 & 59], positioned it well, in ensuring that competences were assimilated and technologies accumulated. There are indications that the country has benefited from past and present technology transfers. An interview with an official of the country's premier health research institute at an e-health stakeholders' meeting in 2009 [72], informed us that a telemedicine equipment was jointly developed in the conduct of this IeTT, is now being utilised in its healthcare system.

KL's financial strength provided by its natural mineral resources endowment ensured a temporally successful Satcom technology acquisition. The technology was essential for providing the telecommunication infrastructure for its national telemedicine initiative (interview with an official, during a conference on e-health policy [62]). Its government exercise of National Agency was demonstrated by its determination, against all opposition, to partner with a global south giant made this feat possible.

Key point: small-sized economy and low financial strength can constrain a recipient's national e-health technology acquisition.

6.4 Poor adaptations and accumulations

Poor technology adaptations and accumulations from IeTTs are identified as accounting for African countries' immature state of national technology capacities. As demonstrated with AB in Chapter 3, these countries have historically struggled to knowledge assimilation; because over time, of their reticence to incrementally accumulate capacities from small-scale subnational experimentations. This is inevitable, because of African countries' poor exercise of National Agency, passivity of National governments and immature state extant NISs (Sections 6.2 and 6.3).

Given that such institutionalism is essential for technology adaptations and accumulations, then, it is not surprising that most struggle with their national e-health implementations.

We instructively observed from, and vividly elucidated by, the national presentations made, and from policy debates, at the 'Science with Africa' [91] and the African Network for Drugs and Diagnostic Innovation [92] conferences, both hosted by the United Nations Economic Council for Africa (UNECA) in 2010. That most African countries lack the mature regulative and normative institutions relative to global standards, required for fostering domestic e-health innovations. What was striking was that African National governments have been reticent in historically underperforming in building these institutions. Their possession of immature extant domestic innovation capacities, prior to the conduct of IeTTs, is making technology acquisitions a challenging task.

Given that as we noted with the frontiers,(Chapter 2), having in place a mature extant domestic innovation capacity is conventionally linked to an evolutionary national e-health technology implementation. Then, the uncertainty of implementations in African countries is hardly surprising. As a mature NIS, creates receptive conditions for domestically absorbing and assimilating technical competences and also for adapting and accumulating technologies. What underpins global frontier's national e-health implementations is an industrial base, which invents and produces incremental and radical domestic innovations. This puts into context African countries' perennial struggle with technology obsolescence and dependency. Most do not possess the requisite domestic innovation capacity and competence. Though, we identified National reticence as the main influence behind this state of structural immaturity, global dominance also has a role to play in it.

A review of these five evaluative reports [48, 93, 94, 95 & 96] on the conduct of N-S and S-S IeTTs in three African countries, including PE, shows the interlinking nature of these structural constraints. Technology obsolescence and dependency result from the recipients' passive reliance on transferred technical expertise finances, for effecting arising subnational technology updates and upgrades. When transferred technologies become aged and outdated, frequent malfunctioning occurs, because of incompatibility with the ever-changing and physically austere African environments. National reticence

manifests due to African governments' omission to institute a governance mechanism to both encourage the transfer and the assimilation of technical skills and knowledge. They have neglected to foster domestic entrepreneurships, i.e. encouraging local businesses and firms to either develop or upgrade acquired software and hardware as a strategic response to, for example encountered technology inappropriateness, such as documented in these evaluation reports [93 & 96].

The immature state of extant domestic innovation capacity to carry out local adaptations to transferred e-health technologies was identified in the case of KL. Mobile vehicular telemedicine units, procured for its national e-health initiative, malfunctioned and were abandoned because they could not be locally repaired (interview of a foreign consultant working on the implementation [72]). This domestic institutional deficiency is noted in most African countries. It explains uncertainty surrounding accumulations and assimilations from subnational experimentations in the conduct of IeTTs. As such we reckon that sustainable national technology acquisitions are remotely unlikely, if transferred technologies are not durably utilised and adapted for long-term experimental and experiential learning to occur and deepen.

Key point: recipients' immature extant domestic innovation capacity leads to poor technology adaptations and accumulations.

6.5 Low subnational utilisations

We explain the dynamics of a recipient's poor state of domestic adaptation and accumulation of transferred e-health technologies by their low subnational technology utilisation and weak domestic industrial capacity. We note that low voluminous subnational technology utilisation in African countries creates a situation where incremental accumulations stagnate, thus frustrating long-term technology acquisition.

Two recipient African countries, one a middle-income country, BC, the other low-income, CE, demonstrate how the two factors hinder assimilation and accumulation.

Table 6.1 summarises domestic e-health technology developments in two recipient African countries

Country	**Domestic E-health technology developments**
BC	BC as a middle-income country, had formulated a national telemedicine policy almost two decades ago, and very recently

	became the recipient of a bilateral S-S IeTT. The transfer involved the joint design and manufacturing of a low-capital telemedicine device appropriate for rural and primary healthcare service delivery. The device is for remote and rural digital healthcare delivery in this country.
CE	CE, in contrast, is a low-income country, with no national e-health policy in place, but has articulated a national vision for e-health. CE also was a recipient of an N-S IeTT, which involved the unilateral domestic long-term development of a low-capital electronic health compliant biomedical-computing device, over a period of ten years, by global actors.

The two IeTTs conducted in these recipients, share a similar focus on developing frugal e-health technologies. However, the similarity stops here. With BC, the invention of an e-health device was conducted on an equal partnership basis with global actors, through a fostering of an international bilateral institutional arrangement. This is a typical exercise of its National Agency. Conversely, with CE, such exercise was not apparent. Device development was unilaterally carried out by global actors. A plausible association between national economic strength and variation of national e-health technology acquisitions is demonstrated by BC being a middle-income country and CE a low-income one.

This section is divided into three sub-sections. The first describes how low subnational utilisations, stemming from poor adoption, contribute to the challenge of technology inappropriateness. The second describes how user-generated clinical and technical data and collected during co-developments of appropriate e-health devices with global actors, can create a vicious national cycle. The third describes how a feedback loop that joins together subnational, national and global innovation systems has to be in place for a domestic incremental accumulation and assimilation to occur.

6.5.1 Technology inappropriateness

The challenge of technology inappropriateness arises from poor adoption within recipients' national healthcare systems. This is found to be common to most African countries; for instance, as associated with low subnational utilisation in AB (Chapter 3),

A review of five evaluation reports of transferred e-health technologies adoption of in four African countries [48, 93, 94, 95 & 96], substantiates this association. Inappropriateness defined as a lack of fitness of transferred devices and equipments to recipients' environments, and to local users' preferences, was associated with a decrease in utilisation. A consequence of this challenge was that doctors, nurses, community health workers as users, working within their national healthcare systems at hospitals, clinics and health centres, poorly utilise them.

A conduct of an S-S IeTT in PE, illustrate the nature of the technology inappropriateness, and a vicious cycle that arises as a result. It manifested as reported technical dysfunctions and telecom infrastructural deficiencies at its implementing hospitals. Typical documented causes were frequent malfunctioning of transferred telemedicine devices exemplified by incompatible videoconferencing cameras and computers and poorly designed and complex software. The risks that these technological constraints posed for continuous clinical working and engaged user-experiences eventually led to their poor utilisation.

The fewer user- generated data that resulted from these poor utilisations, eventually led to the abandonment of the e-health technologies, a negative outcome that is commonly reported in the conduct of IeTTs in most African countries. A persistent scenario is that poor utilisation constrains local technology adaptation. Primarily, fewer user-generated data limit forging domestic designs and solutions. Secondarily, local technology adaptations are impossible to undertake, because these are usually undertaken by cosmopolitans, who are heavily over-reliant on global industry and expertise. For example, in PE, there are documented instances when malfunctioned and defective devices were sent abroad by them for much needed repairs and maintenances. There are two partial causes as to why an incremental domestic e-health innovation accumulation and assimilation is uncertain in the recipients. One is partly due to low utilisation and as a consequence fewer user-generated technical and clinical data. Two, partly, because of frequent overreliance on distant global value-chain. This sequence of actions thus creates a vicious cycle.

Two types of vicious cycles are identified.

The first cycle is the one that occurs at a recipient's health system in hospitals and clinics. Poor subnational technology utilisations resulted in fewer user-generated data

that are suitable and needed for forging domestic technology adaptations. As a consequence, no critical mass needed to foster an incremental national accumulation.

The second is when a long history of low subnational utilisations snowballs into a larger national vicious cycle. The nature of this cycle is identified with the still passive globally dependent AB (Chapter 3). Thus, a unilateral employment by the global industry of the fewer generated data, for producing upgraded technologies for international markets (reverse innovation), creates a situation where technology inappropriateness challenges, are not being addressed domestically in the recipients. In the process, limited domestic accumulation of technologies and assimilation of competence have occurred. AB had no semblance of a domestic e-health innovation capacity, at the time of a research visit in 2011 [2], in spite of being a long-standing recipient of numerous IeTTs in the last three decades.

Key point: low sub-national technology utilisation stifles incremental domestic innovation capacity accumulations.

6.5.2 National vicious cycle

The creation and persistence of a national vicious cycle is identified if no feedback loop is created to reintroduce appropriate e-health technologies for further utilisations. Why a series of small subnational vicious cycles snowballs into a larger national one, is attributed to a loose coupling between a global innovation system and a recipient's domestic equivalent. This implies that a feedback loop is missing between global industrial centres and African countries' immature extant national innovation systems.

We obtained two insights from a conference organised by the Institution of Engineering and Technology (IET) on biomedical technology innovations in developing countries in 2008 [90]. This helps to explain the plausible causes of a national vicious cycle and to identify why no such feedback loop is in existence in most African countries. Several papers, presentations and discussions at the conference on frugal and appropriate medical devices innovations were insightful.

The first insight is industrial in nature. Only limited technology adaptations actually take place domestically in recipient African countries. Most of the real innovation activities such as R&D and manufacturing that contribute to domestic assimilation and accumulation occurred outside the recipients' national technology system. These were being carried out at various global centres by global academia, engineers, designers,

companies and investors. This is despite the fact that the presented devices were reverse innovated on domestic user-generated clinical and technical data. As a consequence, this leads to a lesser domestic accumulation of e-health technologies.

The second insight is institutional in nature. There is a little possibility of any reversed innovated device finding its way back to the local hospitals where they were initially conceived. Experts at the aforementioned conference cited a cosmopolitan indifference to local and mass-production. It is difficult to see how domestic accumulations and assimilations can occur in this global dominant atmosphere.

The two insights: industrial and institutional in nature, can account for the persistence of both types of vicious cycles. As these were not noted with the global e-health frontiers we examined in Chapter 2. These deficiencies are not found to constrain their domestic acquisitions in the conduct of IeTTs; for instance, as in the case of a technology transfer conducted between South Korea and the European Union. A tightly coupled feedback loop exists that acts as a 'conveyor belt' between them, as both geographically separate regions share similar industrial and institutional configurations. Thus, a fostering of a mutual interchange of technologies and competences occurred. In contrast, such existence is difficult to find in most of the African countries we visited. There is no mechanism to act as a 'conveyor belt' between global industrial centres and their immature extant national innovation systems. A vicious cycle makes a recipient passively dependent on cosmopolitanism for solving the frequently encountered challenge of technology inappropriateness.

Key point: creation and persistence of a national vicious cycle can stifle an incremental domestic accumulation of technologies and assimilation of competences and knowledge.

6.5.3 Absent feedback loop

The instrumentality of a feedback loop linking together subnational, national and global innovation systems is to foster a domestic incremental accumulation and assimilation from IeTTs. The existence of a *feedback loop* might facilitate a continuous adoption and utilisation of reverse innovated appropriate devices into Africa's healthcare units. Further usage of the appropriate devices might create a mechanism for a continuous domestic innovation capacity acquisition from global innovation systems.

Conversely, when such a loop is not in existence, i.e. when re-introductions into Africa's immature national innovations systems stall or cease, a vicious cycle persists. A vicious cycle could become a virtuous one only if a tightly coupled feedback loop exists – so that national and global innovation systems are mutually exchanging technologies and knowledge. Two different conducts of IeTTs demonstrate variation of instrumentality of a feedback loop in two African countries: BC and CE. A comparison between the two indicates that a long history of participating in technology transfers might be a key to instituting a virtuous cycle that might address the challenge of low subnational utilisations. Both show a varying mutual interchange of technologies and competences between domestic and global innovation systems in the process of addressing technology inappropriateness. A review of these evaluation reports [58, 59 97, 98, 99, 100 & 101] ascertains and differentiates the instrumentality of a feedback loop in the two separate technology co-development processes in the two countries.

The loop in each process creates a mechanism in the life cycle of the development, during which subnational and global innovation systems are constantly engaged in a mutual exchange of knowledge. The prototypes of devices being developed were regularly improved upon by user-generated clinical and technical data and by global engineering and manufacturing. At the same time, each device was being concomitantly re-introduced back to the hospitals where the data were collected for usage. The re-introduction commences a sequence of actions that repeats itself within the loop, during the life cycles. Each step of this sequence was marked by contestations and negotiations between subnational and global systems and by complex, localised technoscientific processes.

A combination of an inquisitive problem-solving approach with frugal engineering practices and entrepreneurial spirits, eventually produced devices that were evaluated as appropriate and fit for the users and to their local environments. Take this lifecycle as a mini virtuous cycle at the subnational innovation system that addressed the challenges of inappropriate e-health devices. A concentration and convergence of mini virtuous cycles over a long time coalesce to form a larger national virtuous cycle. In CE, the feedback loop only existed in such a mini cycle – between a single and smaller subnational innovation system and a bigger multifaceted global one.

In BC, however, a bigger, national virtuous cycle was already in place due to its relatively matured domestic technology system tightly coupled to the global one, prior to the moment that this particular IeTT was conducted. A big cycle had emerged after a longer preceding history of accumulating mini virtuous cycles, by going though series of many subnational sequences actions. Since the formulation of a national telemedicine policy in late 1990s, BC has undertaken a series of domestic invention and production of e-health (biomedical) devices in collaboration with international partners mostly from Europe. According to discoveries made in these reports [102, 103, 104 & 105] that documented this series of domestic technoscientific actions, these came after a first an unsuccessful attempt at a national e-health implementation, was bedevilled by a catalogue of technology inappropriateness. Over time, and before this invention in focus started (close to a decade afterwards), BC had already accumulated adequate knowledge to domestically develop e-health devices from a series of mutual exchanges with global innovation system.

This extant possession of a domestic e-health innovation capacity ensured that an e-health device was already being domestically developed, before the commencement of the conduct of IeTT in focus. This indicates that its invention was a product of a sequence of domestic actions. We discovered that an incremental longitudinal innovation pathway exists involving an accumulated of mobilising a series of low subnational user- generated clinical and technical data. This comes on the back of a sequence of domestic actions accumulating from a series of previous mini virtuous cycles, created a large virtuous cycle. A long established three-way interaction among subnational, national and global innovation systems had ensured that such a longitudinal pathway came out of a concentration of domestic-led technology experimentations. This ensured that low utilisation was no longer a challenge to bother with; because BC's domestic competence had incrementally accumulated, sufficient to invent an e-health device. This accumulation of competence and knowledge accounts for a structural variation between BC and CE.

An accumulation of previous mini virtuous cycles was not evident in CE. From reviewing these implementation vision documents [106 & 107], it is hard to find a feedback loop between a long established three-level innovation interactions and the domestic development of the device in focus. Any evidence of any domestic invention is limited to this one-off case of a global dominated project, documented in these reports

[97, 98, 99, 100 & 101]. From a national presentation made at a Commonwealth Secretariat's workshop on national e-health policy formulation [71], no other reference was made to domestic development of e-health devices, except this particular one.

The possession of an extant domestic e-health innovation capacity, acquired from a history of subnational accumulations in BC, ensured that in the process of inventing the e-health device in focus, a mutual exchange of knowledge with the global innovation system was evident during the conduct of the IeTT. This is not evident in CE's process. There, the whole process of the device's invention was dominated by global actors and industry and utilised very limited inputs from domestic ones. Without any identified history of an incremental technology acquisition from a concentration of subnational accumulations, it will be near impossible to find domestic actors and industry in CE that can make such inputs. A longitudinal and concentrated accumulation and assimilation underpinned by a history of technology utilisations, albeit low in volume, is necessary for such acquisition.

Key point: a domestic e-health innovation capacity acquisition can only be attained after a long history of participating in various IeTTs.

6.6 Absent domestic industrial capacity

The absence and immaturity of African countries' domestic industrial capacities is hindering national e-health technology the acquisition. Industry in the forms of local firms involved in e-health technology design and manufacturing, and local businesses engaged in entrepreneurship and commercialisation, are identified as immature, and in some cases absent in most recipients. Demonstrations of how the presence or absence of a domestic industrial capacity can drive and make certain technology accumulation and knowledge assimilation by comparing two African countries: BC and CE.

The facilitating roles of domestic public and private sectors play in the building of a domestic e-health industry capacity are demonstrated with these contrasts. To show how BC has been more successful in its technology acquisition, and how CE has been less so.

The ensuing narratives are divided into three sections.

The first demonstrates that public sector investments into a domestic e-health industrial capacity can contribute to a desired accumulation and assimilation. The second

demonstrates that domestic entrepreneurship by local private sector can also contribute to acquisition. The third demonstrates a need for including a domestic innovation strategy in national e-health policy.

6.6.1 Low public sector investments

The facilitating roles that national public agencies can play in the acquisition of a domestic e-health industry are demonstrated by comparing BC and CE together. Public sector investments in the form of financing, leading and participating in research and development (R&D), are identified as facilitators.

With BC, its public agencies, such as Ministries of Health, Science and Technology, Information and Communication Technologies, and its premier medical research and national science and industrial development institute, were actively involved in the said e-health innovation process (evaluation reports [58 & 59] and an interview with the manager-in-charge of the transfer process at this meeting in 2009 [72]).

