Medical Technology Assessment Model for Developing Countries

Isabelle M.P. Roy

A thesis submitted to

The Faculty of Graduate Studies and Research

In partial fulfilment of the requirements for the degree of

Master of Engineering

Telecommunications Technology Management Program

Department of Systems and Computer Engineering

Carleton University

Ottawa, Ontario, Canada

March 2004

Copyright Isabelle M.P. Roy, 2004

National Library
of Canada

Bibliothèque nationale
du Canada

Acquisitions and
Bibliographic Services

Acquisitions et
services bibliographiques

395 Wellington Street
Ottawa ON K1A 0N4
Canada

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

ISBN: 0-612-93970-7

Our file Notre référence

ISBN: 0-612-93970-7

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

In compliance with the Canadian Privacy Act some supporting forms may have been removed from this dissertation.

Conformément à la loi canadienne sur la protection de la vie privée, quelques formulaires secondaires ont été enlevés de ce manuscrit.

While these forms may be included in the document page count, their removal does not represent any loss of content from the dissertation.

Bien que ces formulaires aient inclus dans la pagination, il n'y aura aucun contenu manquant.

Canada

ABSTRACT

The promise of technology as a tool that provides unprecedented efficiency and productivity has great appeal to the donor community as it looks at ways to deliver international assistance in the health sector. However, the last half-century of international development experience demonstrates that large quantities of medical technology equipment that were part of development projects are no longer functioning in developing countries. These failures can arguably be attributed to weak assessment of project viability before they are off the ground. This thesis proposes that faulty risk assessments are the chief culprit for such high rates of failure and that these assessments could be vitally improved with a better risk assessment tool. Using the case study methodology, this thesis presents a medical technology assessment model for developing countries. It hopes this specific tool combined with current risk assessment tools will provide a more accurate and effective way of evaluating the viability of development projects for improving health in developing and transitional countries.

To my husband, Richard, whose love, encouragement,
and support made this thesis possible;

To my three children, Mathieu, Flavie, and Sophie
who teach me everyday to appreciate the simple things in life;

To my parents, for developing my thirst for knowledge;

And to all my friends and relatives for their moral support.

Acknowledgements

I would like to thank my thesis supervisor, Dr. Monique Frize, for introducing me to the fascinating world of biomedical engineering, for her excellent guidance and her dedication to the success of her students.

I would also like to thank Dr. Tony Bailetti for his input at opportune moments during this process.

Thank you to Jean and Pardeep for believing in me.

TABLE OF CONTENTS

CHAPTER I	1
1.1 INTRODUCTION	1
1.2 RESEARCH QUESTION	3
1.3 METHODOLOGY	4
1.4 OUTLINE OF THE THESIS	4
CHAPTER II: CIDA – ITS MANDATE, OBJECTIVES, AND PROCESSES.....	5
2.1 INTRODUCTION	5
2.2 CIDA POLICY – OFFICIAL DEVELOPMENT ASSISTANCE (1995).....	5
2.3 CIDA ACTION PLAN – BASIC HEALTH AND NUTRITION ACTION PLAN (2001)	6
2.3.1 <i>CIDA’s financial commitment to health-related programming</i>	7
2.4 CIDA STRATEGY – KNOWLEDGE DEVELOPMENT THROUGH INFORMATION AND COMMUNICATIONS TECHNOLOGIES (2003).....	8
2.5 CIDA STRATEGY – SUSTAINABLE DEVELOPMENT (2001).....	8
2.6 ICT-BASED PROJECTS AT CIDA – ASSESSMENT PROCESS.....	10
2.7 THE PROJECT CYCLE	10
2.7.1 <i>Country/Regional Programming Framework</i>	10
2.7.2 <i>Project Identification</i>	11
2.7.3 <i>Project Selection</i>	11
2.7.4 <i>Project approval</i>	11
2.7.5 <i>Project Agreement</i>	12
2.8 CURRENT RISK ASSESSMENT TOOLS	12

CHAPTER III: LITERATURE REVIEW	14
3.1 MEDICAL TECHNOLOGY DEFINITION	14
3.2 DESCRIPTION OF APPROPRIATE TECHNOLOGIES	14
3.3 THE CURRENT STATUS OF MEDICAL TECHNOLOGY-BASED PROJECTS IN DEVELOPING COUNTRIES.....	15
3.4 DECISION-MAKING TOOLS.....	17
3.5 EXISTING MODELS FOR ASSESSING TECHNOLOGY.....	20
3.6 OTHER RISK ASSESSMENT MODELS.....	22
3.7 FINDINGS FROM LITERATURE REVIEW ON MODELS	23
CHAPTER IV: RESEARCH METHODOLOGY AND DEFINITION	24
4.1 BACKGROUND.....	24
4.1.1 <i>Models</i>	25
4.1.2 <i>Decision-making process</i>	26
4.2 THE CASE STUDY METHOD	26
4.2.1 <i>Description of cases</i>	27
4.2.2 <i>Objective</i>	27
4.2.3 <i>Data Source</i>	28
4.2.4 <i>Investigators</i>	37
4.2.5 <i>Output</i>	37
4.3 STRENGTHS OF THE CASE STUDY METHODOLOGY	38
4.4 LIMITATIONS OF THE CASE STUDY METHODOLOGY	38
4.5 STRENGTHS OF MY MODEL	39

4.6	LIMITATIONS OF MY MODEL	39
CHAPTER V: CASE STUDY OF MALI		41
5.1	BACKGROUND.....	41
5.2	EPIDEMIOLOGY	42
5.3	GOVERNMENT STEWARDSHIP	44
5.3.1	<i>Background</i>	44
5.3.2	<i>Policy</i>	45
5.3.3	<i>Technology Assessment</i>	48
5.3.4	<i>Regulation</i>	49
5.4	CONNECTIVITY	49
5.4.1	<i>Telecommunications Sector</i>	49
5.4.2	<i>Information and Communication Technology (ICT) Sector</i>	50
5.4.3	<i>Energy Sector</i>	51
5.5	ORGANISATIONAL CAPABILITY	51
5.5.1	<i>Workforce</i>	51
5.5.2	<i>Formal Education</i>	54
5.5.3	<i>Training</i>	54
5.5.4	<i>Process</i>	55
5.5.5	<i>Workforce Ability to Adopt Technology</i>	56
5.6	HEALTH TECHNOLOGY DIFFUSION	56
5.6.1	<i>Medical Services</i>	56
5.6.2	<i>Primary Health Care</i>	56

5.6.3	<i>Secondary and Tertiary Care</i>	57
5.6.4	<i>Private Sector Services</i>	60
5.6.5	<i>Opportunities for Health Technologies</i>	61
CHAPTER VI: CASE STUDY OF BRAZIL		62
6.1	BACKGROUND.....	62
6.2	EPIDEMIOLOGY	63
6.2.1	<i>Burden of Disease</i>	63
6.2.2	<i>Epidemiological Systems</i>	64
6.2.3	<i>Epidemiological Publications</i>	64
6.3	GOVERNMENT STEWARDSHIP	65
6.3.1	<i>Background</i>	65
6.3.2	<i>Policy</i>	66
6.3.3	<i>Technology Assessment</i>	72
6.3.4	<i>Regulation</i>	72
6.4	CONNECTIVITY	75
6.4.1	<i>Telecommunications Sector</i>	75
6.4.2	<i>Information and Communication Technology (ICT) Sector</i>	76
6.4.3	<i>Energy Sector</i>	77
6.5	ORGANISATIONAL CAPABILITY.....	78
6.5.1	<i>Workforce</i>	78
6.5.2	<i>Formal Education</i>	79
6.5.3	<i>Training</i>	80

6.5.4	<i>Process</i>	80
6.6	HEALTH TECHNOLOGY DIFFUSION	82
6.6.1	<i>The Health Industry</i>	82
6.6.2	<i>Medical Services</i>	82
CHAPTER VII: INSIGHTS FROM THE TWO CASE STUDIES		86
7.1	EASE OF GATHERING DATA	86
7.2	SUMMARY OF THE FINDINGS	86
7.3	INSIGHT FOR THE CASE STUDIES	88
7.4	CONCLUSION FROM THE INSIGHT FOR THE CASE STUDIES	90
7.5	PRESENTATION OF THE MEDICAL TECHNOLOGY ASSESSMENT MODEL	90
7.6	ASSESSMENT OF THE QUESTIONNAIRE.....	93
7.7	USING THE MEDICAL TECHNOLOGY ASSESSMENT MODEL TO ASSESS MALI AND BRAZIL	94
7.8	GUIDING PRINCIPLES FOR THE IMPLEMENTATION OF THE MEDICAL TECHNOLOGY ASSESSMENT MODEL	94
7.9	PRESENTATION OF THE PROCESS	95
7.10	DISCUSSION AROUND THE MEDICAL TECHNOLOGY ASSESSMENT MODEL	95
7.11	SUMMARY OF FINDINGS AND CONTRIBUTION TO NEW KNOWLEDGE	96
7.12	CURRENT USES OF THE MEDICAL TECHNOLOGY ASSESSMENT MODEL AT CIDA.....	98
7.12.1	<i>Feasibility stage</i>	98
7.12.2	<i>Planning stage</i>	99
7.12.3	<i>Implementation Stage</i>	100
7.13	SUGGESTIONS FOR FUTURE WORK.....	100

7.13.1	<i>Annual medical technology assessment review and monitoring.....</i>	100
7.13.2	<i>Basis to develop a technology assessment model in other sectors</i>	101
7.13.3	<i>Testing the medical technology assessment model</i>	101
7.13.4	<i>Improving the medical technology assessment model</i>	102
BIBLIOGRAPHY.....		105
APPENDIX.....		111

Chapter I

1.1 Introduction

The promise of technology as a tool that provides unprecedented efficiency and productivity has great appeal to the Canadian International Development Agency (CIDA) as it looks at ways to deliver international assistance in the health sector. In addition, external pressures to “bridge the digital divide” are encouraging many developing countries and Canadian stakeholders to create room for information and communication technology (ICT)¹ in their development assistance programs.