The national agencies provided finances towards the development of the said telemedicine device. In addition, BC's national standard setting and certification agencies were at hand to ensure that the co-invented device conforms to local environmental realities and needs. Its premier medical research institute has a good record of fostering domestic e-health technosciences with local and foreign universities and research centres and domestic private and public sectors. This is informed by the author's prior research collaboration on e-health software design in Africa[20] with some of its senior staff. Moreover, a research visit to one of BC's premier universities to observe on-going work on the invention of a different telemedicine device indicates the emergence of a domestic e-health R&D capacity. With such a capacity for research development and management, the medical research institute was able to lead the co-development in the conduct of the IeTT. Not only that, it also contributed technical expertise to the domestic R&D that took place with the international partner within the local hospitals, where the device was tested.

In contrast, the co-development process that took place in CE was not subjected to the same kind of governmental governance and scrutiny, as reviewing these evaluation

[20] An example was invitation to a week-long Open MRS workshop in Cape Town, South Africa in 2007 to deliberate on fostering innovations in e-health software for building large-scale electronic health record (EHR) infrastructures [108].

reports [97, 98, 99, 100 & 101], suggests. There is no mention made of its National government making any financial contribution to the device's invention. Most of the R&D that led to the invention of the device was carried out by researchers from foreign universities and there is no indication that BC's local universities participated in or made any contribution to the process. Any hint of a contribution was not documented in the reports.

An involvement of CE's Ministry of Health was only apparent when the device was available for subsequent technology adaptations. The use of its local public and private clinics for product testing was a documented involvement, though. Rather, the dominance of global actors such as IGOs, iNGOs and IDOs, in terms of their financial and technical expertise contributions to the device's development, demonstrates the relative passivity of CE's national agencies. Such global dominance is also apparent in the protracted implementation of its national e-health initiative, as we discovered from these documentations [100, 106 & 107]. Investments into domestic R&D and governance from BC's public sector which facilitated the co-development, were found wanting in CE.

We demonstrated with BC that participating in an IeTT on an equal basis by making co-investments is an example of an exercise of National Agency. Any competence acquired in the process could make the difference in carrying out future technology adaptations. For example, learning from domestic invention and production of an e-health device, could make the carrying out of local repairs and maintenance possible. The financial and technological resources that BC's extant domestic e-health industry offers, might have made entering into a mutually beneficial bilateral international cooperation easier than what happened for a country such as CE.

Key point: possessing an extant domestic industrial capacity can contribute to a recipient's national e-health technology acquisition.

6.6.2 Weak private sector entrepreneurships

Weak private sector entrepreneurship is identified as a barrier to domestic e-health innovation capacity acquisition. The energy and inventiveness that a country's private sector brings to a country's e-health industry, has already been mentioned with regard to global e-health leaders in Chapter 2. BC's thriving private sector entrepreneurship is found to be influential in enabling it to assimilate e-health competences and technical

knowledge. Prior to the conduct of this immediate technology transfer, its private sector had already made noticeable contributions to its domestic e-health industrial capacity. This finding is backed by observations made and discussions during multiple research visits to this country in the last four years.

During participations in different technical workshops, such as [72 & 108] and high-level ministerial policy meetings [109], a far reaching knowledge of ongoing domestic inventions and commercialisations of e-health technologies such as hardware, software and telecom architecture were obtained. Also from informal discussions with start-ups, entrepreneurs and companies in these meetings and elsewhere in the country, it was learnt that the state of e-health innovation and entrepreneurship in the country was up and coming. For example, an interview with an m-health entrepreneur at an annual gathering of major players in Africa's telecom landscape [110] revealed a decade long history of a domestic innovation that underpinned the invention of an e-health device. He described how in the early 2000s, he started working on inventing a mobile medication adherence device, before the advent of Smartphones.

The invented device, now being offered on the global market is also in use in BC's home market, was commercialised through the mobilisation of financial resources from local venture capitalists. Moreover, the device is being manufactured domestically by a local firm. The device company, is not only selling the devices globally, but is also rendering remote virtual e-health monitoring services to clients all over the world. This is a measure of what we learnt of other local firms' activities from the aforementioned meetings.

It is this kind of private sector driven innovation and entrepreneurship that constitutes and drives BC's industrial capacity. Its domestic companies invent, commercialise and manufacture, even, prior to the said IeTT's conduct. We noted that its National government finance and institute R&D in local universities, and invest into human resources development in the process. Such was the strength of BC's domestic industry and market, that a multinational company that co-invented the e-health device in focus, has established a subsidiary private firm in the country to start offering products and services (information gained at an interview with a key informant at an e-health stakeholders' meeting in 2010 [72]).

It can generally be said that BC's private sector's contributions are more than the design, manufacturing and commercialisation of e-health services and products. We have also learnt of emerging local consultancy firms that are providing technical expertise for e-health innovations and entrepreneurships. In addition, we discovered that financial supports by local foundations, venture capitalists and businesses are available for fostering domestic innovations. All these national endowments were in place and would in no small means have facilitated the technology acquisitions.

In the case of CE, the influence of its domestic private sector was found missing. BC's extant industrial capacity is found to be far more established and matured than CE's, an advantage that might provide a more suitable condition for acquiring technologies from the IeTTs.

Such endowments are not identified with CE. As far as can be inferred from a review of its national e-health vision documents [98, 99, 100 & 101], there is no mention made of any local private sector consultations or contributions to its national e-health implementation. The kind of entrepreneurial drive that we have identified with BC is not apparent. Rather, there is a reason to argue that CE's private sector is relatively weaker. For example, one of the aforementioned reports documented a global capitalist competition battle, between an Asian company and a North American one, battling to supply technologies for a proposed national e-health implementation. In a review of the evaluation reports [97, 98, 99, 100 & 101] that chronicled the development of an e-health device during a conduct of an N-S IeTT, there was no mention of any contribution made by its domestic private sector. Though it was a domestic invention by a locally registered company, the finances and the technical expertise that underpinned it, came largely from the benevolence of global altruism and diplomacy.

The poor state of CE's domestic e-health industry is also underscored by the fact that sourcing qualified and technically competent human resources from the domestic market is documented as a challenge during the said device's development.

Key point: possessing an extant domestic e-health industrial capacity and private sector entrepreneurship is instrumental for a recipient's national e-health technology acquisition.

6.6.3 Lack of domestic innovation strategy

The case for including an innovation strategy in a national e-health policy in African countries is identified as important, judged by comparing the likely adoption rate of the invented devices in BC and CE. Though, the different devices have not been widely deployed within their health systems; however, the reported uptake within BC's health system is far more than in CE's. There is reason to predict that in the near future, the telemedicine device will be far adopted in BC.

An informal discussion with a staff member of the aforementioned national premier research institute in BC at the Royal Society of Medicine eHealth & Telemedicine annual conference in 2011, suggests such a possibility. Another reason is that BC has just formulated a new national e-health policy, released in 2012, which showed inputs from its domestic private sector (knowledge acquired from contributing to the process that led to the policy's formulation, and through participation in different stakeholder meetings in the country, for example at [72]). After a prior dependence on IeTTs that partly contributed to an earlier setback to build a national e-health infrastructure, the new policy prioritises e-health hardware and software adoption as a strategic focus. It also recognises the imperative of instituting domestic technology certification and standards.

With CE, the possibility of a similar national scale-up is quite remote (judging from observations made at a national e-health policy workshop, organised by the Commonwealth Secretariat in 2011 [71]). At that time, it had no national e-health policy in the mould of BC's in place. A presentation made on its national e-health implementation did not give a good impression of progress. The high costs of e-health hardware were pointed out as a challenge, among other constraints that were mentioned. Evidence to corroborate a lack of affordability (documented in the national e-health vision document [106] and an evaluation report of a national pilot [107]), is similar to the one we identified with AB in Chapter 3. A reported lack of adequate national finance to support the procurement of equipment and devices (possibly from the company that invented the device in focus) and their installation, limited a planned national scale-up to just 2% of CE's health facilities. An interview with its Ministry of Health official at the aforementioned workshop [71], did not give encouraging pointers to the device's future prospect of a national scale-up.

CE's weak financial and industrial capacities mean that adoption rate will be relatively poorer than in BC. The latter's private sector can contribute financial and technological resources towards the implementation of a national e-health initiative. Having what is close to an innovation strategy included in its national e-health policy, points to an exercise of its National Agency.

Key point: having an innovation strategy included in a national e-health policy can foster national technology acquisition.

6.7 Conclusion

The main conclusion drawn from this narrative is that National reticence is identified as a structural constraint to a recipient's national e-health technology acquisition. We strongly identified three institutional barriers as manifestations of National reticence. The first barrier is a lack of the exercise of national agency in the conduct of IeTTs. Uncooperative organisational behaviour within recipients' public sectors is identified as an institutional constraint. There are two factors we identified as the reasons behind this behaviour. These are at the sectoral level: inter-agency rivalry and organisational techno-centrism.

The second barrier is that African National governments' passivity in the conduct of IeTTs is also matched by a lack of pro-activity in influencing global technology governance. Absent national e-health policies, weaknesses in national economies and low financial capacities are constraints to national e-health technology acquisition.

The third barrier is that poor domestic technology adaptations and accumulations, which arise from low subnational utilisations and absent or immature domestic industrial capacity, account for poor national technology acquisition. Low subnational utilisations caused by technology inappropriateness, create a national vicious cycle, which constrains the accumulation of technologies and assimilation of knowledge.

A need for a feedback loop that tightly coupled together subnational, national and global innovation systems is noted as instrumental in making a vicious cycle of innovation failures to a virtuous one.

Table 6.2 summarises institutional constraints

Narrative themes	Institutional constraints

Inter-agency rivalry	Domestic inter-organisational rivalry can constrain a recipient's national e-health technology acquisition.
Organisational techno-centrism	Organisational technocentrism can constrain a recipient's national e-health technology the acquisition.
Passive national governments	How African governments can proactively engage with and influence global governance, can determine if e-health technologies are successfully acquired.
Deficient national policy	Not including an innovation strategy in their national e-health policies is a manifestation of African national governments' reticence.
Weak national capacities	Small-sized economy and low financial strength can constrain a recipient's national e-health technology acquisition.
Poor domestic adaptations and accumulations	Recipients' immature extant domestic innovation capacity leads to poor technology adaptations and accumulations.
Technology inappropriateness	Low sub-national technology utilisation stifles incremental domestic innovation capacity accumulations.
National vicious cycle	Creation and persistence of a national vicious cycle can stifle an incremental domestic accumulation of technologies and assimilation of competences and knowledge.
Absent feedback loop	A domestic e-health innovation capacity acquisition can only be attained after a long history of participating in various IeTTs.
Low public sector investments	Possessing an extant domestic industrial capacity can contribute to a recipient's national e-health technology acquisition.
Weak private sector entrepreneurships	Possessing an extant domestic e-health industrial capacity and fostering private sector entrepreneurship is instrumental for a recipient's national e-health technology acquisition.
Lack of domestic innovation strategy	Having an innovation strategy included in a national e-health policy can foster national technology acquisition.

The absence of domestic e-health industrial capacities in African countries, associated with low public sector investments, weak private sector entrepreneurships and lack of an innovation strategy in their national e-health policies, is also noted.

The main conclusion that we draw from these findings is that a recipient's immature national innovation systems cannot on a large-scale accumulate and assimilate from IeTTs.

7 Discussion and Conclusion

7.1 Introduction

We have examined and demonstrated the economics and sociology of e-health innovation. The conduct of international e-health technology transfers (IeTTs) is necessary for national e-health technology acquisition in African countries. In this thesis, we have identified and demonstrated that certain institutional factors can either constrain or condition domestic acquisition. The identified constraints can nevertheless be employed to understand how such acquisition can be fostered in African countries. To achieve this will require an understanding of how the different institutional forms and identities of the involved multiple actors and organisations at global, continental and national levels can be harnessed and managed for success.

We have employed a pragmatic and pluralistic combination of moderate and middle-range Science and Technology Studies (STS), and NIS institutionalism theories and Deleuzian poststructuralist narrative method to study e-health at the interface of health informatics and global development. To identify and demonstrate that the institutional structures of global technoeconomic interactions, can constrain or condition the national e-health technology acquisition. We inquire how e-health technologies diffuse trans-nationally in the context of globalisation at a macro-societal/institutional level as opposed to the micro-individual one preferred in conservative health informatics studies. The combination is employed to organise and order messy, complex large qualitative data collected from different and diverse sources over the last four years. The thesis is unique, as we have yet to identify any other study on the conduct of IeTT or in health informatics that has this unique combination.

Existing studies in the policy contexts of health techno-globalism and international development on the transfers of e-health, ICT and biomedical technologies, are lacking in depth, scope and scale that we have achieved with theoretical and methodical pragmatism and pluralism. Typically and conservatively, previous work from health informatics on national e-health implementations and ICT4D (Chapters 1 & 2) on the conduct of e-health technology transfers have commonly taken an *information society*, action-oriented, micro-level and managerial approach. The conducts of Global Health

and STI (Chapter 2) have typically and conservatively neglected agential asymmetry, politics and power in the conduct of biomedical technology transfers.

As opposed to the traditional *information*-based approach to study national and trans-national implementation of e-health technologies, we found that a Schumpeterian industrial model of technology development and utilisation is relevant. We contend that in the current cosmopolitan conduct of IeTTs and in its associated Global Health and ICT4D policy, technology development and utilisation, is Schumacher and consumerist in orientation. Instead of a cosmopolitan agency in the Global, a national one is presented as an alternative is recommended for consideration in global and national policy.

7.2 Narrative themes

The narrative themes we have identified in Chapters 3, 4, 5 and 6 are summarised in a cyclical, actor network theory (ANT) - like interaction in Figure 7.1. We identified four structural mechanisms that manifest as institutional structures in globalised complex and contested interactions among constitutive actors and organisations (Figure 7.1). As opposed to cyclical interaction typical of analysis of organisational, micro-individual analysis in health informatics, i.e. (Sunyoung Cho, et al., 2008; Davidson & Chiasson, 2005; T Greenhalgh & Stones, 2010), a concept of *Symmetry* from middle-range STS constructivism articulated in (Chapter 2) is employed.

In a globalised development and utilisation of e-health technologies, Symmetry as opposed to ANT's equality of agency of humans and technologies in horizontal sociotechnical interactions (F.W. Geels, 2004; Roberts, 2012; Wyatt & Balmer, 2007), is observed. In ANT, Symmetry occurs in flat, horizontal and circumscribed interactions. For instance, in the way that Cerny, 2000 and Fritsch, 2011, pp. 37-38 took for granted national agential asymmetry in globalisation, in that they ascribed symmetry of agency to state and non-state actors. Whereas, ours represents that institutional interactions are not only symmetrical but also both vertically hierarchical and horizontally diffuse. This is unlike a core-periphery orientation of technology dependent relationships between producing technology leaders and receiving laggards, implied in ITTs literature (Christol, 1974; Colino, 1968; Contractor & Sagafi-Nejad, 1981; Habib-Sy, 1992; Häusler & Simonis, 1985; James, 2002; Reddy & Zhao, 1990; Ya'u, 2005).

The sociology of the complex interactions in conduct of IeTTs occurs in a complex network of diverse geographies, technologies, institutional power and knowledge bases. These, historically evolve in a dynamic network of actors, institutions and technologies of temporal and geographical dimensions. Hence, the institutional structures constraining and conditioning domestic innovation learning, that manifested in complex vertical and horizontal interactions of subnational, national, continental and global levels.

Thus, we gave evenness to the influences of the structural constraints or conditions on lack of domestic e-health acquisition from IeTTs in African countries. In addition to demonstrate that the institutional structures manifest in complex and contested interactions of technoglobalism.

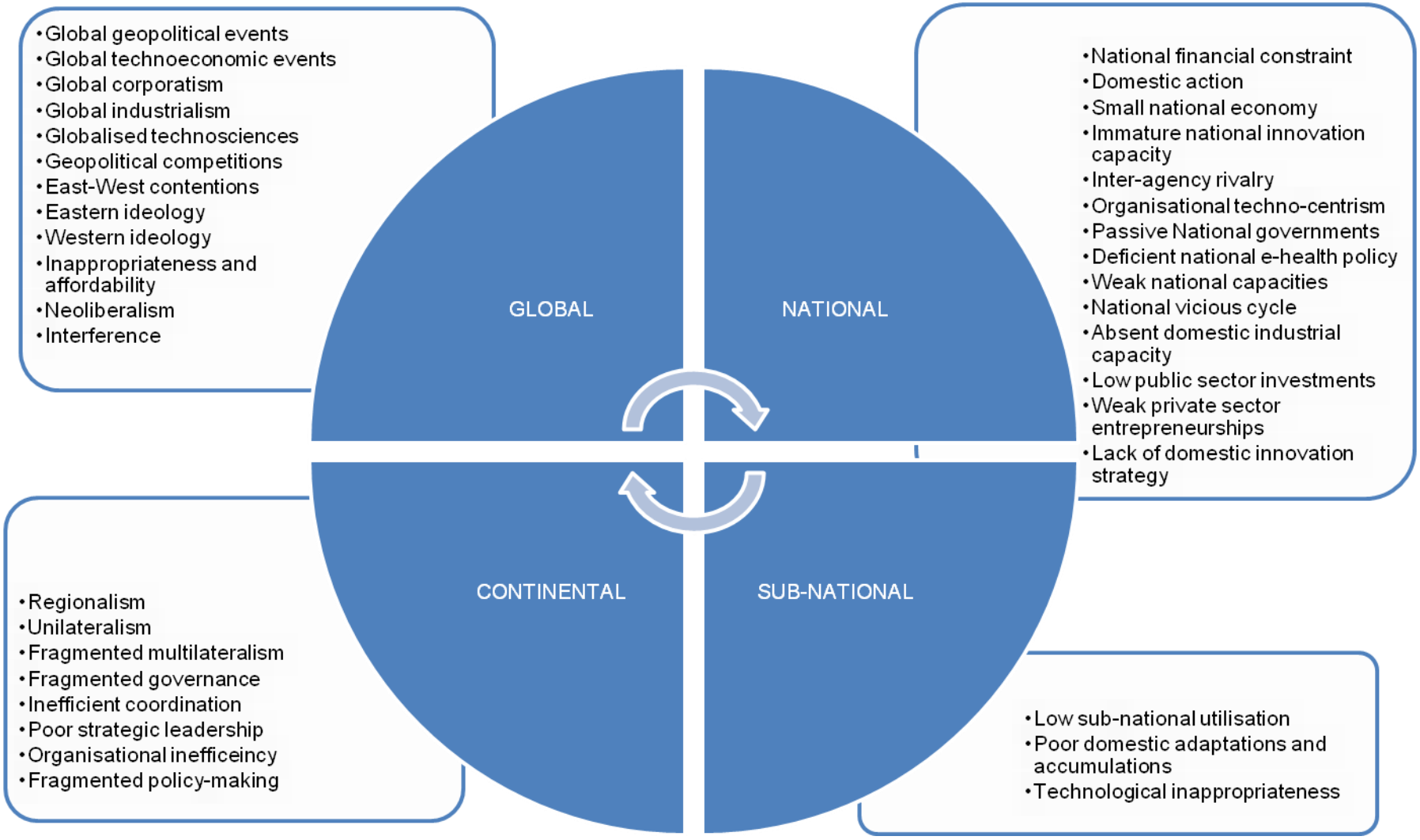

Figure 7.1 Narrative themes

The key narratives from the chapters are summarised as follows.

1. Chapter 3 showed that there exists a technological path-dependency between an African country's ability in implementing its national e-health initiative and the preceding history of struggling to acquire domestic e-health technologies from IeTTs. It also identifies global technoeconomic and geopolitical events and institutional structures of global corporatism and industrialism in this history of uncertainty. However, a lack of the exercise of National Agency is identified and demonstrated to be behind the country's present poor and globalised (there are many international actors and organisations involved in the implementation) state of e-health implementation.
2. Chapter 4 showed that global geopolitics is manifested in East-West contention, which can work to constrain the acquisition of national e-health technology capacity from IeTTs in Africa. The contention is characterised by corporatism, mercantilism, industrialism and technology neoliberalism, and may make challenging for the recipients the transfers of affordable and appropriate e-health technologies from global markets.
3. Chapter 5 showed that fragmentation of governance mechanisms at the continental level in Africa can work to constrain the acquisition of national e-health technology capacity from IeTTs in Africa. Regionalism and breakdown in continental multilateral arrangements can lead recipient countries to take unilateral decisions, which might make acquisition from e-health technology transfers uneven across the board.
4. Chapter 6 showed that domestic actions taken by National governments can work either to constrain or to enable the acquisition of national e-health capacity from IeTTs. Actions taken by both domestic public and private sectors in recipient countries can either enable or constrain the accumulation of e-health technologies and the assimilation of technical knowledge and competence from e-health technology transfers.

The concept of Symmetry is further elaborated upon later in this Chapter. First, we examine the interconnectedness of the effects of institutional structures at global, continental, national and subnational levels on the exercise of National Agency.

By applying theoretical pragmatism and pluralism to the research objectives, we have found that the transfers of e-health technologies in Africa in the context of globalisation occur in a dual/dichotomous (vertical and horizontal) complex and contested interactions. The first is hierarchical in nature – a vertical interaction exists among constitutive actors and organisations at global, continental, national and subnational levels.

The second is that a horizontal relationship exists among institutional forms and identities of the involved diverse actors and organisations. The interactions at the horizontal are characterised by conflicting and multi-stakeholders' institutional interests of all that are involved at the different levels, which manifests in self-interested motives and agenda. Power, politics and contestations are identified in both the vertical and horizontal relationships in the interactions. Some of our findings support and also contend with those identified in the literature we presented in both Chapters 1 and 2 as regarding the general conduct of technology transfers.

We highlight in Section 7.8 novel contributions made primarily to the health informatics domain such as the role of National governments, the essential nature of domestic innovation capacity, national economic prowess and global geopolitics in the development and utilisation of e-health technologies.

7.3 Discussion

We take the technology focus adopted in the thesis for discussion as was in the narratives in Chapters 3, 4, 5 and 6 and identify a common thread that runs through the narratives, that the exercise of National Agency in the conduct of IeTTs in African countries is weak and absent in most countries we have studied. On this basis, we contend that the horizontal orientation of interaction implied by STS constructivism in the contexts of global development (Sismondo, 2010), and of techno-globalism (Fritsch, 2011). The contention stems from a counter-argument put forward by these authors (Forje, 2006; Freeman, 2002; Juma, 2010; Juma & Bell Jr, 2006; Juma, et al., 2001; Klein & Kleinman, 2002; Lall & Pietrobelli, 2005; Lundvall, 2007; Mazzucato, 2011; Muchie, 2008; Pavitt, 1998) that a country is the basic unit of technology invention and production in the age of globalisation. With all caution, we cannot see how African countries, in a medium to long time scale, can acquire domestic e-health technology capacity from IeTTs without proactive actions of their National governments. We therefore put forward that the hypothesis of *cumulative advantage* presented in Section 2.7 is applicable in *constructing* how African countries can acquire domestic e-health technology from international transfers. In short, it is to counter that 'data is not destiny' or that 'nature need not equate to nurture'. African countries can *learn* from what global technology leaders are doing.

We build on the existing work on national e-health implementation in Africa presented in Sections 1.5 and 1.6 to argue that together with the possession of a mature national innovation system (NIS), a domestic innovation capacity is also required to drive an incremental implementation. To *learn* is to know what they are doing. These countries possess mature NIS and have over a long period acquired domestic technology competences in biomedical, telecommunication and computing industries. The technologies produced by these industries are then being utilised to incrementally build their national e-health infrastructures. In addition, African countries can learn from global leaders how their National governments' and public and private sectors' investment into the three identified domestic industries are associated with their incremental national e-health implementations.

On this basis, we identify two areas to present and articulate the discussion.

1. The first is to assert that a large-scale implementation of a national e-health initiative is difficult without the possession of a domestic innovation capacity.
2. The second is to propose and present a framework to advocate collaboration and cooperation amongst the diverse actors and organisations involved in the conduct of IeTTs in Africa.

7.4 Cumulative advantage and national e-health technology capacity

We contend that, rather than passivity, the proactive exercise of National Agency of African National governments is needed to navigate and negotiate complex interactions in the conduct of IeTTs. We stress particularism in the face of the universal notion implicit in techno-globalism, that all African countries possess the requisite innovation capacities for accumulating e-health technologies from IeTTs. In doing so, we employ literature that emphasises the role of technology in national and global survival and progress. The proactive actions of African countries might help in starting to acquire domestic e-health technology capacities for implementing their national e-health initiatives. The locus of agency in most of the technology transfers studied in the thesis is at global level. The technologies are designed and manufactured in the global East and West and only utilised at the subnational levels in recipient African countries. This description represents the contested and complex nature of IeTTs in African countries, such as in AB in Chapter 3, ZP in Chapter 4, CE and PE in Chapter 6 and to a lesser extent in KL in Chapter 4 and 6. All these transfers are happening in the context of global geopolitical contentions between, and the corporatism and industrialism of, global East and West and in the absence of strong continental leadership (Chapters 3, 4 & 5).

The transferred technologies flow from the global to the subnational with minimal investment from their passive National governments (public sectors) and private sectors. Besides, the national innovation systems in these countries are immature and weak. Contrast this with a country such as BC in Chapter 6. With BC, we demonstrated that it possesses a relatively mature NIS – exemplified by the actions of its public and private sectors' financial provision, domestic R&D and manufacturing and entrepreneurship. In this case, the technologies flow from the global to the national and then to the subnational. This model of transfer was observed in the conduct of globally sponsored pan-Africa e-health initiatives, partly because of the fragmented governance at the

continental level (Chapter 4 & 5). In contrast, in the dynamics in AB and CE, the transferred e-health technologies flow from the global level straight down to the subnational level, with minimal investments from their National governments. This is not too different from the dynamics of the transfer of green technologies conducted in Tanzania, a low-income and less global technology laggard African country investigated by (Caniëls & Romijn, 2009) .

The nature and consequences of the technology transfers vary among countries. From analysing the narratives, we identified two models to make meaning of the conduct of IeTTs in Africa. The two models are reflecting the divergent principles espoused by Schumpeter and Schumacher, for example by (Kaplinsky, 2011) of how material technologies are developed for, and trans-nationally transferred to, developing countries. The two models differ, based on the 'doing it all *for* me'/ cosmopolitan approach, implicit in the conduct of IeTTs, and the national/ 'let me learn and do it myself' approach of an *industrial* e-health model. The former is attributed to Schumacher and the latter is Schumpeterian in nature. The two approaches apply to how transferred e-health technologies can be accumulated in African countries. We employ them to demonstrate how the hypothesis of *cumulative advantage* applies to recipient African countries studied in the narratives.

Table 7.1 Schumpeter versus Schumacher

Country	**BC**	**CE/AB**
Technology Transfer model	Schumpeter	Schumacher
Transfer dynamics	Global-National-Subnational	Global-National
National Economic Size	Middle-income	Low-income
National e-health model	Proto-industrial	Consumerist
Learning mode	Active	Passive

The two technology transfer models explain the divergent domestic flow of e-health technologies in the cases of BC and CE presented in Chapter 6 and AB in Chapter 3.

As noted with BC, a history of accumulating technologies from a series of domestic and transferred small-scale e-health projects is bringing the exercise of National Agency to bear. In CE, this incrementalism was not identified. Its National government, public and private sectors were not as active as BC's.

The divergence between the two countries can be explained by how Schumacher advocated that small scale intermediate technologies must be transferred to low-income countries. We explain why CE and other low-income countries such as PE, AB and ZP were recipients of a Schumacher type of IeTT. With AB in Chapter 3, we traced a history of technological path-dependency on being a recipient of environmentally inappropriate and costly transferred e-health technologies. A similar type of technological constraint was identified with ZP in Chapter 3 and PE in Chapter 6. With AB, CE and ZP, their plans to implement a national e-health initiative have yet to materialise. The *consumerist* model of national e-health technology development associated with these countries is the opposite of what we articulated and demonstrated with BC.

7.4.1 Schumpeter and African countries

In a middle-income country, BC, a proto-*industrial* model of national e-health technology implementation, close to the Schumpeterian approach of the global e-health leaders, is demonstrated. A feedback loop between largely domestically conceived subnational e-health experimentations and its national techno-science infrastructure, is demonstrated in the conduct of the IeTTs BC was involved in. KL in Chapters 3 and 6 is not a middle-income country but a mineral-resource rich country with a national financial capacity. It was therefore able to procure a satellite technology from a global East economic giant. However, an uncertainty of the technology coupled with its relatively immature NIS made its national e-health implementation to suffer a massive setback. Even so, the influences of global geopolitical contentions between the West and the East and their competing corporatist, mercantilist and industrial interests, might have partly contributed to the uncertainty. BC's national e-health technology competence is not yet in the league of the global e-health leaders. Nevertheless, its divergence from KL and the others can be explained by the former's national economic size and far more mature NIS.

The acquisition of domestic e-health technology capacity in BC follows a Schumpeterian model. What distinguishes this model from Schumacher's (from a NIS perspective) is the different mode of *learning* that BC adopts and which others have not. Leaning on (Juma et. al., 2001, p. 632, Section 2.2 and Lundvall 2007), we present the *industrial* model as active learning from IeTTs, while the learning in the *consumerist* model, associated with CE and AB, is passive.

We take the *industrial* model of global e-health leaders as active learning. It reflects the proactive role of developing countries' National governments in establishing the regulative and normative institutions essential for fostering domestic techno-science and entrepreneurship in the public and private sectors. It also shows us that capable countries actively strive to acquire e-health technology capacity from IeTTs. This model explains the *cumulative advantage* that BC has over the others. Its active learning separates it from the passive learner, AB, despite both sharing a history of being recipients of transferred technologies. It is the difference between the 'let me learn and do it' approach in BC and the 'doing it all *for* me' approach in others such as AB and also PE and CE. The proto-*industrial* model in BC is ensuring that national e-health technology capacity is being acquired by a combination of both domestic techno-sciences and accumulation from e-health technology transfers. This model ensures that, in the conduct of an IeTT, the exercise of National Agency will ensure that the flow of transferred e-health technologies does not occur only between the global and the subnational.

Active learning is what underpins the Schumpeterian national e-health model. On the other hand, passive learning has more in common with how (Kaplinsky 2011, pp. 195-196) described the Schumacher's model. That is, developing countries should be passive consumers of intermediate technologies designed and manufactured by global technology leaders, without leaving the recipients with technology choices. We contend that most African countries were presented with limited technology options in the conduct of IeTTs. They had limited influence and contributed no inputs to the design and manufacturing of transferred e-health technologies. The technologies were, in most instances, passively received, hence giving limited or no opportunity for active learning.

Consumerist AB is an archetypical recipient of transferred e-health technologies of Schumacher's model. We demonstrated that with a historical linkage between past and present of conduct of IeTTs. The lack of technology choice that this mode implies for a recipient country, such as AB, does not augur well for active learning, and hence the acquisition of national e-health technology capacity in Africa. However, we have demonstrated with BC, as a result of a relatively more mature extant NIS, that an African country can actively *learn* from being a recipient of technology transfers. This forms the basis for challenging the cosmopolitan, Schumacher's model that currently informs the conduct of IeTTs in Africa.

We contend that the Schumpeterian *industrial* model has proved itself with the global e-health leaders as a domestic platform to incrementally implement a national e-health infrastructure. African countries can *learn* from these leaders and follow BC's example. The role national techno-science plays in the development and utilisation of e-health technologies is prominently demonstrated in countries with such an *industrial* model. It is underpinned by their National governments' exercise of National Agency, rather than the passive dependence on receiving e-health technology transfers, that Schumacher, advocated.

The *consumerist* model in Africa is outdated and is out of touch with academic reasoning on the new direction for Africa's socio-economic progress, as it cannot serve its developmental needs in the age of technology globalisation, contended (Forje, 2006; Muchie, 2004; Ymele, 2011). In addition, a new policy direction on Science, Technology and Innovation from Africa's continental governmental organisations is encouraging National governments to invest more into fostering and forging domestic innovations and industries (Brundenius & Mawoko, 2010). A Schumpeterian model for national innovation and industrial capacity acquisition is now a strategic option for developing countries to adopt (Arocena & Sutz, 2003; Baskaran, 2005; Juma, 2010; Juma & Bell Jr, 2006; Muchie, 2008). Not least because other African countries can emulate South Africa, with its emerging industrial, research and financial infrastructures, on how this can be done (Kraemer-Mbula & Muchie, 2009).

Nevertheless, we acknowledge that Schumacher (Schumacher, 1972) on the production of small-scale technologies, is useful and suitable for explaining how the *cumulative advantage* hypothesis will work for the acquisition of national e-health technology capacity in Africa.

7.4.2 Schumacher meets Schumpeter

Schumacher's model can inform us how the challenges of technology inappropriateness, such as obsolescence and incompatibility to users and environment, can be addressed in the conduct of IeTTs. We employ this model to explain how national e-health technology acquisition can incrementally develop from the accumulation of small scale subnational experimentations. In this regard, we concur with Kaplinsky that *Schumacher* can meet *Schumpeter* in how domestic e-health capacity can be fostered in Africa. In particular, we subscribe to the view that the industrial model of technology

production advocated by Schumpeter, is suitably employed to incrementally innovate – for inventing and producing affordable and appropriate technologies in Schumacher's sense.

Technical knowledge and competence assimilated in the process of accumulating transferred e-health technologies, is needed for domestic production or re-inventing of appropriate technologies in recipient African countries. In the narratives, we identified that the inappropriateness of transferred e-health technologies in the countries constrained domestic accumulations (Section 6.4 with ZP and KL and Section 7.5.1 with CE). Variably, these countries did not possess the domestic innovation capacities needed to deal with technical setbacks and uncertainties when they arose. With AB, we argued that it should not depend on foreign expertise and industry to remedy the challenges of technology inappropriateness encountered at its hospitals. For example, the country was incapable of carrying out maintenance and technical repairs locally. This wouldn't have been the case, had AB's National government exercised National Agency to assimilate technical competence from previous conduct of IeTTs. The narrative on BC in Sections 7.4-7.6 informed us that such exercise by the proactive actions of its National government and public and private sectors can translate to accumulation of technologies and assimilation of competence.

With BC, we demonstrated that, if a feedback loop exists between subnational experimentations and utilisations and a country's NIS, challenges of technology inappropriateness can be addressed domestically. Such desired domestic action (or exercise of National Agency) points to how *Schumacher* can meet *Schumpeter* in the acquisition of national e-health technology capacity in recipient African countries. The *industrial* model employed by BC contributed to an incremental development of affordable and appropriate technologies in Schumacher's sense.

We advocate that an incremental accumulation of technologies and assimilation of technical competence from small scale projects can lead to the acquisition of national e-health technology capacity. De Laet & Mol, 2000, pp., 238-242, for example, demonstrated with a domestic engineering and implementation of water pump devices and infrastructure in Zimbabwe. Learning from, and accumulation of, small subnational experimentations, can eventually and incrementally snowball to make domestic invention and production of appropriate e-health technologies possible. Hence, *vicious*

cycles of setbacks and uncertainties being caused by technology inappropriateness at the subnational levels can turn to *virtuous* cycles of domestic accumulations (Chapter 6).