However, the last half-century of international development experience demonstrates that large quantities of medical technology equipment that were part of development projects are no longer functioning in developing countries [5]. The Standish Group International has estimated this equipment failure rate at 50-60%. More recent figures about e-government initiatives in developing and transitional countries demonstrate similar results [D]. According to these,

- 35% are total failures (the initiative was never implemented or was implemented but immediately abandoned)
- 50% are partial failures (major goals for the initiative were not attained and/or there were significant undesirable outcomes)

¹ Information and Communication Technologies (ICTs) is the term given to define the sector encompassing all converging technologies that carry information, including traditional telecommunications, informatics, broadcasting (radio and TV), cable television, multimedia Internet, and Geographic Information Systems, among others.

- 15% are successes (most stakeholder groups attained their major goals and did not experience significant undesirable outcomes)

According to these figures, the chance of success of ICT projects in the developing countries is poor at best. Although these success rates are acceptable to venture capitalists, they are not acceptable justification for spending Canadian taxpayers' money.

Dr. Frize's doctoral thesis "Evaluating the effectiveness of clinical engineering departments in Canadian hospitals" develops a model for clinical engineering effectiveness in Canadian hospitals. Frize cites clinical engineering as "providing safe and effective management of technology used in patient diagnosis, therapy and monitoring, within health care institutions". [10] Frize also suggests, regarding the use of medical technology, that "future researchers should develop a model for developing nations, to address their specific problems which are certainly at a level of magnitude larger than those of the developed nations". [10] She recognizes that elements taken for granted in developed countries are not necessarily present in developing ones.

This thesis is an attempt to answer that call. Currently there is no hard data available on the rate of failure for medical technology projects in the developing world. (Most of the available information focuses on issues with no statistical data.) [7] However, one can argue that the failure rates of e-growth initiatives overall also apply to medical technology projects.

These failures can arguably be attributed to weak assessment of project viability before they are off the ground. This thesis proposes that faulty risk assessments are the chief culprit for such high rates of failure and that these assessments could be vitally improved with better risk assessment tools. The Logical Framework Analysis (LFA), CIDA's current risk assessment tool,

is a general risk assessment tool for all types of projects that CIDA undertakes. This thesis provides a specific tool for medical technology-based projects that would complement the LFA. This thesis hopes the two combined will provide a more accurate and effective way of evaluating the viability of development projects for improving health in developing and transitional countries.

1.2 Research Question

What are a model, tool and process for assessing developing countries' readiness for acquisition and diffusion of medical technology² to ensure durability³?

Because international development is an environment of uncertainty and unpredictability, models, even simplistic ones, are more valuable than none at all. [12] A literature review revealed there was no existing models that would help CIDA reduce the risk of failure when planning medical technology projects in the health sector. However, there are several existing models for assessing ICT-based projects for any sector in the international development environment that could be used as a basis to develop such a model.

² defined as the drugs, devices, and medical and surgical procedures, and the organisational and supportive systems within which care is provided.

³ That continues to work once donor assistance is gone.

1.3 Methodology

I will analyze which modeling approach will work best to answer the research question, and develop a preliminary model using the case study method to extract the model's attributes from the data. For initial validation, the model developed in this thesis will be used to assess two countries that are located at the two extremes of the medical technology spectrum: Mali and Brazil.

1.4 Outline of the thesis

This thesis is presented in seven chapters. Following the first chapter, the Introduction, I will discuss the Canadian International Development Agency, its framework, and current assessment tools and processes. The third chapter defines medical technologies. It also provides a detailed literature review of the current situation of medical technology uses in developing countries, decision-making tools and current developing country assessment models. This complete, I then begin discussion of my proposed model, beginning with a description of the methodology used to develop the model and some important definitions. Chapter five and six provide quantitative material, detailing the health sector environment of Mali and Brazil, respectively. The last chapter is an analysis of the Mali and Brazil cases. It also presents a model along with a process and suggestions for testing and improving this model. This model is then used to evaluate both Mali and Brazil.

Chapter II: CIDA – Its mandate, objectives, and processes

2.1 Introduction

The Canadian International Development Agency (CIDA) is the Government of Canada's arm for international development, supporting sustainable development activities with an aim to "reduce poverty and to contribute to a more secure, equitable and prosperous world." [C]

CIDA's objective is to assist people of developing countries to achieve self-sustainable economic and social development in accordance with their needs and environment. By cooperating with them in developing activities and by providing humanitarian assistance, CIDA contributes to Canada's political and economic interests abroad in promoting social justice, international stability, and long-term relationships for the benefit of the global community.