The Schumacher model is employed to explain how national e-health capacity can be domestically acquired from being a recipient of IeTTs. However, the model presents African countries with limited technological and institutional choices, as regarding their exercise of National Agency in fostering domestic e-health capacities. The "doing it all *for* me" approach, exemplified by (Schumacher, 1972), informed the cosmopolitan nature of the conduct of IeTTs in African countries. We identified in the narratives that the development and utilisation of e-health technologies were taking place in recipient African countries (i.e. in AB and CE (Chapter 3 & 6)), and their invention and production were carried out by global actors, who conducted their design and manufacturing outside the continent. The approach gives agency to global actors and not national actors in the design and manufacturing of e-health technologies, even though, some transfer of competence can occur. Schumacher's model inclination is that the design and manufacturing of appropriate technologies should take place outside the recipient countries (Kaplinsky 2011, p. 198, Section 2.2). This model promotes passive learning and constrains National Agency. In contrast, the Schumpeterian model that underpins national e-health technology implementation in technology frontier countries, promotes active learning.

7.5 Domestic e-health innovation

We identify with (Baskaran, 2005; Bauer, et al., 2012; Forje, 2006; Freeman, 2002; Fritsch, 2011; Juma, et al., 2001; Achim Lang, et al., 2012; Lundvall, 2007; Mazzucato, 2011; Mohan, et al., 2002; Muchie, 2008; Sharif, 2006; Ymele, 2011) that a country is the primary agent of technology development in the age of technology globalisation. The challenges encountered by AB, BC, ZP and KL with transferred inappropriate technologies, cannot be dissociated from their lack of the Schumpeterian domestic e-health innovation capacity.

BC was presented as possessing a *proto-industrial* model of national e-health technology development because the country is South Africa. It doesn't possess yet a domestic e-health innovation capacity that matches up to global e-health leaders in terms of industrial competences in computing, biomedical and telecommunication. Though, it might still be catching up with the UK and Scandinavian countries in

carrying out advanced domestic lifescience technosciences (Pavitt, 1998, pp. 801-803). However, it is the closest in Africa to these advanced countries, in terms of national economic size and domestic innovation capacity. Regarded as the most technologically advanced country in Africa (Kraemer-Mbula & Muchie, 2006, 2009), South Africa has just started thinking of putting in place a domestic e-health innovation plan (Van Dyk, et al., 2010). It doesn't yet host multinationals with competence in semiconductor innovation and manufacturing of consumer electronics such as Smartphones, as we noted with global e-health leaders. Though, it has an m-health innovation company *Cell-Life*, which came out of a triple helix partnership funded by its National government with technologies developed by its universities and research institutes. The emerging domestic e-health technology industry in South Africa (Chapter 6) lends itself to the 'let me learn and do it myself' approach that the Schumpeterian model represents.

We note that, in the age of technoglobalism, 'fortune favours the brave'. In this respect, African countries must emulate their Asian counterparts. Countries such as South Korea, Malaysia and India, hitherto identified as technology laggards, have recently and astonishingly become known as global economic giants. These and including UK, USA, Norway and Germany we identified in Chapter 2, have national research centres that carry out e-health R&D combinations and also host global technology multinationals. As entrepreneurial or developmental states, they have instituted domestic technoscience, and are encouraging and investing into their public and private sectors, by stimulating entrepreneurship and industrial capacity in the process of implementing their national e-health initiatives.

South Korea, a country that (Sachs, 2003, pp. 138-139), acknowledged as an overnight success in domestic technology invention and manufacturing, is adopting an *industrial* model to engineer an incremental implementation of its national e-health initiative. Reported progress being made in its national implementation isn't coming as a surprise, as state entrepreneurship and steerage are evidently demonstrated (Briggs, et al., 2001; Holliday & Tam, 2004; Lee, et al., 2009). Informatively, Samsung, a global multinational leader in consumer electronics, nurtured by an exercise of proactive National Agency in its infancy (Holliday & Tam, 2004, p. 761), acted a key industrial engine of domestic e-health innovation and implementation in South Korea (Briggs, et al., 2001).

Following a similar pattern of agency, Indian National government's incentives and investments have created domestic Satcom industry (Baskaran, 2005), which now supports its national telemedicine implementation (Mishra, et al., 2009). It is also evident in Japan's (Fujimoto & Miyazaki, 2000), Germany (A. Lang & Mertes, 2012; Achim Lang, et al., 2012) and US's (Johnston, et al., 2000; Spivack, 2005; Zuzek & Bhasin, 1996) national e-health implementation that its National government and domestic consumer electronic industries are in the driving seats. Malaysia (Mohan, et al., 2002), hitherto a technology laggard, initiated an ambitious and a world class e-infrastructure, partly a as platform for its national e-health implementation. South Korea's progress provides a classical example of how state entrepreneurship and steerage can transform a hitherto laggard into a global technology leader. A similar exercise of National Agency is documented in China's recent astronomical rise to become a global economic giant (Fu, Pietrobelli & Soete, 2011).

South Korea, Japan and India are noted as global rising stars in biomedical and biotechnology industries (Salter & Faulkner, 2011) and in (Macher, et al., 2007) semiconductors innovation and manufacturing.

Evidently, with these frontier countries, innovation and implementation haven't been based on the Schumacher *consumerist* model that is implied by Sachs, 2003. This comes as a surprise, even that he also acknowledged the instrumental roles of National governments and domestic public and private sectors in technology acquisition and accumulation. Even so that in the areas of biomedicine and biotechnology that shares similar technological complexity and financial intensity with e-health, African countries are being encouraged (Al-Bader, et al., 2010; Chataway, et al., 2009; Frew, et al., 2006; Juma, 2010) to foster national innovation capacities and certain countries have made encouraging progress.

Two types of national e-health implementation governance models we noted with global e-health frontiers are applicable to African countries. Such differentiation can determine how subnational experimentations or small-scale health service implementations evolve and accumulate. This is either centralist or federalist in configuration – how their National Health Service is administratively organised and financed. Though, African countries differ in their national governance, we reckon that most will share with either of the two types. Centralist type noted with England can be replicated in Uganda and

Kenya where their National governments finance and administer healthcare services in subnational constituents. In contrast, a federalist type noted with Germany and USA will better serve national implementations in Nigeria and South Africa, where their respective National governments have devolved power to constituent subnational governments.

South Africa has shown itself to be head and shoulders above other African countries, at least in ICT (telecommunication and computing) research and industry, with a mobile telecom multinational as an evidence of its comparative strength (Kraemer-Mbula & Muchie, 2009). We also know that the challenges of e-health technology inappropriateness and regulation to address them are being recognised in the country (Kachienga, 2008; Poluta, 2006). The emergence of a computer hardware industry cluster in Nigeria, identified by the World Bank, is also an interesting and encouraging development (Abiola, 2008). Notwithstanding, there is no African country that got a mention as a rising industrial star in either the globalisation of biomedical technologies (Salter & Faulkner, 2011) or semiconductor (Macher, et al., 2007).

Based on South Africa's relative progress, we can see that it is closer to the centre of technoglobalism than other African countries. The others are occupying peripheral positions in the context of techno-globalism. This emphasises that the exercise of National Agency by other African countries is urgently needed for them to catch up or leapfrog. Encouraging but slow progress being made in this direction is presented in the African Innovation Outlook report (Brundenius & Mawoko, 2010).

To sum up, we emphasise that the exercise of National Agency must be a policy imperative for African countries, by arguing that the continental model of innovation advocated by (Muchie, 2004) may not suffice in the conduct of IeTTs. The narrative in Chapter 5 inform us that a smooth transfer of e-health technologies from global to national level can be hindered by the preference of global actors for regional and bilateral arrangements to the detriment of plausibly conducive multilateralism. More so, the unilateral decision taken by certain African countries in the conduct of IeTTs (Chapter 5), gives an indication that bilateral arrangements with global actors might be more favourable.

Two areas are identified in which Schumpeter contrast with Schumacher in the development and utilisation of e-health technologies. The first is in the area of learning

in acquiring national e-health innovation capacity. The second is about nature of e-health technologies: how they scale and how they come into being.

7.5.1 Learning

Learning in a Schumpeterian sense is an active assimilation of both explicit and tacit knowledge (Arocena & Sutz, 2003; Baskaran, 2005; Lall & Pietrobelli, 2005; Lundvall, 2007). In Chapter 2, we noted that with Schumacher model, how recipient countries can acquire and assimilate of knowledge in the conduct of ITTs is not visibly evident. Especially, if, an agential asymmetry exists in a lopsided techno-globalism – a nations' innovation capacity determines its ability to address domestic digital divide.

A historical linkage with past cosmopolitan transfers of Satcom technologies in the last four decade (Christol, 1974; Colino, 1968; Habib-Sy, 1992; Howell, 1988; International Space University, 1994; Pelton, 1987), is noted in the current conduct of IeTTs (including m-health) and ICT4D in Africa. Similar pattern is noted between past practice of biomedical technology transfers (Donald, 1999; Free, 2004; Quaye, 1996) and current Global Health policy. Yet, despite being perennial recipients, African countries still possess immature technical competence and industrial capacity (Al-Bader, et al., 2010; Chataway, et al., 2009; Frew, et al., 2006) in these areas.

Schumacher model is largely about using transferred implicit or tacit knowledge by global actors to develop technologies for recipient local users or consumers. There is no accounting for the explicit nature of tacit knowledge that is required for active acquisition and assimilation of domestic *industrial* competence in a Schumpeterian socio-technology sense. Cosmopolitan fixity with technology appropriateness subsumes that of innovativeness and production (Kaplinsky, 2011, p. 193). Moreover, the unproductive dependency of the recipients on the donors for radical and incremental knowledge in the medium to long-term is not taken into account in global policy.

On the other hand, active or industrial learning is both to acquire technical competence from transfers and to domestically upgrade them, with an eventual goal of developing new ideas and knowledge needed to forge long-term technology accumulation. As with South Africa (BC) and with global e-health technology frontiers (Fujimoto & Miyazaki, 2000; Halford, et al., 2009; Johannessen, et al., 2012; A. Lang & Mertes, 2012; Lee, et al., 2009; Spivack, 2005), learning is noted to occur though incremental domestic technosciences jointly carried out by both public and private sectors. Learning equips a

country to industrially develop and upgrade technologies for utilisation in its health service sector. In a way that Kaplan, 1987 demonstrated in the case of the invention, commercialisation and utilisation of CT-Scan machines in the USA.

We view learning as step towards *becoming* a Schumpeterian entrepreneurial or developmental state, for consumerist African countries. Even India, a country where Fritz Schumacher originally conceived his *Small is beautiful* idea from (Toye, 2012) now possess domestic competence in hi-tech, semiconductor-based Satcom industry (Baskaran, 2005). Such competence has gone into building its national telemedicine infrastructure.

Transferred e-health technologies have, in some instances, saved and prolonged lives. For example, the life of a Swazi child was reportedly saved by expert advice provided by a UK based doctor (Section 4. 3.2). In general, in Africa this kind of virtual e-health service predominates over the transfers of material technologies; for example, a virtual teleconsultation service that operates in several developing countries (Cartwright, 2000; Edworthy, 2001; Geissbuhler, et al., 2007). Most of these virtual services employ open source software platforms, mostly designed and produced outside the continent. Though, a mention can be made of the transfer of e-health software design knowledge, which has led to the invention of open source platforms such as Open Medical Record System (Open MRS) and District Health Information System (DHIS), in several African countries.

Even if software design skills can be acquired over these virtual platforms, the same cannot be said for e-health hardware and devices. The open-source movement draws inspiration from Schumacher. Interested individuals can freely join the movement so far they have a computing device and a connection to the Internet. Considering that personal Internet access in Africa is still below par with the lowest global benchmark (Bowman, et al., 2009; Kirigia, et al., 2005; Oyelaran-Oyeyinka, 2006), it is not surprising that most of the Open MRS and DHIS developers are based in frontier countries such as the USA and Norway respectively.

Notwithstanding, a fixation on software development in the cosmopolitan conduct of IeTTs, might be drawing attention away from challenges being encountered with e-health hardware. Even users of virtual e-health services require appropriate hardware such as videoconferencing and telecommunication devices. The narratives demonstrated

that the challenge of technology inappropriateness is one that most African countries are grappling with (Chapters 3 and 6). For example, in the case of AB, presented in Chapter 3, we demonstrated how shortage or deficiency of domestic competence continually frustrated the accumulation of transferred e-health technologies and the implementation of its national e-health initiative.

It is possible that useful expertise for domestic production of e-health software can be acquired via such virtual platforms can transfer, and can in the process contribute to healthcare delivery in recipient African countries (Allen, et al., 2007; J. Braa, et al., 2004). However, this is not suitable for repairing, maintaining and manufacturing e-health devices and equipments. Never mind, considering the capacity to invent new ones from the scratch.

Technical skills that are required for such more complex tasks are tacit knowledge, which we have found not to be easily transferred in the conduct of IeTTs. Moreover, these areas of knowledge are not freely available (they are not open source), but have to be deliberatively impacted by technology producers, and willingly learned by consumers.

Accordingly, we view Schumacher's as not appropriate for inventing hi-tech combination and production of converging e-health technologies. A small-scale village industry model of producing dated technologies that Schumacher advocated (Schumacher, 1972) is at odds with the Schumpeterian engine of technology combination, dynamism, novelty and upgrading are being powered by domestic consumerism . Because of this reason, the technical competence that can be acquired from passive learning will not be enough to engineer a large-scale national e-health infrastructure. On this ground, we contend with Kaplinsky, 2011, p. 202, who following Schumacher, suggested that African countries will benefit from transfers of affordable and appropriate devices by the rising global East economies. Texts in Chapters 4 and 5 demonstrate that such over-optimistic view will not translate into domestic acquisition. We contend that such Schumacher inspired Kaplinsky's cosmopolitanism will further push African countries into a retrogressive state of passive learning and consumerist recipient.

Learning can only take place if the consumers and producers are closely linked together in a mutual exchange of knowledge and technologies. Such mutual learning occurs

when instrumental drivers of industrial capacity acquisition such as manufacturing and domestic consumerism are tightly and dialectically coupled with global innovation or value chain system (Caniëls & Romijn, 2009; Freeman, 2002; Juma, et al., 2001; Macher, et al., 2007; Salter & Faulkner, 2011). African countries should and can *learn* from the *industrial* model of national e-health technology development and implementation. This requires the possession of a mature national innovation system, which can, to a limited extent, be acquired from receiving IeTTs, but must largely, developed domestically. Accordingly, (Juma et. al., 2001 pp.637) admonished developing African countries not to forever depend on transferred biomedical technologies and ICTs for their survival and sustenance. Instead, he encourages technology lagging countries to emulate the *industrial* model, and advocates that recipient countries must forge domestic innovation capacity so as to leapfrog.

In our view, Schumacher's innovation model *cannot* turn vicious cycle into a virtuous one in a low-income recipient African country. The acquisition of a hi-tech innovation and industrial capacity, that can power an *engineering* of a global standard of national e-health implementation, is lacking. Only industrial learning can empower an African country to combine e-health technologies that requires a convergence of different technical and industrial competences.

7.5.2 Nature of technology

Virtuous cycle of domestic innovation system was demonstrated in countries AB, PE and KL as technology upgrading could not meet up with fastidious sun-national utilisations. With global e-health frontiers, a hi-tech and modern nature of e-health innovation (Aanestad & Jensen, 2011; Bergmo & Johannessen, 2006; Ellingsen & Monteiro, 2012; Fujimoto & Miyazaki, 2000; Johnston, et al., 2000; A. Lang & Mertes, 2012; Spivack, 2005; Zuzek & Bhasin, 1996) is noted. Driven by a Schumpeterian creative destructionism powered by a domestic consumer market demands (Windrum & García-Goñi, 2008) explains how combinatorial, novel and incremental e-health innovations come into being and scale. A convergence of consumer electronics and lifescience industries drives the combinations of biomedical, computing and telecommunication technologies. Rapid and intense digitalisation of health information and connectivity of devices are the hallmark of these technoeconomic changes. Perhaps, the turbulent cycles of viciousness and virtuosity, observed in less innovating AB, KL,

PE and relatively more innovating South Africa (Chapters 3 & 6), are patterns of an emerging creative destructionism. Albeit, without an engine of domestic consumerism.

Schumacher's model doesn't articulate how these cycles result in incremental accumulation and assimilation. But explains technology adaptation – existing and dated innovations are employed to create intermediate or lagging technologies. Schumpeterian engine, however, fits the dynamics of technology upgrading and novelty could have been instrumental for *engineering* the challenges of obsolescence and incompatibility encountered by AB, KL and PE. With Schumacher, agency for domestic engineering is un-developmentally cosmopolitan. As such, it will only produce low-tech innovations that might not meet Africa's harsh climatic and environmental ambience, and the fastidious nature of its rapidly changing and complex healthcare service provision needs.

A policy concern is that, Schumacher's preference for less-capital intensive devices might not necessarily meet these needs or even becoming commercialised or attaining economies of scale. The combinatorial and converging nature of e-health technologies makes their manufacturing and engineering in national large-scale implementations, capital-intensive in a Schumpeterian techno- economic sense. As such, dynamic creative destructionist recombination required for attending to constant, fuzzy and uncertain ambient and health service, needs and demands, must be built on a foundational hi-tech industrial competence. At the moment, with a reasonable exception of South Africa, such competence is immature or absent in other African countries (Brundenius & Mawoko, 2010; Kraemer-Mbula & Muchie, 2009).

Our view is that as combinatorial innovation in global consumer electronics and lifesciences industries persists, countries with industrial strength in semiconductor and biomedical technoscience and manufacturing will inevitably become frontier nations in fostering such convergence. If that is going to be a global technoeconomic trend, domestic knowledge will struggle to accumulate with the current practice of cosmopolitanism and consumerism. Implying that domestic industrial capacity will remain immature or absent in recipient countries, if, this practice persists.

Schumacher vision for the production of less capital-intensive devices (Toye, 2012, p. 395) might have been fulfilled with an availability of affordable mobile phones globally (Kaplinsky, 2011, p. 201 and Pippin & Qureshi, 2012); nonetheless, such industrial

capacity to design and manufacture them, is still visibly absent in recipient African countries.