2.2 CIDA Policy – Official Development Assistance (1995)

CIDA articulates the goals of its programs in its current policy framework *Official Development Assistance* (ODA). Introduced in 1995, the program concentrates resources on: 1) basic human needs; 2) gender equality; 3) infrastructure services; 4) human rights, democracy, and good governance; 5) private-sector development, and 6) the environment.

In 1996, the Development Assistance Committee of the Organisation for Economic Co-operation and Development (OECD), of which Canada is a member, created new guidelines [endnote: *Shaping the 21st Century* (1996)] that included specific health-related goals in international development. These include:

1. A reduction by two-thirds in the mortality rates for infants and children under 5 and a reduction by three-fourths in maternal mortality by 2015
2. Access through the primary health-care system to reproductive health services for all individuals of appropriate ages by 2015⁴

In 2000, CIDA found that its program priorities needed further refinement. Given the enormity of poverty in the world, new international objectives in health-related issues, and the limited resources available for addressing urgent development needs, it was clear that their 1995 priorities needed expansion. CIDA decided to strengthen its programming in four priority areas: basic education, basic health and nutrition, HIV/AIDS, and child protection.

2.3 CIDA Action Plan – Basic Health and Nutrition Action Plan (2001)

As part of its new mandate, CIDA created the *Basic Health and Nutrition Action Plan*. This new plan was created to address the interwoven nature of factors influencing health in developing nations. The plan states clearly: “Poor health and nutrition are not only consequences of poverty, they are also leading causes of poverty, because they greatly reduce the ability to learn and work, diminishing productivity and creating dependency.” [CIDA Health and nutrition action plan]

⁴ Other health-related objectives in the document include: the eradication of polio by 2005; a reduction of iron-deficiency anaemia in women by one-third of 1990 levels; the elimination of iodine and vitamin-A deficiency disorders; a 50% reduction in the number of undernourished people by 2015; a 95% reduction in measles deaths by 2005; and a 95 % reduction in deaths due to malaria by 2005. Finally, HIV/AIDS is cited as a disease that is deemed worthy of specific attention, with education and services-related objectives regarding HIV/AIDS prevention as well as target levels for reduction laid out.

Health and poverty are closely linked, and strategy development cannot effectively address one aspect without the other.

With this principle in mind, CIDA prioritized its interventions as follows:

1. Improving food security and nutrition
2. Improving access to clean water and sanitation
3. Preventing and controlling communicable diseases
4. Improving sexual and reproductive health
5. Preventing and controlling non-communicable diseases
6. Strengthening health systems
7. Fostering the implementation of sound public policy

In addition, CIDA created the HIV/AIDS action plan, targeting prevention, community capacity-building, care treatment and support, human rights, vulnerable populations, political commitment and leadership, and research and development.

These action plans guide CIDA in all of its programming.

2.3.1 CIDA's financial commitment to health-related programming

An aggressive five-year investment plan to strengthen programming in each area supports these priorities. From 1999-2000 to 2004-05, CIDA's social development priorities indicate that funding for health and nutrition will more than double, increasing to \$305 million a year. This represents a total investment of more than \$1.2 billion over this period. Funding for HIV/AIDS will quadruple over this same period, increasing from \$20 million to \$80 million per year in 2005, for a total investment of \$270 million.

2.4 CIDA Strategy – Knowledge development through information and communications technologies (2003)

In 2003, CIDA published its *Strategy on Knowledge Development Through Information and Communications Technologies*. The strategy cites information and knowledge as “among the resources fundamental to the development process. Access to information and knowledge, other than strengthening civil society, contributes to poverty reduction by allowing individuals and communities to expand their choices.” [C] Further, it states that “information and communication technologies (ICTs) offer new ways of providing access to information and knowledge, and thereby create significant opportunities for learning; networking, social organization, and participation; and improving transparency and accountability.” [C]

ICTs include a wide range of essential tools for sharing information: radio, television, telephony, and the Internet are some examples. They are seen as potential aids in the development process, especially as tools that facilitate the gathering, dissemination, and distribution of knowledge for development. The appropriate use of information and communication technologies, coupled with the development of required associated skills, can promote socio-economic development. For this reason, the *Knowledge for Development Strategy* names ICTs as one of the three areas of programming focus for development of the health sector.

2.5 CIDA Strategy – Sustainable Development (2001)

A key governing principle at CIDA for any development project is sustainability. In 2001, CIDA introduced the *Sustainable Development Strategy 2001-2003*, which has two development policy and program goals and one management goal. They are:

1. To support sustainable development in developing countries in order to reduce poverty and to contribute to a more secure, equitable and prosperous world
2. To support democratic development and economic liberalization in Central and Eastern Europe by building mutually beneficial partnerships
3. To apply a management system approach based on continual improvement in implementing CIDA's sustainable development mandate. Sustainability is part of the CIDA mandate and is critical to a project's overall value and deemed success.