Mobile phones and to a very lesser extent Smartphones are widely utilised for essential public health m-health interventions in Africa and elsewhere; and, their implementations are usually presented as less-capital-intensive alternative to other e-health ones (Fleishman, et al., 2010; Gerber, et al., 2010; Mechael, 2009). Though in a Schumacher sense, mobile phones can be regarded as an appropriate technology because they are less capital intensive to utilise, own and consume; nevertheless, the reality that they are high capital-intensive to design and manufacture is lost in global development policy. Moreover, limited policy interest has been indicated to make affordable presently expensive high performing Smartphones, which are more suitable for delivering combinatorial e-health services (Briggs, et al., 2012). As it is often taken for granted that the invention and production of even mobile phones is underpinned by a hi-tech semi-conductor or consumer electronics industry.

On scaling e-health technologies, Schumacher is at odds with Schumpeter. Not least because scaling up of e-health service implementations is a policy and managerial challenge around the world (Briggs, et al., 2012; Coiera, 2009; Gulube & Wynchank, 2002; Heeks, 2006; Kaplan, 1987; Kaplan & Harris-Salamone, 2009; Kellermann & Jones, 2013; Kifle, et al., 2008). Same kind of challenge is reported with m-health initiatives in developing countries (Tomlinson, et al., 2013). With these implementations, problem of scalability has been commonly and usually attributed to a lack of interoperability of amongst diverse and disparate technologies, actors and organisations. Thus, reflecting Schumpeterian sociotechnical and technoeconomics.

The engineering of a large-scale national e-health technology infrastructure is in spatial and geographical spans and in functional sophistication (Aanestad & Jensen, 2011; Coiera, 2009; Ellingsen & Monteiro, 2012; Johannessen, et al., 2012; Larsen & Ellingsen, 2012). Civil and electrical engineering of a Schumpeterian large-scale infrastructure, is about building for mass service utilisation, and durable accumulation and functional adaptations, of e-health technologies, in a long period of national implementation. Such requires incremental and radical combinations of technologies and institutions underpinned by a nation's competent and attentive industrial and technocratic workforce and by the domestic mass consumerism. Meaning that large-

scale implementation involves coalescing and managing complex institutional interactions of innovation and engineering (F.W. Geels, 2004; Frank W Geels, 2007; Juma & Bell Jr, 2006; Nelson, 2008; Nelson & Nelson, 2002; Oyelaran-Oyeyinka, 2006; Windrum & García-Goñi, 2008). That is conditioned by entails a long wave of dynamic technoeconomic changes at both national and transnational levels and durable sociotechnical transformation at sectoral/subnational/service levels.

We argue that Schumacher model is incapable of providing a satisfactorily understanding of how large-scale e-health engineering comes into being. Its utility for the production of small-scale single devices and largely designed for close-knit communal utilisation (Schumacher, 1972) *cannot* fit into Schumpeterian scales of national e-health implementation. It is a misfit with the complexity involved in combining and integrating diverse and perhaps un-interoperable e-health technologies, actors and organisations that span geographical and institutional spaces.

Ethically, Schumacher's preference for high-labour intensive mode of technology production (ibid.) might also be at odds with the Schumpeter when it comes to utilising e-health technologies in a health service sector. A large-scale or intensive e-health utilisation can lead to a mechanisation and automation of healthcare processes, with a possible unintended consequence. For instance, it can result in a situation where less health professionals are needed, especially if implemented in a time of low-disease burdens. In Africa, where disease burdens are currently high and faces a chronic health human resources shortage, that might not be the case. However, the risk *deskilling* we noted with a conduct of an IeTT (Chapter 4, pp. 114-115), is an ethical concern. In the event of a sudden epidemic outbreak, demographic explosion and natural disasters, for instance, deskilling can prove catastrophic. Notwithstanding, teleconsultation services in such time of medical emergencies, can be life-saving in the early phases.

To sum up Schumpeter and Schumacher meet up in how e-health technologies can be accumulated and adapted to address the challenges of technology incompatibilities and obsolescence. However, Schumpeter provides a more convincing model for understanding the evolutionary, scalar, combinatorial and converging nature of national e-health technologies and infrastructures. It explains how through an exercise of National Agency, tacit and explicit e-health knowledge can be learned and assimilated to domestically develop sectoral e-health services.

Schumpeterian model informs that national implementation is a large-scale, long-term *engineering* endeavour, involving the alignments of diverse and often competing sociotechnical and technoeconomic institutions.

7.6 National Agency in e-health technology globalisation

Most African countries' peripheral position in the context of technoglobalism puts them at risk of not acquiring innovation capacity in the conduct of IeTTs. This is more precarious, especially when governance at the continental level was shown to be fragmented and weak (Chapter 5) and when the interests of global corporatism, industrialism and mercantilism and ideological differences between the global West and East (Chapter 4) loom large in the conduct of IeTTs. More so, we cannot ascertain how disruptive global geopolitical and technoeconomic events and changes (Chapter 3 and 4) will be on the acquisition of national e-health technology capacity in Africa. However, we analyse how national acquisitions differ amongst recipient African countries and how global development practise have fallen short in addressing the deficiency of national innovation capacity.

7.6.1 Geographical-institutional network

As regarding an exercise of National Agency in technoglobalism, being a technology laggard in a global peripheral position, need not a structural constraint to domestic acquisition. Though, we acknowledged that global mercantilism (Chapter 4) and industrialism and fragmented continental multilateralism and national unilateralism (Chapter 5) in both the hierarchical and diffuse interactions of IeTTs, can limit the agency of the recipients. As a consequence, these constrained an assimilation of tacit knowledge and accumulation of skills and craftsmanship. This implies that any domestic innovation learning in the recipients will take place within a complex symmetrical network of geographies, technologies, institutional power relations and distributed knowledge bases. That connotes complex interactions of diverse and multiple actors, institutions and technologies that will make this happen.

Hence, we argue that the complexity of symmetrical interactions depends on, orientation size and intensity of the network. These network characteristics can determine if a recipient African country will either acquire more or less.

The vertical orientation of hierarchical relationship of IeTTs, might not promote *learning by interacting* and *doing*. Neither would the diffuse horizontal one does.

Whether learning will occur is dependent on the degree of complexity of the network of interactions.

In low degree of complexity, where the size of the network is small and there is a low intensity of interactions. The dynamics is that with few actors and organisations to deal and negotiate with, instead of floundering, learning can fledge or flourish. In a pattern demonstrated in recent China's rise (Fu, Pietrobelli & Soete, 2011), South Africa for example, acquired domestic innovation capacity following a telemedicine device co-development with a global East country (Chapter 6). The opposite by contrast, was noted in the case of AB in Chapter 3.

A higher degree of complexity was observed in AB, where the size of the network is relatively bigger. Hence, a higher intensity of interactions resulted in a lesser domestic acquisition. We noted that with too many *chefs cooking the broth*, an exercise of National Agency was frustrated and learning flounders.

States of learning in CE, KL and PE (Chapter 4, 5 & 6) can be positioned along a spectrum of the South Africa and AB extremes. As regarding how they exercised National Agency as recipients of IeTTs, CE and PE will be positioned closer to AB in the spectrum, while, KL will be at a mid-point between the extremes.

A relative better performance of South Africa suggests the possession of an extant domestic innovation capacity can determine how National Agency can be exercised. We, thus, maintain that a Schumpeterian *industrial* model of national e-health technology development and implementation is needed, to nationally scale-up transferred e-health technologies in Africa.

7.6.2 Global techno-developmentalism critique

We come into a direct contention with the Schumacher cosmopolitan 'doing it all *for* me' model that is currently defining the conduct of IeTTs in Africa. On this basis, we draw on the divergent view shared by Sachs, 2003, Juma, et al., 2001 and Kaplinsky, 2011 on the suitability of international technology transfers for developing countries in the context of global development in the practices of ICT4D and Global Health. Hence, contending that Sach's policy preference is informed by Schumacher model of technology development and utilisation. In turn, mirrors that of Amartya Sen's global redistributive policy (Toye, 2012, p. 398 & 401) on a preference for communal/ small-scale industrialisation.

Cosmopolitanism limits recipient African countries to being passive consumers of transferred e-health technologies. Sachs (2003, p. 140) pragmatically advocated that a *consumerist* model of biomedical technology transfer, underpinned by a cosmopolitan/Schumacher approach, should be encouraged in developing countries. What is always taken for granted in global development is that digital divide is an innovation divide (Freeman, 2000; James, 2002). Semiconductor innovation and manufacturing competence are tacit knowledge (Macher, et al., 2007), which are not wilfully or easily transferred in a competitive age of technoglobalism. Moreover, we reckon that, the emergence of semiconductor-based hi-tech industries was a product of public-sector supported national technosciences in technology frontiers (Bauer, et al., 2012; Freeman, 2000; James, 2002; Achim Lang, et al., 2012; Mazzucato, 2011; Oyelaran-Oyeyinka, 2006; Pavitt, 1998). Most these innovations were spurred by their National governments' stewardship, ethical financing and markets organisation.

Institutionally, this emergence has a historical linkage with similar investments made in the preceding decades into Satcom technology innovations; for example in the European Union (Dario, et al., 2005; Häusler & Simonis, 1985; Sweeting, 2000) and the USA (Lambright, 1994; Levy, 1975; Pelton, 1987; Peter, 2006; Zuzek & Bhasin, 1996). We noted that a less entrepreneurial sort of investments was made by PE and KL, as being recipients of IeTTs (Chapter 6); nonetheless, not by AB, in spite of being a long-term recipient (Chapter 3); but was not directed at spurring domestic innovation. Instead, the consumerist adoption fostered a passive learning.

Hence, we reiterate the policy imperative of the essentiality and instrumentality of exercising National Agency in the conduct of IeTTs. Just as (Forje, 2006; Juma, 2010; Muchie, 2008; Ymele, 2011) have encouraged African countries to do, in the interest of fostering resilient socio-economic progress. Currently, such NIS principle is not evident in global development policy and practice, which is restrictively dominated by Sen Capability approach.

The current Global Health and ICT4D policy and practice have not warmed up to a survival and prosperity imperatives of exercising National Agency in fostering domestic technology invention and manufacturing in the age of techno-globalism. At the moment, in global development practice, a Schumacher model of technology production predominates over a Schumpeterian one. Certainly, in the cosmopolitan implementation of e-health and m-health in Africa (Chapter 1), the former predominates.

We noted in Chapter 2 that Sen's capability approach to individual but not national development is evident in the cosmopolitan agency ascribed to technology development, in the way implied in the e-health/m-health, Global Health and ICT4D literature (Chapter 1 & 2).

The argument we presented in the preceding sections has advanced that such cosmopolitanism cannot foster large scale national e-health implementation in Africa. Besides, in respect to Africa's development, Muchie, 2008 eloquently challenged the instrumentality of the capability approach in the case of most African countries that are still proto-industrial states. He argued that, it is akin to putting the *cart before the horse* when a focus on individual capabilities takes precedence over acquisition of national innovation capacities, which determine whether the state can domestically provide quality healthcare services to its citizens. Though, implementing and utilising e-health technologies for example, telemedicine services for Africa's demographically and geographically dispersed population is in line, the reality of immature extant domestic innovation capacity can constrain citizens from benefiting from quality healthcare provision. Nonetheless, Sen Capability approach might be applicable for addressing the challenge of deskilling that might arise from an intensive e-health utilisation.

Most African countries are still far from acquiring or developing measurable and tangible NIS indicators such as national economic size, hi-tech R&D institutes and manufacturing companies to become entrepreneurial or developmental states.

Capabilities on the other hand, are intangible and difficult to measure and compare across cultures and nations, as NIS indicators can be. Intangibility, therefore, might make it difficult for African policymakers to invest into domestic technology capacities that would create economic growth and citizens' wellbeing.

We contend with Lundvall, 2007, p. 114 and Sismondo, 2010, pp. 200-202 in this regard. Though, Sen might be useful for understanding as (Howitt, 2005; van Zon & Muysken, 2007) have articulated, that the domestic provision of quality and effective healthcare to a nation's citizens can remarkably improve their *individual* innovation learning. Nevertheless, it must be understood that the observed improvements in individual learning capabilities, were identified in technology frontier countries whose NIS indicators are global pace-setters.

Fittingly and perhaps, belatedly, the United Nations Development Programme, hitherto Senian in orientation, has finally woken up to Schumpeterian innovation. The Human Development Index 2013 titled *The Rise of the South: Human progress in a diverse world* highlighted the rapid and remarkable technoeconomic transformations of BRICS[21] countries.

7.7 Geopolitics and e-health innovation

African countries can learn by acquiring technology capacity and appreciating that fostering domestic innovation is not a linear passive learning process, but that it requires navigating and negotiating barriers put up by complex and hierarchical global technology systems. Not least, the influences of global technoeconomic and geopolitical events (Chapter 3); global geopolitical contentions (Chapters 4); and regionalism and fragmented continental governance (Chapter 5) were demonstrated in the conduct of IeTTs.

We demonstrated and examined in the narratives of the conduct of IeTTs (Figure 7.1), manifestations of institutional structures in complex and uncertain horizontal and vertical interactions. The manifested mechanisms of global geopolitics, continental fragmentation and national reticence can either symmetrically constrain or condition national learning. For instance, with AB in Chapter 3, we demonstrated these

[21] BRICS include Brazil, Russia, India, China and South Africa that are collectively increasingly account for a considerable chunk of global GDP outputs and trade volumes.

constraints in a technological path-dependency narrative. In contrast with South Africa (BC in Chapter 6), we demonstrated how the mechanisms can condition incremental acquisition when National Agency is exercised.

NIS theory explains how the subnational, national, continental and global, are temporally, institutionally and geographically networked in the conduct of ITTs (Freeman, 1995 & 2002). Such structural link between the subnational and national are foundational creating domestic innovation, and are built on tight coupling between national and continental institutions essential for fostering mutually beneficial transnational cooperation.

National-continental tight coupling is essential for domestic technology acquisition. However, geopolitical contention and competition amongst countries in a global innovation system can condition dynamics of acquisition (Contractor & Sagafi-Nejad, 1981; Fritsch, 2011, p. 35-36; Lambright, 1994; Levy, 1975; Peter, 2006 & Sharif, 2006, p. 760-761). For example, we demonstrated such in Chapters 3 and 4 in the conduct of Satcom IeTTs. In addition in Chapter 5, we demonstrated how fragmentation caused by national unilateralism and regionalism constrained the conduct of IeTTs at the continental level. In Africa, national-continental loose coupling to an extent caused by global and regional geopolitics is observed.

Compare this with what is observable in other continents are regarding geographical e-health innovation. The Asian tiger economies converging investments into semiconductor-based and consumer electronic industries, created an institutional foundation for *engineering* their national e-health infrastructures (Holliday & Tam, 2004). Likewise, in Europe, a historical and contemporary accumulation in these industries (Freeman, 1995; Lang, Schneider & Bauer, 2012; Pavitt, 1998; Perez & Soete, 1998) has become a platform for transnational cooperation on a continental e-health infrastructure (Karopka, Frank & Blank, 2012; Lang & Mertes, 2011). Moreover, a geopolitical cooperation between the Europe and US on e-health (Friedman, et al., 2009), can also be explained by their sophisticated convergence in these industries.

Despite optimism for collective innovations in biomedical and telecommunication by technology pan-Africanist (Bowman, et al., 2009; Chataway, et al., 2009; Habib-Sy, 1992; Howell, 1988; Juma, 2006, 2010; Lall & Pietrobelli, 2005; Muchie, 2004; Ya'u, 2005), rather than a national-continental tight coupling, our findings revealed that of

loose coupling. For example, national unilateralism, fragmented regionalism, global geopolitics and technoeconomic events, constrained the implementation of pan-Africa e-health initiatives (Chapters 3 & 4). We identified a fragmentation of continental multilateralism due to preference of international actors for bilateral cooperation with individual African countries. Therefore, what pan-African innovation optimist omits, is that, as (Freeman, 1995, 2002; James, 2002; Achim Lang, et al., 2012; Macher, et al., 2007; Pavitt, 1998; Perez & Soete, 1988; Sachs, 2003) have noted with the Asian, European and North American countries, a tightly coupled national-continental innovation system underpinned their rapid industrialisation in computing and telecommunication innovations. The emphasis is that a strong transnational continental cooperation is essential for acquisition from a competitive and contested global innovation system.

7.7.1 Global e-health innovation system

We demonstrated in the case of AB in Chapter 3 and 4 how global technoeconomic (credit crunch) and geopolitical (Cold War rivalries) events, conditioned its exercise of National Agency. Such events that stifled a smooth transfer of Satcom e-health technologies to African countries in the past decades are observed in the current conduct of IeTTs (demonstrated in the implementation of pan-Africa e-health initiatives (Chapters 4 & 5)). Similar events are shaping the emergence of a global e-health innovation system.

Emerging global trends inform us that combinatorial e-health innovations driven by a convergence of mobile, genomics and biomedical technologies are creating a boom of inventions and enterprises. Multinationals and global East state operated enterprises (SEOs) from pharmaceutical, telecommunication and biomedical industries are prominent in these interesting creative destructionism. Most are either acquiring or spinning out e-health-oriented and innovative companies and start-ups. These organisations are involved in the conduct of *reverse innovation* (Kaplinsky, 2001, p. 201). In this conduct, developing countries are employed as ‘outsourced R&D labs’ for inventing frugal e-health technologies, for example, in the case of AB (Chapter 3) and CE (Chapter 6). Oftentimes, in the conduct of global health and ICT4D, reverse innovation are financed by well meaning foundations, nations, IGOs and iNGOs.