Clearly, two key objectives of this new strategy are to strengthen strategic planning and support more integrated decision-making, two key areas that are seen as critical to the durability of a project.

Jeffcott Johnson confirms the importance of integrated decision-making to the successful ICT-based project: "Technology (Information System) projects cannot succeed without comprehensive consideration of the organizational, social and political factors"[15]. Integrated decision-making that considers the infrastructural state, political and social climate, and available resources most fully permits the possibility of local self-sustainability.

2.6 ICT-based projects at CIDA – Assessment process

Currently, the assessment process at CIDA follows an extensive cycle of consultation and assessment. As I have seen in my own experience at CIDA, it can take anywhere from three months to many years for a project to go from identification to implementation, depending on the mechanism used to deliver the program. Timelines vary widely because of the in-depth consultations that take place both within CIDA (with the project team) and externally, usually with all potential stakeholders. CIDA and country or regional partners in development must mutually agree to, and strongly support, the objectives and expected results of the proposed project. Typically, CIDA programming results in multi-million dollar projects that are implemented over a minimum of 5 years.

2.7 The Project Cycle

2.7.1 Country/Regional Programming Framework

The cycle begins with the Country/Regional Programming Framework (C/RPF). The C/RPF brings together the recipient country/region development needs, CIDA program objectives, and Canadian capabilities. This stage is an exploratory phase with knowledge first gathered during the research, discussions and consultations, including assessments of the economic, political, and social characteristics of a region/nation. This and other sources provide project concepts and ideas. The result is a document that outlines priority programming areas, serving as a master guideline for planning projects.

2.7.2 Project Identification

This stage further refines the earlier C/RFP stage. Potential project ideas are gathered, put forward, or identified within the context of CIDA's bilateral directed programming within a country or region. The goal is to put forward as many feasible ideas as possible, so that the best project idea may be selected from them.

2.7.3 Project Selection

This is where the definition and design of the project takes place. Various potential project ideas are filtered through three screens. Two or three project ideas are selected for formal consideration as a Concept Paper(s). The three screens are:

- enabling environment
- target group screening
- technical and capacity screening

The first two screens address the effect that the project context may have on achieving developmental results. The last screen provides an initial identification of technical and capacity issues related to this potential project initiative.

2.7.4 Project approval

A Project Approval Document (PAD) is prepared by the Project Manager in consultation with the Project Team. This document defines the project, including expected results, performance indicators, critical assumptions, budget, schedule, risks, and implementation methodology. It must demonstrate that the project meets the project appraisal criteria and must demonstrate links with the Country/Regional Programming Framework (C/RPF) or the overall CIDA policy framework.

2.7.5 Project Agreement

Following project approval, CIDA (on behalf of the Government of Canada) normally signs a project agreement with the recipient country. Further negotiations on the understanding, obligations, contributions, responsibilities, and duties of each government can be made at this stage.

Following these stages, project implementation, project management, and project completion and closure can then take place.

2.8 Current risk assessment tools

To plan and manage a project, CIDA relies on several common project management tools. These project design tools include the Logical Framework Analysis (LFA); the Work Breakdown Structure (WBS); project budgets and schedules; project progress and results reporting; and the contract or Contribution Agreement governing the implementation of the project. Both the LFA and the WBS are part of the planning process, and evolve as a project progresses.

The Logical Framework Approach (LFA) is a key project management tool that assists CIDA officers and Canadian and recipient country partners conceptualize the project. Underlying assumptions and risks related to the implementation of the project are considered. The LFA is essentially a brainstorming session that attempts to generate as many ideas as possible on how to address particular problems within a country or region. The LFA is also an integral part of project documentation for project design and approval.

When conceptualizing a project, the LFA asks some fundamental questions of the project team and stakeholders. In terms of risk, the LFA poses the question: “What are the assumptions

and risks involved in undertaking this project?” It does **not** attempt to measure the probability of a risk or its potential impact on a project. Currently, there is no tool available to specifically assess technology-based projects for health.

Assumptions describe the necessary conditions that must exist for the attainment of the expected results (i.e., for a cause to create an effect). However, all projects are subject to external factors (**risks**) that are not within the control of project personnel but that may have a decisive effect on the results, thereby altering the cause-and-effect relationship. Examples of risks range from macro issues (such as the rate of monetary exchange between the Canadian dollar and the local currency) to national issues (such as the passage of important new legislation) to very specific project-related matters (such as the creation of a particular institution by the government or the availability of appropriate candidates for training).

In reality, because international development is very complex and CIDA’s planning cycle is lengthy, the Project Team makes decisions under conditions that are difficult to predict and therefore bear considerable risk. CIDA project teams often rely on personal experience to make their decisions, using anecdotal evidence to form judgements on assumptions and risks. As a result, project evaluations are heavily dependent on the project teams and their personal experience, competence, and skills.

Chapter III: Literature review

3.1 Medical technology definition

Medical technology is traditionally defined as “the drugs, devices, and medical and surgical procedures, and the organisational and supportive systems within which care is provided.” [2] As this tool is to be implemented at CIDA, their definition is expanded to include knowledge and supportive technologies. [2]

Knowledge emphasizes the human capital and processes, which are part of the CIDA mandate for project implementations. Supportive technologies focus on positive, pre-emptive measures for maintaining health and promoting general well-being.

Technology in the health sector is categorized in two types:

1. *Clinical technology*, which consists of medical technology used in direct patient care
2. *Ancillary technology*, which is used to support the provision of health care services including administration, transportation, communication, and technical infrastructure (i.e. electrical, mechanical, civil engineering aspects) both within and among health-care facilities.

The model being proposed encompasses both categories of medical technology.

3.2 Description of appropriate technologies

CIDA’s knowledge for development strategy states that:

“... While they are one important driver of economic growth, they should not be considered a panacea. **It is equally necessary to assess which type of technology is the most effective and appropriate to achieve specific objectives.**”

For the purposes of this thesis, we can use the definition of “appropriate technology” as set out in a joint WHO and UNICEF report. The report defines “appropriate technology” as “besides being scientifically sound, the technology is also acceptable to those who apply it and to those for whom it is used”.^[43]

In other words, the technology needs to be self-sustainable, so that the local users can continue using and benefiting from the technology-based aid even after the project has ended: “Sustainable ICT projects must be locally owned and accompanied by human capacity development, to ensure the ability of individuals and communities to use, maintain, and benefit fully from ICTs.”

3.3 The current status of medical technology-based projects in developing countries

“The price of knowledge is high but the cost of ignorance is greater”

Professor Alan Maynard [19]

According to Richard Heeks of the University of Manchester’s Institute for Development Policy and Management, the success rates of e-government initiatives in developing and transitional countries have been dismal. Heeks states that, of the technology-based projects that have been implemented, “35% are total failures⁵, 50% are partial failures⁶, and 15% are

⁵ Defined as: the initiative was never implemented or was implemented but immediately abandoned.

⁶ Defined as: major goals for the initiative were not attained and/or there were significant undesirable outcomes.

successes⁷.” [D] Another source indicates that the success of ICT projects in developing countries is poor at best. Indeed, the Standish Group International has estimated failure rates of 50-60% as not uncommon. [5] Unfortunately, consistent with the international donor findings, few projects that have a technology component at CIDA have seen much success in terms of durability.

In developing countries, medical technology-based projects are often implemented without sufficient assessment of local needs or comparison with alternative forms of treatment. The fact remains that “old” technologies are being used to a fraction of their potential. [2] The common barriers to effective use of medical technology are: [2]

1. Inefficient prioritization of available resources throughout the world
2. Unequal rights for women and the lack of involvement of women in the development and application of technologies
3. The most appropriate technology for a particular requirement is not necessarily the one that is adopted
4. High technology equipment is not only expensive to buy, but it is also expensive to maintain and to run
5. Lack of regulation can result in the use of technologies that are unsafe or potentially harmful to the public and/or to the operator
6. Cultural barriers relating to the discussion of death or dying, pain or family planning often lead to inadequate use or overuse of available resources

⁷ Defined as: most stakeholder groups attained their major goals and did not experience significant undesirable outcomes.

7. In the early stages of marketing, many products are highly priced
8. Lack of political will to implement a far-sighted program to promote the introduction of suitable technologies for the country in the quest of health for all
9. Low availability of services to maintain the equipment

Proposed projects in developing countries have had a history of overlooking the urgent needs of a countrywide equipment maintenance service, [9] often resulting in closets filled with equipment that is useless or unusable. Technology that is more mundane, however beneficial, tends to be overlooked in favour of technology that is fashionable or interesting. The cases of failure in health technology projects are well documented, but a recent publication nevertheless maintains there is the potential for technology in the health sector in developing countries. The authors suggest there are at least three ways in which technologies could improve health: 1) as an instrument for continuing education; 2) by improving delivery of health and disaster management services to poor and remote locations; and 3) by increasing the transparency and efficiency of governance, which should in turn improve the availability and delivery of publicly provided health services. [7]

3.4 Decision-making tools

“Machines are not responsible for making the decision; people are.” [4]

Managers today do not make decisions only on the basis of intuition, judgement and experience. Numerous quantitative decision-making tools are available, such as:

1. The expected Value Concept and the Payoff Matrix
2. Program Evaluation and review technique (PERT)

3. Activity Scheduling
4. Break-even point
5. Decision tree Analysis
6. Capital budgeting Techniques
7. Operations Research

There also exist several other tools that are more qualitative. These include:

1. *Questionnaires*. These ask a set of direct questions about a sector in a country, for any given country.
2. *Statistical methods*. These mathematically analyze prior data on the country to test for relationships between the individual factors.
3. *Best practices*. These use experience learned in other countries or direct comparison with other, similar countries.
4. *Historical analyses*. Analyses of the unique political, economic and social events in the country use these unique events to explain or forecast a sector in the country.