A case in point is the emerging combinatorial m-health and medical diagnostic technologies (Briggs, et al., 2012), now a focus of global health innovations, as it was with past cosmopolitan biomedical ones (Free, 2004; Malkin, 2007). These have become a vehicle for conducting reverse innovations in recipient African countries (Chapter 4). Going by the immature but improving states of most African countries' domestic biomedical innovation capacity (Chataway, et al., 2009; Frew, et al., 2006; Juma, 2010) and that in the past national acquisition had not sufficed (Quaye, 1996), we are not too sanguineous about this prospect. Not least because the complex political economy of such global innovation system (Chataway, et al., 2010; Donald, 1999; Ngoasong, 2010), or that Schumacher model is now anachronistic (Free, 2004); nevertheless.

In the face of such global conduct, as we demonstrated in the conduct of IeTTs (Section 6.5), and in the absence of a coordinated continental governance mechanism, a Schumacher approach will not result in a desired accumulation of e-health technologies in recipient African countries. That African countries should be consumerist recipients of cosmopolitan ITTs is a preferred policy option by (Schumacher, 1978 & Kaplinsky, 2011, p. 202). Loose national-continental coupling has created a situation in which African countries are peripheral contributors to the emerging global e-health innovation system. Their possessions of immature NISs would negate equal participation in any symmetrical global e-health innovations interactions.

Notwithstanding, reverse innovation can contribute to the acquisition of national e-health capacity in a proactive recipient country. In Chapter 6, we demonstrated how a bilateral cooperation between South Africa and a global East country resulted in e-health technology accumulation and knowledge assimilation. Moreover, if multinationals and SEOs can wilfully transfer tacit knowledge, national acquisition can occur when domestic cognitive, regulative and normative innovation institutions are matured and receptive. For example, as (Corea, 2000; F.W. Geels, 2004) have articulated.

We identified in Chapter 6 that due to 'Technology neoliberalism', multinationals are not transferring affordable e-health technologies to African countries as SEOs are doing. If that continues to be the case in this emerging context, there is a need to highlight that the technologies owned by multinationals, were developed on the back of

public finances of their host countries. The invention of the Smartphone is an example. In Chapter 2, we highlighted the exercise of National Agency in how frontier countries such as South Korea and USA, through state entrepreneurship steered the creation of Samsung and Apple respectively. Another example is the invention of CT-Scan by the US's National Institute of Health.

Therefore, global diplomacy can be instrumentally employed by IGOs and foundations to encourage multinationals to transfer affordable e-health technologies. Such approach is to a certain degree of success, currently being used in global health to support affordable transfers of medicines to developing countries (Chataway, et al., 2010; Howitt, et al., 2012).

An increasingly rise of multinationals' and SEOs' commercial interests in maturing developing countries' markets is an evident sign of economically converging globalisation (Kaplinsky, 201-202). Accordingly, we observe that global rapid e-health technoeconomic changes (Perez, 2010) framing, underpinned by incremental, radical and combination innovations and convergence of life science and consumer electronic industries is emerging. We speculate that these emerging global changes will with a Schumpeterian creation destruction engine, create new inventions and industries in the mould that (Freeman, 2000, pp. 157-158) predicted that ICTs would, at the dawn of this century.

7.7.2 National e-health innovation system

Aspiring countries can acquire capacity by embracing and practising the principles of a National Innovation System (NIS); which, informs that domestic *industrial* capacity and local entrepreneurs drives socioeconomic progress (Section 2.3). The acquisition of e-health technology competence is *learning* the capacity and possibility of making necessary technical and institutional changes nationally and globally. Possessing domestic industrial and technoscientific competences are needed and essential for coping with, and adapting to, global technoeconomic changes. Learning is for a recipient country is as becoming entrepreneurial or developmental – it is about a recipient country exercising its National Agency.

Therefore, we argue that agency in the conduct of IeTT needn't be restricted to cosmopolitanism, which assumes a neoliberal view that countries interacting in globalisation have similar capacities to accumulate technologies in a cyclical interaction

(Fritsch, 2011, pp. 37). Neoliberalism views technology transfer in an ANT sense, as a cyclical interactive process, in which, nations interacting in globalisation possess equal or similar domestic innovation capacities.

By not treating agential asymmetry in techno-globalism, it has resulted that the essentiality of possessing extant domestic innovation capacity in recipient countries are taken for granted. In addition, the influences and effects of the institutional structures listed in Figure 7.1 on state entrepreneurship are foreign to mainstream ITT literature (Section 2.2) and in the conduct of IeTTs (Chapter 1).

We, rather, demonstrated in the narratives that African countries will automatically acquire competence or assimilate knowledge from symmetrically complex IeTT interactions. Thus, by employing the *cumulative advantage* hypothesis, we argued that African countries can *learn* from global technology leaders, identified as 'global e-health leaders or frontiers' in Chapter 2. Being technology laggards and consumers of transferred e-health technologies, most African countries can consciously imitate these leaders. Implying that learning from these frontier countries, informs that their evolutionary national e-health initiative implementation, is an *engineering* process. This, to a large extent, is being powered by a Schumpeterian *industrial* engine and domestic techno-sciences. South Korea exemplifies this model. It has instituted a national e-health policy that promotes both domestic innovations and international collaborations, through the support of its private and public sector entrepreneurship (Briggs, et al., 2001; Holliday & Tam, 2004; Lee, et al., 2009).

Individual entrepreneurship is also essential to domestic accumulation. With South Africa in Chapter 6, we demonstrated how local e-health entrepreneurs have created start-ups, and technology commercialisation funded by domestic public and private investors. Such was not demonstrated in AB in Chapter 3. The intrepidity of these individuals is the spark that ignites the Schumpeterian engine of combinatorial innovations. The creativity of these domestic actors stands a stronger chance of domestically retaining expertise and economic values; for example, as it is the established e-health innovation practice in the US and Norway (Halford, et al., 2009; Johannessen, et al., 2012; Johnston, et al., 2000; Spivack, 2005), than those of cosmopolitans'.

In short, national entrepreneurship is driven by creative and intrepid individuals. Notwithstanding though, strong and competent normative and regulative institutions must be in place to harness, nurture and transform entrepreneurs' energy and skills.

7.8 Symmetry – A framework for global collaboration

We propose and present a multi-level framework, inspired by the STS concept of *symmetry* as we articulated in Chapter 2. This is to guide all involved institutional stakeholders in navigating and negotiating complex political, power and contested interactions in the conduct of IeTTs in Africa. The structural conditions we have identified in the thesis are collectively employed to develop a framework, (though in the narratives, they were shown to be constraints on the acquisition of national e-health technology capacity from technology transfers). The framework will inform an understanding of how e-health technologies can be sustainably acquired in African countries. The intention is to shift the locus of agency of e-health technology development from the cosmopolitan to the national.

We reverse the focus of the institutional factors, and propose that the framework can be employed for informing policy at global, continental and national levels, as to how e-health technologies can be successfully acquired from IeTTs in African countries.

Figure 7.2 shows how both the vertical and horizontal dynamics will be aligned. It demonstrates how the institutional structures we have identified (Figure 7.1) inter-relate and how they can be aligned for ensuring that African countries can acquire e-health technologies from IeTTs. We propose that an alignment depends on a transformative reversal of the identities and forms of all involved actors and organisations.

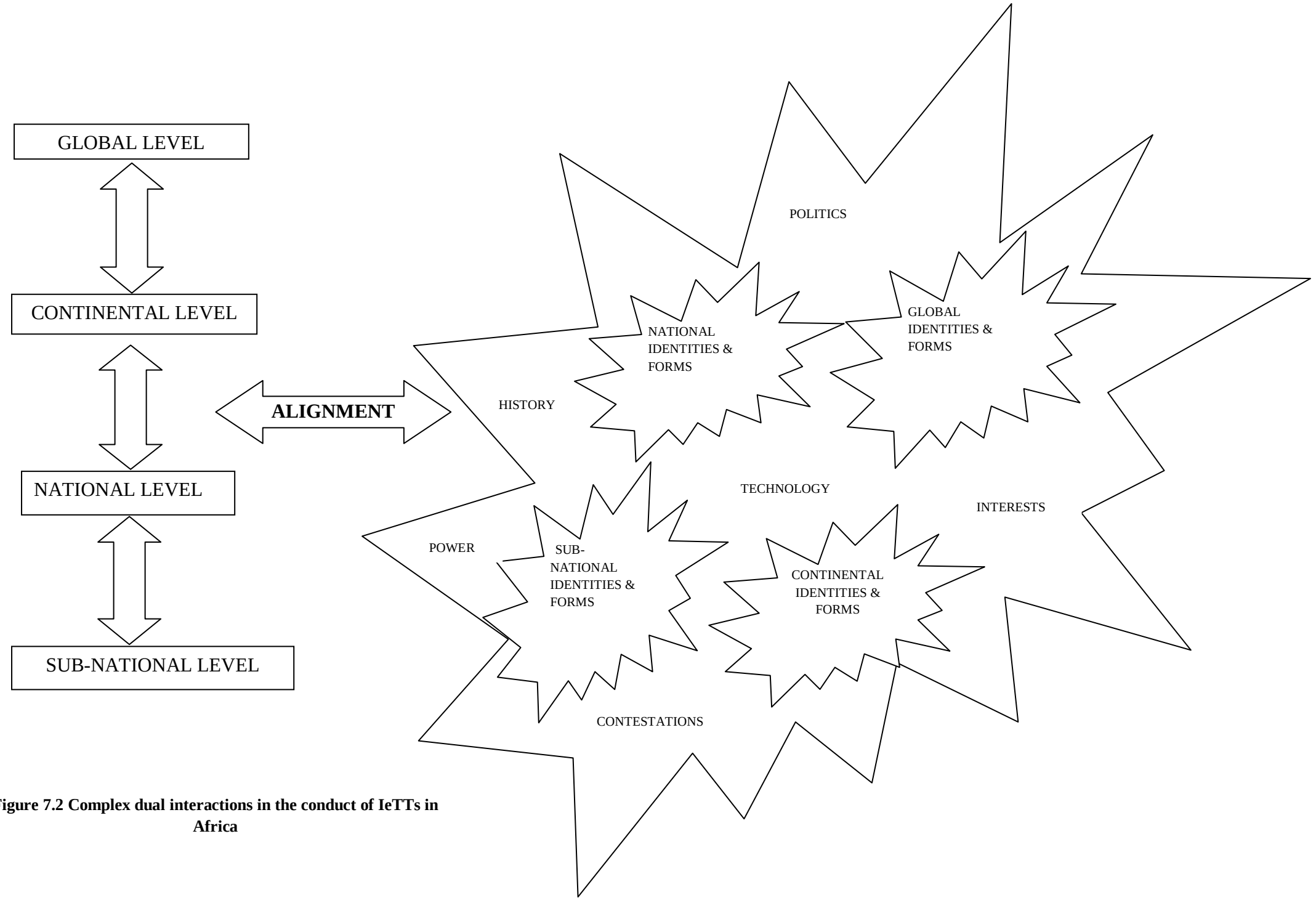

Figure 7.2 Complex dual interactions in the conduct of IeTTs in Africa

7.8.1 Vertical and horizontal dynamics

In the framework, we identified two dynamics of technology transfer in the complex interactions that occur among the involved diverse actors and organisation. The utility of the framework is illustrated with conjectures we preferably select from the narratives. This is to indicate and point out how the constitutive actors' and organisations' identities and forms can be aligned to serve the technological needs of recipient African countries. That is their exercise of National Agency. We show that *Symmetry* is needed amongst the diverse actors and organisations involved in the conduct of IeTTs in Africa.

The first dynamic is vertical and hierarchical in nature and is shown on the left side. It mirrors the Schumpeterian interaction that occurs in the conduct of international technology transfers. The interaction mirrors the competitive and power driven relationships that characterise technology transfer in globalisation (Fritsch, 2011, Sismondo, 2010, pp. 198-200 & Muchie, 2008). In the relationship, technology flows vertically from global, continental, national, and down to subnational levels. The locus of agency is national; because, following the Schumpeterian model, National governments competitively put in place regulative and normative institutions that foster and forge domestic techno-science.

The second dynamic is horizontal and diffuse in nature and is shown on the right side. It mirrors Schumacher's model of technology transfer that encourages and promotes cosmopolitanism. The interaction reflects the complexity of the interconnectedness of institutional identities and forms. In the relationship, a technology is transferred from the global level directly to the subnational level. The locus of agency is cosmopolitan. The horizontal and diffuse dynamics capture the manifested institutional identities and forms in the conduct of IeTTs. It presents complexity by capturing each level from the vertical dynamic, as occurring in fuzzy circles situated within a bigger fuzzy circle. The bigger circle captures politics, power, history, contestations and interests that mediate in the interactions of the constituent actors and organisations.

In the framework, we take the view that the flow of technology is easier to manage in the first dynamic than the second, because fewer actors are involved.

Table 7.2 conjectures and reversal of roles and identities

Conjectures	**Actors and organisations**	**Reversal of identities and forms**
Global identities implicit in the organisational form of global East-West geopolitical contentions can either constrain or enable acquisition of technologies from IeTTs (Chapter 6).	IGOs, IDOs, i-NGOs, multinationals, philanthropists	Ethical technology producer and donors at global level.
Continental identities implicit in the organisational form of poor coordination of inter-departmental responsibilities contributed to hindering the hitch-free transfers to recipient African countries (Chapter 5). Multilateralism that binds countries together at the continental level can be employed to their advantage. However, as we demonstrated in the conduct of IeTTs, regionalism can result in the fragmentation of multilateralism and make countries take divisive unilateral decisions (Chapter 4).	Policymakers, bureaucrats, consultants.	Assured facilitator and moderator at continental level.
Bilateral relationship between a recipient country and a global East or West country can translate into successful acquisition, if it works well for both. A country, such as BC, managed to co-develop a telemedicine device with a foreign country (Chapter 6). In contrast, a country, such as AB, was not able to accumulate technologies from IeTTs because of global geopolitical and technoeconomic events (Chapter 3).	National governments, ministries, policymakers, private sector, public sector, entrepreneurs, research centres and universities.	Able and competent accumulator and assimilator at national level.

Low volume of utilisation of transferred technologies at the subnational level can either enable or constrain the development of appropriate e-health technologies. It can enable, if an incremental assimilation of competence from IeTTs occurs over time (Chapter 3 & 6). Appropriate technologies can be made available for users at hospitals and clinics at the subnational level, if they utilise the technologies and generate clinical and technical data needed to improve them (Chapter 6).	Health workers, hospitals, clinics, health centres.	Receptive users and data generator at subnational level.

7.8.2 Alignment

In the framework, we present a reversal of identities and forms, based on the conjectures we have preferentially selected from the narratives in Table 7.2 on each level of the vertical dynamics. This reversal can make actors and organisations collaborate in ensuring that the conduct of IeTTs can translate into the accumulation and subnational utilisation in African countries. We show that an alignment between the vertical and horizontal axes can be attained, if there were Symmetry amongst the constitutive multiple actors and organisations on the horizontal axis.

In the framework, the alignment depends on the dynamics of how the horizontal interactions in each small fuzzy circle, replicate themselves in the corresponding levels on the vertical axis. We select conjectures from the narratives – the forms, arrangements and identities that manifest in the interactions among actors and organisations within and across each level in the vertical dynamics. The conjectures are derived from the horizontal interactions, and are employed to show how the framework will work. We envisage reversal of roles for actors and organisations on each level of the vertical dynamics. For example, a reversal of national identities and forms implies that the right action is taken at the national level during the conduct of IeTTs.

An alignment between the two inter-locking vertical and horizontal dynamics can occur when Symmetry is attained with diverse identities and forms in the latter. A scenario we envisage is that the politics, power, contestations and self-interests that characterise horizontal interactions can converge to ensure that e-health technologies flow

seamlessly from the global level to the subnational level. If an alignment can be attained between the two axes, then e-health technologies might be sustainably acquired in African countries. This is an optimistic scenario and can only become a reality if the actors and organisations at each level collaborate with each other.

In the scenario, national actors can become able and competent accumulators of e-health technologies and assimilators of competence in the tradition of a national innovation system. Recipient countries can achieve this, by financing and equipping their healthcare systems, by fostering domestic innovation and industry, and by facilitating entrepreneurship in their domestic private sectors. Subnational actors can become receptive users by utilising transferred e-health technologies, and by generating utilisation data that can be employed for making or re-inventing appropriate e-health technologies.

Global actors can become ethical producers and donors of appropriate e-health technologies by understanding the domestic needs and being more open to transfer the technical knowledge needed for maintenance and repairs. Continental actors can become more assured in facilitating e-health technologies transfers and in the process act to moderate relationships between recipient countries and global actors.

Collaboration is needed amongst the constitutive actors and organisations involved in the conduct of IeTTs in Africa that we are advocating with the framework. We are taking the view that such collaboration will galvanise the exercise of National Agency to foster domestic invention and manufacturing of e-health technologies. African countries might start emulating the *industrial* model for their national e-health implementations.

The primary purpose for the framework is to advocate collaboration among all the involved actors and organisations, and to identify their roles and responsibilities in the conduct of IeTTs. We propose that the reversal of identities and forms at each level in the vertical dynamics, will serve well the involved actors' interests and intentions in the process of e-health technology transfers.

In addition, policymakers, programme managers and potential donors from national and global levels need to identify and understand the potential risk and reward factors to be considered when conducting an e-health technology transfer in Africa. The institutional

factors that we have identified can be employed for the purpose of minimising risks and maximizing benefits from transferred e-health technologies.

7.9 Contribution to knowledge

We now highlight our contributions to academia and policy.

7.9.1 Academia

Our study is unique by taking an innovative combination of moderate and middle-range STS constructivism (Frank W Geels, 2007; Wyatt & Balmer, 2007), Deleuzian poststructuralist narrative (Gale, 2010; Sikes & Gale, 2006) and NIS institutionalism (Nelson & Nelson, 2002; Oyelaran-Oyeyinka, 2006) from the perspectives of global development and technoglobalism. By pragmatically and creatively explore convergence amongst these theories and methods to analyse the multiplicities and connections in messy plural qualitative and textual data. We demonstrated and examined how e-health technologies diffuse along global, continental, national and subnational multi-levels in Africa. The extent of the investigation we have undertaken to influence policy at global and national levels is unique when compared with similar work on international technology transfers in the context of globalisation from the information system (IS) and science on ICT4D policy, technology and innovation (STI) disciplines on Global Health policy.