The tools available today, in addition to the level of information provided within the different tools, have drastically changed with the advent of high technology. And this onslaught of data coming from the new tools has put new demands on managers and policy makers, often turning them into researchers. [12] Tools such as data mining and data warehousing to make sense of this data are now regularly employed to make business decisions.

However, using traditional statistical techniques to find value in this information is more difficult. As Hoch and al. points out, “the sheer volume and complexity of data creates

challenges in getting it into a standard format for analysis, determining the right variables to model, and testing for interactions across variables.” [12]

Purely statistical analysis for development projects is not an efficient use of resources, given the vast number of variables that would need to be tracked and measured. While modern technology has made the processing of large amounts of data possible, the same challenges around knowledge management remain: what information to track, how to track that information, how to integrate the manifold systems, lack of infrastructure, and lack of resources are just a few.

However, while purely statistical analysis may be unfeasible, some statistical analysis is very possible and cost-efficient. Identifying and rating a few key indicators can provide valuable metrics for the evaluation of medical technology projects in the developing world. This kind of crude statistical analysis can make the best of both worlds, combining intuitive methods of decision-making with quantitative analysis.

Indeed, modern theories of cognitive psychology and neuroscience have shown that humans comprehend risk in two fundamental ways: analytic (using an algorithm of normative rules such as probability, formal logic and risk assessment) and experiential (using primarily intuition). Experiential methods of absorbing risk remain the most natural and most common way to respond to risk, and are also the least time-consuming, while analytic methods remain more thorough. In a recent paper, Slovic and al. argued that the analytic and experiential methods should be combined for “a high-level maximization process.” [30] A combination of the two methods seems to be the most effective way to comprehend risk.

My model for risk assessment proposes a combination of these two fundamental ways of comprehending risk. The assessment process uses analytical methodologies combined with

extensive consultation to make the most of the experiential capabilities. By combining these two methods effectively, I hope to improve the assessment process for measuring risk on medical technology projects.

3.5 Existing models for assessing technology

Over the last three years, a number of assessment tools have been developed to measure the ‘e-readiness’ of a situation/place, to gauge how ready a society or economy is to benefit from information technology and electronic commerce. Not many are accessible, as few organizations have made their assessment tools widely available. These tools use a wide range of definitions for e-readiness as well as widely differing methods for measurement. Further, they do not apply specifically to medical technology projects, but rather to ICT-based projects in general.

However, there is a wide range of reports and other resources that can be re-worked into ‘assessment tools,’ including position papers and survey results. A detailed description of these tools can be found in Appendix A.

The table 3.1 below summarizes the tools that several organizations have used to gather information and assess e-readiness.

Tool	Questionnaire	Statistics	Best Practices	Historical Analysis	Number of attributes	Number of stages	Overall score
CSPP	Y	Y			5	4	averaging
CID	Y	Y			5 (19 subgroups)	4	Narrative
APEC	Y	Y			6	N/A	Narrative
WITSA	Y	Y			Range of issues	N/A	Narrative

McConnell		Y	Y	Y	5	3	Narrative
Crenshaw & Robinson		Y			10	N/A	Narrative
CIDCM		Y	Y	Y	4	N/A	Narrative
Mosaic	Y	Y	Y	Y	6	N/A	Narrative

Table 3.1 – Summary assessment of e-readiness tools [B]

One of the challenges of assessing e-readiness measurement tools is the lack of constancy in goals, strategies, and results used in project assessment and implementation. The sheer number of variables presents major difficulties in the development of an assessment tool.

Some generalizations can be drawn, however, in observing the commonalities in the table above. Overall, these tools proved useful for assessing at least one of the following:

1. The readiness of a particular company or group of companies to participate in e-commerce
2. A country's preparedness for e-commerce
3. The current level of technology in a region as a basis to forecast future technology levels
4. A quick but rough gauge of technology usage
5. Understanding the relative roles of political, economic, and social factors in technology's growth and usage
6. Understanding why particular countries progress differently
7. The effects of the technology on the lives of people, and how widely the technology is really being used

3.6 Other risk assessment models

Probabilistic Risk Assessment (PRA) is an integration of several techniques that aims to quantify and assess the potential for failure and to help find ways to reduce risk. However, although effective at revealing technologically centred failures, most PRA techniques do not provide any explicit means of representing organizational or human factors failures [16]. Also, the PRA was designed for industrial and engineering environments, which do not share many commonalities in terms of situation, risk factors, or goals with medical technology projects in developing countries.