Those writing from the STI discipline such as (Chataway, et al., 2009; Chataway, et al., 2010; Donald, 1999; Free, 2004; Howitt, et al., 2012; Malkin, 2007; Ngoasong, 2010) on the transfer of biomedical technologies in Global Health policy as well those we identified on ICT4D policy (including m-health ones) attribute agency to the cosmopolitan rather than to the national.

We contend that the Schumacher model of technology development and utilisation inspired by Sen Capability approach will not create long-term domestic innovation capacity acquisition. Global ICT4D and Global Health policies have neglected geo-political and -economic considerations of technoglobalism. Issues of reverse innovation, international trade and transfer of tacit knowledge that condition Schumpeterian national *learning* were treated with levity. Something the post-2015 Millennium Development Goals policy-setting agenda can take on board.

These bodies of work lack the depth and breadth of the diverse and conflicting factors we have identified at multi global, continental, national and subnational levels. They have narrowly focussed on investigating information or data exchange, so would not capture the complex and contested nature of e-health technology transfers in the age of globalisation. For example, none of the authors noted that global geopolitical contention and industrial ideological differences can influence the sustainable diffusion of e-health technologies in African countries. We have broadened the debate by capturing the extent and nature of the complexity and the interconnectedness of the involved technologies, actors and organisations. In general, these bodies of work lack the depth and breadth of the diverse and conflicting factors we have identified at multi global, continental, national and subnational levels.

A key finding is geopolitics that runs through the narratives in Chapters 3, 4 and 5. The identification of a geopolitical contention between the global West and East in the conduct of IeTTs in Africa is presented as a novel finding from the perspective of health informatics literature. This was observed in historical global geopolitical events and manifestations of: corporatism; and industrialism and mercantilism of the transfer of Satcom and telemedicine devices and software. In contemporaneous transfers of similar technologies, manifestations of industrialism and mercantilism and technology liberalism were identified. We have yet to identify any study that explicitly associates geopolitical actions and events and technoeconomic events with e-health in this literature. Notably, we have yet to identify any study that highlights regionalism and fragmented continental governance in either the conduct of IeTTs or ITTs in general.

We took an *innovation*-based approach to study the development and utilisation of e-health technologies as opposed to the *information society* driven managerial and action-orientation in the emerging literature on national e-health implementation in Chapter 2. The ICT4D literature such as (Gilhooly, 2005; Heeks, 2008; Mbarika, et al., 2005; Pfister, 1999; M. Thompson, 2004; M Thompson & Walsham, 2010; Ya'u, 2005) and those with a health informatics/e-health leaning such as (Bowman, et al., 2009; J Braa, et al., 2007; J. Braa, et al., 2004; Heeks, 2006; Kifle, et al., 2008; Kirigia, et al., 2005; Meso, et al., 2009; Nchise, et al., 2012; Ouma & Herselman, 2009; Ruxwana, et al., 2010) and on the conduct of virtual IeTTs have followed suit. With an exception, (Avgerou, 2003; S. Cho & Mathiassen, 2007; Corea, 2000; W. L. Currie & Finnegan, 2011) took a sectoral innovation-based approach in their studies in the frame of (Hwang

& Christensen, 2008) . Instead, we studied e-health as an innovation at transnational and national levels as informed by NIS theory and in the process engaged with all Schumpeterian market, product, organisational, input and organisational innovation types (Windrum & García-Goñi, 2008), which were not collectively treated in the health informatics literature. The information-based studies have narrowly focussed on relevant micro-level institutional constraints of power, politics and individual agency; but, as we have done on National Agency from macro-society.

Our research is unique in the context of health informatics research. We associate successful national e-health implementation in Africa with national economic strength and the possession of domestic innovation capacity. Though (Bowman, et al., 2009; Gulube & Wynchank, 2002; Kachienga, 2008; Kifle, et al., 2008; Kirigia, et al., 2005; Meso, et al., 2009; Nchise, et al., 2012; Ouma & Herselman, 2009; Ruxwana, et al., 2010) pointed out that certain cultural, infrastructural and organisational factors that might constrain scalability in African countries. We, on the other hand, have pointed out that the material possession of national e-health technology and financial capacities can determine a successful national e-health implementation in African countries. The World Health Organisation (World Health Organisation, 2007, 2011) has employed quantitative data on national income levels to rank how countries of the world compare with each other on e-health implementation. A recently released report from the WHO that encourages countries to formulate and implement National e-health strategy (World Health Organisation, 2012) did not consider the imperative of domestic innovation capacity. Neither, were similar policy reports (World Health Organisation, 2010a, 2010b) from WHO Africa Regional Office.

We expand this by using narratives to richly and explicitly demonstrate how important national economic size and national innovation domestic capacities are. The two national factors, were also taken for granted in the health informatics literature we presented on national e-health implementation. For example, Holliday & Tam, 2004 (from health informatics literature on Asian countries) and Castro, 2009 (on global West countries from the perspective of innovation policy), did not explicitly identify these two structural factors in their analyses. Moreover, while we have focussed on the national level from a Schumpeterian NIS perspective, Holliday & Tam, 2004, had a sectoral approach, focusing on identifying factors that limit the diffusion of e-health technologies in Asian countries' health systems.

Our combination of theories and methods is in line with and build on the notions of pragmatism and pluralism in health informatics discipline (Scott & Briggs, 2009), as we took a macro-societal/institutional perspective. Rather than the typical micro-individual and organisational focussed studies, that are based on either implicit or explicit actor-network theory (ANT) or social construction of technology (SCOT) cyclical view of sociotechnical interactions, for example (Aanestad & Jensen, 2011; Chiasson, et al., 2006; Sunyoung Cho, et al., 2008; W. Currie, 2009; Ellingsen & Monteiro, 2012; T Greenhalgh & Stones, 2010; Nicolini, 2010). We gave Symmetry to diverse and disparate institutions. The combination operated through Deleuzian poststructuralist narrative method (Gale, 2010; Sikes & Gale, 2006), enabled us to reveal hidden, and make connections with, politics, agential asymmetry, power, diversities, multiplicities and contestations. With this, we had in narrative Chapters 3, 4, 5 and 6 demonstrated a complex and rhizomatic nature of the conduct of IeTTs.

Instead of a narrow focus on individual agency implied in ANT and SCOT theories, our employment of NIS institutionalism foregrounded the *collective* in exercising National Agency. We gave not evenness to humans and technologies in a complex socio-technical interactions; but, in as in the collaboration model, the equality of global, continental, national and subnational institutions.

On these findings, we make contribution to the wider ITT literature such as (Christol, 1974; Colino, 1968; Contractor & Sagafi-Nejad, 1981; Cowhey, 1990; Demerliac & Metzger, 1984; Goldsby & Boyd, 2001; Habib-Sy, 1992; Häusler & Simonis, 1985; Holmes, 1995; Howell, 1988; Lambright, 1994; Levy, 1975; Peter, 2006; Reddy & Zhao, 1990) and virtual IeTTs (Asamoah-Odei, et al., 2007; Blum, 2002; Cartwright, 2000; Crump, 2006; Edworthy, 2001; Geissbuhler, et al., 2007; Geissbuhler, et al., 2003; Gerber, et al., 2010; International Space University, 1994; International Telecommunication Union, 2007; Jongman, et al., 2005; Lacroix, et al., 2002; Mandil, 1998; Nakashima, et al., 2004; Rigby, et al., 2000; Sinha, 2000). These take a neoliberal view that all countries will easily acquire national innovation capacity without an exercise of entrepreneurial agency and assumes linear vertical interactions. We contend that a constructivist or poststructuralist view that treats inherent complexities, uncertainties, multiplicities and horizontal interactions of ITTs. The constraints of national reticence, continental fragmentation, and global geopolitics as we identified in the narratives, are not usually recognised.

7.9.2 Policy

We contend that without the possession of a mature domestic innovation capacity that any country will seriously struggle to engineer a large-scale national e-health infrastructure, as others outside the continent are doing at the moment. As such, we contribute to the on-going policy debate an insight that, implementing a national e-health initiative, is a long-term national technoeconomic and sociotechnical *engineering* endeavour.

Engineering in the sense that in the African countries that we have studied, the lack of or immaturity of national e-health techno-science constrained their exercise of agency in addressing the challenges of technology inappropriateness and obsolescence. This is not to preclude that African countries should continue as recipients of cosmopolitan-driven small-scale e-health experimentations. But such will only un-developmentally restrict them from moving towards an evolutionary large-scale e-health national implementation (Aanestad & Jensen, 2011; Ellingsen & Monteiro, 2012). Small-scale implementations at subnational hospitals and clinics can sustain, if well financed and regularly technologically upgraded by its sponsors; but might not scale spatially and functionally in a Schumpeterian sense. If the utilised technologies and expertise for regular maintenance and repairs were perpetually imported, then whether small-scale implementations will sustain and scale will depend on if consumerist countries must forever dependent on producers.

A possession of a domestic hi-tech industrial capacity is instrumental in supplying timely combinatorial technologies to meet the fastidious demand of health service sector for innovations; we argue. We therefore contend that the implementation of a national e-health initiative is akin to building a large-scale technology infrastructure. The technology development models shared by Schumpeter and Schumacher are both useful for understanding how domestic e-health technology capacity can be acquired from IeTTs in Africa. In Chapter 6, we demonstrated how South Africa proto-industrial model is setting it apart from its neighbours. Therefore, engineering skills for lagging African countries can be acquired not only by *learning by interacting*, but also through *learning by doing*. The former emphasises knowledge assimilation, while skills and craftsmanship development required for electrical, mechanical and civil engineering in the latter.

Schumacher model is not designed for accumulating technologies and for assimilation of tacit knowledge required for a large-scale engineering; however, we contend. This is because, Schumpeterian creative destruction engine explains how diverse e-health technologies combine and accumulate in the process of an evolutionary national e-health implementation. Schumacher can explain how small-scale implementations sustain; however. How incremental small technology adaptations made in solving the challenges of inappropriateness can accumulate in the long-run. However, a communal approach to solving such inevitable problems of subnational utilisation suggested by (De Laet & Mol, 2000, pp. 245-246) will not suffice for combinatorial e-health innovations.

Ongoing policy debate on the performance and efficiency of national e-health implementations, is going to be a long-drawn battle; because of inherent complexity and uncertainty of the contentious marriage between technology and healthcare (Lehoux & Blume, 2000; May, 2006). We offer that instead of these never-ending debates, state investments into national e-health initiatives should be seen as a domestic innovation growth strategy. Such investments can create technologies which can be employed by businesses and sectors such as education and agriculture. The public should not baulk at the scale of financial investments being made, but as we demonstrated with BC in Chapter 6, public finances would in the long-run create societal economic and welfare values.

Policy reviews of the implementation of *NPFiT* in England such as (Currie & Finnegan, 2011 and Greenhalgh, et al. 2011) omitted to appreciate the successful world class engineering of BT built N3 – a dedicated and secured broadband telecom infrastructure. Undeniably, this national endeavour has suffered numerous setbacks. Perhaps, a more affirmative exercise of National Agency might have sufficed. For instance, policy could have supported an incremental development of the national EHR software by nimble and flexible domestic companies.

Ironically, in *Entrepreneurial State*, Mariana Mazzucato omitted National government's intervention in UK's e-health industry, as a strategic area for domestic investment and innovation. In this light and with the benefit of hindsight, we see the outsourcing of the development and the procurement from foreign multinationals the EHR software implemented in the defunct NPFiT, as a poor policy choice. An alternative option was

to rather steer and finance domestic companies to innovate, in the mould of the USA's HITECH (Buntin, et al., 2010; Kellermann & Jones, 2013) and established practise in South Korea (Briggs, et al., 2001; Holliday & Tam, 2004; Lee, et al., 2009).

Based on how global e-health leaders such as England, Germany, USA, and South Korea have acquired their domestic e-health industrial capacities, African countries must learn to emulate their Schumpeterian *industrial* model. By exercising their national agencies, these countries host world class technology multinationals and operate functional national e-health technoscientific normative and regulative institutions. These institutions have been incrementally built on the possession of world class competences in semiconductor and lifesciences industries. Whilst, Wendy Currie elevated individual agency termed *institutional entrepreneurship* in national e-health implementation (Currie, 2009, p. 74), we rather contend. An exercise of National Agency is broader than those of individuals such as doctors, nurses, managers or even ministry/department of health policy makers. These institutional actors are essential, but only from a narrow sectoral health service innovation perspective. Not in the sociology and economics of NIS institutions in the frame of the collectives (Corea, 2000; F.W. Geels, 2004; Frank W Geels, 2007; Nelson & Nelson, 2002; Oyelaran-Oyeyinka, 2006).

The entrepreneurial behaviours and developmental ambitions of nations in building and developing innovation institutions, equip them in engineering large-scale technology infrastructures. This finding is similar to a suggestion provided by (De Laet & Mol, 2000, p. 247) that domestic manufacturing is essential for ensuring dynamic technology upgrades in an African country. Though, how this can be achieved as we have articulated in the case of BC in Chapter 6 was not provided.

Therefore, we propose an *institutional engineering* of large-scale e-health infrastructure. This is a long-term evolutionary engineering of complexity and uncertainty. That is a combination of sociotechnical and technoeconomic aggregation and configuration of constitutive diverse and disparate actors, institutions and technologies. Mechanical and electronics engineering is for making combinatorial e-health innovations and civil engineering for building the e-health infrastructure. Building a national e-health infrastructure and fostering requisite interoperability of diverse and diffuse hardware, software and architecture, requires an incremental accumulation of material engineering skills and craftsmanship.

Being a passive recipient of e-health hardware alone, without a possession of a domestic industrial capacity, might not be enough for e-health software engineering. A telecommunication infrastructure for example, can be built by a donor or a foreign technology company, as physical technologies can be mechanically assembled within a specific period of time. However, it is a different matter when it comes to building a virtual e-health software one. The fastidious technological needs of health service sector require inevitable long-term incremental fixes and upgrading are attended to by flexible and nimble domestic companies.

We highlight the transfers of, and the need to regulate, material e-health technologies in the conduct of IeTTs in Africa. Existing research work has narrowly focussed on the transnational transfer of virtual e-health services. We pointed out in (Section 6.3), that a limited exercise of National Agency in the global regulation of e-health (m-health) technologies, contributes to the inappropriateness of transferred e-health technologies in Africa. Authors, such as Blum, 2002 and Mandil, 1998, that have given a passing mention to it, did not examine the conduct of IeTTs in Africa. In addition, none of the work we identified addresses the question of *how* recipient countries can acquire domestic e-health technology capacity from IeTTs. They did not also explicitly indicate that biomedical technologies such as connected biomedical devices (i.e. glucometer or X-ray machines) utilised for remote diagnoses and therapeutics are to be regulated alongside telecommunication and computing ones. However, we contend with Blum that the financial stakes of manufacturers and governments in e-health technologies are lower than of pharmaceuticals. These organisations are equally interested in financing e-health innovations. The HITECH is an example of a state financing, which is driving a triple-helix partnership amongst government, industry and academia in the USA.

7.9.3 Contributions to practice

1. Paper presented at UNECA at Science with Africa conference on the need for innovation in e-health in Africa published in the proceedings of the conference (http://new.uneca.org/Portals/swa2/documents/swa2proceedings.pdf).
2. We are invited to contribute a presentation on e-health in Africa based on our contributions to development of policy on Europe-Africa ICT cooperation (http://euroafrica-ict.org/files/2010/03/EuroAfrica-ICT_Manifesto1.pdf).
3. Delivered presentations on factors that can contribute to successful national e-health implementation in developing countries at United Nations ESOSOC

conference in 2009 (http://www.un.org/en/ecosoc/newfunct/amr2009ghanaprog.shtml).

4. Delivered presentations on factors that can contribute to successful national e-health implementation in Africa and at the Commonwealth Secretariat conference on national e-health policy development in Southern and West Africa in 2009 (http://www.thecommonwealth.org/files/220414/FileName/Programme.pdf).
5. Our definition for m-health, a sub-set of e-health and a recommendation that stresses the role of recipient's National governments was documented in a seminal publication on m-health in developing countries in 2008 (http://unpan1.un.org/intradoc/groups/public/documents/unpan/unpan037268.pdf).
6. We have been contacted and acknowledged for contributing to the global m-health policy development by mHealth Alliance/United Nations Foundation (http://mobileactive.org/files/file_uploads/WHOHealthReviewUpdatedAug222008_TEXT.pdf and http://www.ghdonline.org/uploads/Barriers__Gaps_to_mHealth_in_LMICs_-_White_Paper_-_May_2010.pdf)
7. In 2011, at the invitation of the African Union, we contributed to the first convocation of e-health expert meeting, which culminated in the first declaration made by African Ministers of Health on e-health in Africa (https://sites.google.com/site/auehealth/).
8. We jointly co-authored an evaluation report on the conduct of the Commonwealth Secretariat's technical assistance to English speaking developing countries on developing their national e-health policies (http://www.thecommonwealth.org/files/250663/FileName/EHealthintheCWJune2012_e-copy.pdf).
9. One of our papers on m-health in developing countries is referenced by a World Bank publication (http://siteresources.worldbank.org/INFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/Resources/mHealth_report_(Apr_2012).pdf).
10. We were invited to a Chatham House conference to comment on how ICT can contribute to health in developing countries in 2008 (http://www.josemariafigueres.org/documentos/Chatham_House_final_programme.pdf).
11. One of our publications was referenced in a policy document compiled for the European Commission on e-health development in developing countries, after we were contacted in 2008 (http://zealot.mrnet.pt/govnet/images/articles/9986/assess-eh-dev-countries.pdf).

12. We were invited by the Chatham House Global Health programme to a panel discussion on the 10th year review of the Macroeconomic Commission for Health in 2011 (http://www.chathamhouse.org/sites/default/files/public/Research/Global%20Health/0112summary.pdf).

7.9.4 Recommendations

We make policy recommendations for global, continental and national institutions.

Global

We identify deficiencies in the current global regulation of e-health technologies that must be addressed in order to foster the acquisition of national e-health technology capacity in Africa. These – can limit or hinder how e-health technologies can be effectively utilised for healthcare services in African countries. Therefore, addressing these structural constraints can go a distance in addressing challenges of technology incompatibilities, inappropriateness and obsolescence. In addition, in order to foster the acquisition of national e-health technology capacity in Africa.

A recommendation for global organisations is to collaborate to set standards for regulating the development of appropriate e-health technologies in a constructive and globally inclusive manner. International Standard Organisation (ISO), World Trade Organisation and the World Health Organisation must collectively address deficiencies in the current global regulation of e-health technologies. These deficiencies can limit or hinder how e-health technologies can be effectively utilised for healthcare services in African countries. Addressing such structural constraints can go a distance in addressing challenges of technology incompatibilities, inappropriateness and obsolescence.

A recommendation offered by both Sachs, 2003 and Juma et al., 2001, that rigid intellectual property rights (IPRs) should be relaxed for biomedical technology transfers (i.e. transfers of drugs, vaccines) to developing countries, is applicable to the conduct of IeTTs. We highlighted in Section 6.5 that the IPRs that come out of co-development of e-health technologies between African countries and global actors as *reverse innovations* (Immelt, et al., 2009), require that the former's interests must be protected. African countries require protection, and deserve to share in any IPRs that come out of e-health technologies co-developed in their hospitals and clinics. We demonstrated in Chapters 3 and 4 that African countries past technoscientific contributions made to

global Satcom innovations, never translated into their domestic technology capacity acquisitions.

Therefore, we recommend that an international regulation regime is also required for e-health technologies. What is good for the *goose is also good for the gander*. E-Health technologies like medicine or vaccines are also essential for saving lives and for empowering health workers in Africa. As such, we highlight the need for regulating the transfers of material e-health technologies, which was not explicitly stated in the IeTT literature presented in Section 1.7. Another concern for global e-health regulation is how to make lagging African countries benefits from these emerging technologies. We demonstrated in Chapter 4 that constraints of affordability – and high costs of procuring e-health technologies from global markets can hinder African countries from acquiring them. Thus, we subscribe to a public health rationale in the scope of existing global regulation of medicines put forward by Blum (2002, p. 102) for e-health technologies. A responsive global regulation must be instituted in order to enhance affordable access to such e-health technologies in African countries, because they are essential for remote diagnosis of and treatment of geographically dispersed and rural African populations.

Continental

At the continental level, efforts can be made to address the challenges of affordable e-health technologies, in a manner suggested by (Blum, 2002), if constraints of institutional fragmentation, regionalism and unilateralism are addressed. Whilst (Blum, 2002), specifically called for the creation of a 'global development authority' for financing the production and transfer of e-health technology transfers, we, rather call for a continental equivalent in Africa. The African Union together with the NEPAD Planning and Coordinating Agency and the United National Economic Council for Africa, can emulate the European Union's (Karopka, et al., 2012; A. Lang & Mertes, 2011) in using policy and financial instruments to stimulate domestic e-health innovations. Moreover, continental aggregation of demand could create economies of scale.

National

African countries must learn to navigate the complexity of global innovation systems in order to obtain fair access to appropriate e-health technologies, if perennial constraint of *national reticence* is addressed. They must aspire to become entrepreneurial or

developmental states by starting to finance and invest into national e-health research centres and institutes. Such an exercise of National Agency can go a long way in accumulating e-health technologies and assimilating technical competence. They can emulate how South Africa (Juma, 2001 & Blum, 2002) successfully strategically and tactically negotiated and navigated the global pharmaceutical regime, in order to ensure that its citizens had access to affordable and quality and life-saving medicines. A 'window of opportunity' (Perez & Soete, 1988) is presented to African countries, who aspire and desire to acquire, accumulate and assimilate competence in this emerging and strategic industry.

Large-scale implementation of e-health technologies is needed by African countries to address the health challenges they are facing, so as to provide quality, accessible and effective healthcare to their geographically dispersed populations. As such, we encourage African countries that they must invest in fostering and forging domestic techno-sciences so as to self-reliantly solve their societal public and clinical health challenges.

7.9.5 Future research

There are four areas identified for future research work.

1. The first is related to the framework. The multi-level interrelationship among the institutional factors can be modelled using an appropriate quantitative method from the field of health informatics. This modelling can be used to weigh and assess the impacts, relevance and relativity of different structural constraints and the identified institutional manifestations. For example, to model how political, economical, organisational, social and technological factors we have identified at global, continental, national and subnational levels interrelate to either constrain or enable the development and utilisation of e-health technologies. How to quantify these qualitative measures can be the focus of the research and a potential contribution to knowledge.
2. The second is to investigate how the conduct of IeTTs in Africa can be studied from the perspective of the preferred STS Constructivism by using Social Construction of Technology (SCOT). To make material e-health technologies the focus of a similar narrative study, to trace and map how e-health technologies diffuse trans-nationally in the context of globalisation and how

their material properties shape, and translate into, national adoptions. A form this investigation can take is to separate e-health into three technological components: -computing, telecommunication and biomedical. The diverse factors we have identified can be examined with each technology as a focus and explore how domestic innovation capacity in each influence the national development and utilisation of e-health technologies.

3. The third is to employ quantitative measures to model how national e-readiness measures, national innovation capacity indicators and the World Health Organisation (WHO) national e-health index are combined to compare and contrast how African countries will measure up among themselves and with the rest of the world on national e-health implementation. The measures of e-readiness of ICT utilisation and infrastructure sophistication are periodically published by the International Telecommunication Union and the World Bank for raking and comparing countries from around the world. The global comparisons of national innovation capacity in the same vein are published by Organisation for Economic Cooperation and Development and measures indicators of domestic capacities such as economic, research and industrial capabilities and outputs. The NEPAD Planning and Commissioning Authority publish similar data that are specific to African countries. The WHO periodically publishes global comparison of, and ranks its member states on their adoption of e-health technologies. The indicators from the three can be modelled to compare and contrast and to identify how African countries are measuring up.

4. The fourth is to fully explore the National Innovation System framework for investigating how a national e-health implementation can be successfully socially and technologically engineered. To further explore in-depth how a possession of domestic innovation capacities in telecommunication, computing and biomedical industries and infrastructures can determine and correlate with incremental national e-health implementation. A form this investigation can take is to select countries from around the world and compare and contrast them based on their national health system structure and configuration. For example, the public sector driven approach of the National Health Service in the UK can

be compared with the private sector driven approach employed in Germany and in the USA.

7.9.6 Research limitations

The data we have collected were mostly from participant observations and interviews of key stakeholders at meetings and conferences, transcribed notes and from privileged access to project and programme documents and meeting and technical reports obtained from stakeholders. We have extrapolated data from a small number of African countries and conducted field trips to these countries. With qualitative data, a limitation might be that the accounts we presented in the narratives were biased, for instance, for the purpose of attending to the research objectives (Sikes & Sikes, 2006). The data we collected were fitting and extremely suitable for investigating the conduct of IeTTs.

We employed a combination of Deleuzian poststructuralist narratives and middle-range STS constructivism to balance the use of qualitative data with the literature, as (Sismondo, 2010, pp.152-153) has shown that using rhetoric merges objectivity with subjectivity (ibid, pp. 146-147).

Given that there was no precedent to follow in our research; the combination enabled us to *narratively construct* a new reality of the conduct of IeTTs in Africa (Sismondo, 2010, p. 167). We were enabled to bring coherence and order to messy, multiple and unstructured qualitative data; and narratively constructed a deeper comprehension of the complex political nature, and the agential asymmetry (Jasanoff, 1996) of the conduct of IeTTs in Africa across time and space. In the process we have constructed new meanings of e-health technology development and utilisation in Africa through improvisation and contingency. We were enabled in such a way that an a priori structure was not imposed on the rich and diverse data we have collected.

Perhaps a case study approach or the use of a quantitative method to compare countries might have sufficed. However, such approaches would not have captured the complexity and the diversity of views that we have identified at the multiple and policy levels. More field trips and interviews might have yielded more data or information; for instance, we might have excluded other relevant policy or programme documents or reports. However, the different countries we have studied were representative of diverse and contrasting states of e-health implementation and domestic e-health innovation capacities in Africa. The scale and richness of our data enabled us to capture and

connect the complexity and diversity of actors and organisations involved in the conduct of IeTTs at multiple levels.

Poststructuralist narrative method can be seen as subjective, but that is its strength. It enables a researcher /ethnographer 'to make sense of the world (subject matter) as she perceives and experiences it' and to relate to an audience what has been discovered (Sikes & Sikes, 2006). The boundary between becoming yourself and others in Deleuzian narrative requires a delicate act of balancing (Gale, 2010). Interpreting what transpired in interviews and decoding texts in documents or transcribed notes in folding process of writing is a creative and reflexive act of an ethnographer. The use of NIS institutionalism theory was influential in this act in our analytical and ethical focus on the development and utilisation of e-health technologies.

A case-study approach will not be suitable for engaging with the rhizome of becoming and fold – interpreting diversities, multiplicities and divergences that we have demonstrated in the narratives (Wyatt & Balmer, 2007). This could have limited us to the study of one country and this would not capture and connect complexities, diversities and multiplicities. A quantitative study will not make these rhizomatic connections as well.

We made policy judgements or recommendations in the narratives and in the conclusions we have drawn from them, which might come as controversial or subjective However, STS constructivism informs that in technology controversies of policy concerns, the knowledge produced is taken as an interpretation of the real world (Sismondo, 2010, p. 134). Narratively constructed knowledge uncovers hidden histories, politics and power so as to challenge or re-order existing or established stable practices and structures. According to (Jasanoff, 2006, p. 403) it is about the 'politics of explanation' in which the reflexivity and creativity of an ethnographer plays a major part in this exercise of re-ordering. Therefore, making or prescribing policy recommendations is 'part and parcel of STS critical enterprise' (ibid.); and, it is about engaging in the controversial or contentious interfaces of technology and society (Kling, 1992; Lehoux & Blume, 2000; May, 2006; Roberts, 2012). This is about policy dilemma of siding either with technology determinism or social essentialism. Whether making technology choices and selecting options and alternatives are conditioned by path-dependencies intended and unintended consequences.

A non middle-range or moderate STS perspective could not have enabled us to engage with such concerns and controversies. Such could have imposed on us predetermined views that could have constrained a full engagement with the diversity and richness of our data.

7.10 Final words

As, globally and nationally, technological advancement in the fields of genomics, antibiotics, mobile computing, vaccines and e-health continue and converge, African countries will certainly benefit. The rapid diffusion and the ever advancing mobile and wireless technologies and infrastructures are ubiquitous platforms can make this happen.

We have identified and highlighted issues that require the urgent attention of national, continental and global policymakers and leaders. The thesis exposed the limitations of cosmopolitan driven consumerist model in the conduct of technoglobalism. The factors of political differences, widening technoeconomic divides, sociotechnical complexities, industrial lopsidedness and rapid technological changes and uncertainties in the age of technoglobalism, stresses the need for the exercise of National Agency. A particular constraint being faced by African countries – the lack and immaturity of domestic innovation capacity, must be recognised in the universal practise of cosmopolitanism that is defining the conduct of IeTTs in Africa. The current *consumerist* model is un-developmental and will not result in an *industrial* e-health technology accumulation and knowledge assimilation.

For African countries not to be left behind in the global trend of national e-health implementation, we foreground the relevance, importance and necessity of domestic technoscience and innovation in national and global policies. We assert that the global techno-optimism, which is underpinning the rush to implement national e-health initiatives, provides a window of opportunity for African countries to acquire technologies from IeTTs.

Whilst not taking for granted that national e-health technology capacity is instrumental for African countries, we stress that collaboration amongst national, continental and global actors and organisations is urgently needed, so as to foster appropriate and affordable e-health innovations in, *and to make e-health work in Africa*.

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Appendix A — List of policy meetings

Participation & Meetings	Details
BEANISH- Europe-Africa Synergies on ICT Strengthening on Collaborative Networks 2007-2009 at the European Union Secretariat, Brussels [BE].	• An European Union Directorate for Development sponsored eHealth technology and policy programme for Africa under University of Oslo Health Information System Programme. • A research and academic eHealth development and discussion forum that fostered the development of District Health information Software (DHIS). • Invited to speak on mHealth innovations in developing countries.
EU-Africa ICT Policy & Programme Forum – 2008-2009 at the European Union Secretariat, Brussels [EU].	• An European Union Directorate for Information Society sponsored eHealth technology and policy programme to foster international cooperation with Africa • An international forum for governmental, non-governmental, public and private forum on ICT innovation and development • Invited to speak at the 1st Summit in 2009 on the implementation of large-scale eHealth initiatives in Africa • Contacted and interviewed on an EU report on eHealth for development in developing countries.

Participation & Meetings	Details
The UN ECOSOC eHealth Ministerial Meeting 2009. Accra, Ghana [UN].	• Organized by the United Nations Economic and Social Council with the World Health Organization and the National Government of Ghana and its Ministry of Health. • Focussed on articulating a common eHealth agenda for the UN system towards the achievement of the MDGs • Invited to convene, chair and speak on mHealth innovations and eHealth policy in Africa
Commonwealth Secretariat eHealth Strategies Ministerial Meetings and Policy Workshops 2009-2011 in South-East Asia and Africa [CM].	• Organized by the Commonwealth Secretariat Social Transformation Division in concert with the Ministry of Health of her member states. • Assists member states in developing their National eHealth Policy and Strategy. • Invited to provide Expert and technical advice to the Secretariat and the member states on national eHealth policy development.
Pan-African eHealth initiatives Meeting 2009-2010, The African Union, Ethiopia [AU].	• A meeting organized by the African Union Commission to chart a future for the European Space Agency, the World Health Organization and the Indian Government sponsored eHealth initiatives in Africa. • Invited to give Expert opinions on policy and adoption issues.

Participation & Meetings	Details
eHealth in Low-resource setting 2009. Stockholm, Sweden [SP].	• An international meeting organized by Swedish Program for ICT in Developing regions and Karolinska Technology Institute, and sponsored by Swedish International Development Agency. • Focussed on policy and programme development on eHealth in low-resource setting in view of a large-scale eHealth implementation in Uganda • Invited to speak and convene a workshop on the telecommunication aspects of eHealth implementation in developing countries
International Year of Science and Technology for Africa: The importance of Telemedicine in fighting disease and promoting health conference 2007. Senato della Repubblica, Rome, Italy [IT].	• Organized by the Italian Association on Telemedicine and Medical Informatics Organized and the Italian Parliament and other international organizations like UNESCO & WABT • Invited to speak on eHealth innovations and implementations in Africa
International Society for Telemedicine & eHealth, 2007. Luxembourg [IS].	• An annual international conference of Experts and Industry on eHealth • Convened a group on eHealth/Telemedicine in low-resource settings • Co-convened a group on mHealth policy in developing countries • Co-founded an online discussion group on Telemedicine in low-resource settings
Science with Africa workshops and conference. June 2010. UNECA, Ethiopia [UN-2].	• Organized by the United Nations Economic Commission on Africa with other development partners to foster science, technology and innovation programme and policy in Africa. • Invited to speak and chair meetings on Global Health and presented eHealth innovations.

Appendix B – list of data sources

This is the list of the different and diverse sources of qualitative data used for writing the narratives in Chapters 3, 4, 5 and 6.

1. STRETCH- Strengthening Community Health in Uganda Project Stakeholders' meeting, 27th of April 2011 at Ankrah Hotel in Mukono, Uganda
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3. Draft Health Sector ICT Policy Implementation Strategies & Action Plans, Republic of Uganda Ministry of Health, 2004.
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5. National Health Information Resource Centre Vision 2012, Strategic Framework, Republic of Uganda Ministry of Health, 2009.
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Appendix C – summarises three pan-African e-health initiatives

IeTTs	Africa Health Infoway	The Indian Pan African Telemedicine Network	eHealth for Africa
Transfer objectives	To support the collection of sub national health data and statistics for analysis, dissemination and for supporting decision making in Health at the District level.	To implement telemedicine infrastructures in selected tertiary hospitals of 53 African countries.	To pilot satellite-based regional telemedicine infrastructure in the Eastern Africa.
Implementation status	Still in pre-implementation planning.	1. Conceived as one of three of the Pan-Africa e-Network in 2005. 2. First presented at the India-African Summit by the then Indian Prime Minister in 2005. 3. First pilot in Ethiopia in January 2006.	A pilot in East and West Africa is currently underway since early 2011.
Services	1. Epidemiological analysis and research. 2. Health service monitoring and evaluation. 3. Supply chain management medical stock inventory.	1. International Teleconsultation services. 2. Medical eLearning and Clinical mentoring.	1. Medical eLearning and Clinical mentoring. 2. Local and international teleconsultation. 3. Remote clinical diagnostic and disease surveillance services. 4. Health data Health Management Information System.

IeTTs	Africa Health Infoway	The Indian Pan African Telemedicine Network	eHealth for Africa
Partners	1. Global Telecommunication Standard setting and Regulatory Agency. 2. Global Health Governance. 3. Global ICT4D advocacy organization. 4. An international development promotion agency. 5. Global philanthropic organization.	1. Indian External Affairs Ministry. 2. Telecommunications Consultants India Limited (TCIL). 3. Indian Elite Universities. 4. Indian Space Research Organization (ISRO).	1. Global Space Agency. 2. Global Geopolitical Agency. 3. Global Space Industry.