Willcocks and Margett also developed a risk assessment model specifically for analysing the development, introduction, and use of information systems in general. [33] Their model introduces six conceptual, inter-playing categories: History, internal context, external context, content, processes, and risk outcomes. This model was applied to a number of Information System projects in different domains, including local governments, and the electronics and manufacturing industries.

Although the application of this model in the health sector for information systems is thought to be useful to guide designers and managers to properly evaluating the risks that arise from the environment within which the project will reside, it is unknown whether it can be used as an a-priori analysis (instead of post hoc). It was also found to be subjective in nature and did not include a measure of change. [15]

Heeks of the University of Manchester's Institute for Development Policy and Management also developed a risk assessment technique for e-Development Exchange to assess e-government projects in developing countries. [D] The technique is based on the analysis of a general set of success and failure factors that affect e-government projects. Users are asked in a

questionnaire to rate the presence/absence of seven factors on a scale from 0 to 10 (see Appendixes B and C). The tool looks at seven factors: information, technology, processes, objectives and values, staffing and skills, management systems and structures, as well as other resources such as time and money. The overall rating attempts to provide a likely outcome for the e-government project.

3.7 Findings from literature review on models

Some commonalities are observed in these different assessing models:

- All the assessment models use a least two tools
- All of them use statistics as a tool
- Questionnaires are another preferred tool
- The manageable size of attributes ranges from four to ten, with five being the most common
- Multiple questions can gauge each attribute
- When attributes are measured in stages, the preferred number of stages used is four
- Most overall scores are narrative

The types of assessment models that exist today in the international development field such as e-readiness and overall rating models are deemed more appropriate for CIDA's work and will therefore be used as an inspiration for the development of my model.

Chapter IV: Research methodology and definition

4.1 Background

The research question consisted of three key components: model, tool and process of decision-making. I started with a few basic concepts as well as an overview of these components that are currently available for decision-making. I intended to examine them in CIDA's decision-making environment. As a starting point, it was important to understand the approaches to decision-making, environmental conditions of decision and decision-making today. Presently at CIDA, project assessments tend to rely heavily on intuition, personal values, and judgment. The processes in place attempt to create a rational approach to decision-making, however, because they fail to consistently take into account important influencing factors, decision-making is weighted more heavily to personal judgment. A critical part of the decision-making process at CIDA involves group decisions. Many of the stages of the project assessment, selection, and implementation involve extensive consultation and discussion among group members. This is because having buy-in from the many different partners, stakeholders, and local beneficiaries is absolutely fundamental to a project's success. Therefore, control must be relinquished in favour of collaboration with all concerned parties if self-sustainability is to be made possible.

With a common understanding of the decision-making elements and the environment in which CIDA operates, initial findings indicated that there were no perfect decisions. However, they suggested that we could select a satisficing model, that still met CIDA's main policy objectives and that ultimately strove to do the right thing.

With that intent, I identified current risk-assessment models. I analyzed the classical risk-assessment tool: scoring models. The research included their history, what they were and what they are used for. It turned out that such models were not suited for CIDA's context.

4.1.1 Models

Scoring models are tools used to control risk more effectively, to reduce the cost of decision-making, and remove human bias from decision. The basic premise of scoring is that analytical technology allows us to learn from our past. It also assumes that the future will resemble the past. It involves statistical analysis of large amounts of data to identify which information available at the time of key decision-making decision correlate most to subsequent performance. Scoring models are used extensively by lending institutions. Findings suggest that they are an effective decision-making tools used to address a specific type of risk. However, they do not consider environmental factors such as political or economic risks. Because international development is highly dependent on environmental factors, scoring models as developed in the financial sector would not be suited for CIDA's decision-making. The volume of data required to develop and validate such a model is not readily available and the volume of projects that would benefit the model would not warrant the large investments by CIDA to develop, implement and maintain such tools. More details on scoring models can be found in Appendix E.

This thesis looked for models that are related to technology in general but more specifically, medical technology and developing country environments. Results from the review confirmed that a medical technology assessment model did not exist. Lacking an existing model, I analyzed current developing country assessment models to extract some commonalities. These were used as a basis to develop my model.

4.1.2 Decision-making process

Based on the findings of CIDA's decision-making environment and considering processes such as the nominal group technique (NGT) and Delphi, the element of group discussion and consultation at CIDA was not challenged in this thesis. Indeed, it was a vital part of the project's success. Where I challenged the decision-making process at CIDA was in its heavy reliance on consultation. Indeed, Hoch and al.'s research findings made the case that models and experts worked better together than either alone. [12] He also found that even if a model was poorly chosen, models and experts nonetheless complemented one another. [12] My belief was that CIDA's consultation process could have benefited from additional, standardized, quantifying tools. Hoch and al. also noted in his research that models were more valuable in unpredictable environments such as CIDA's than in predictable ones. [12] In our situation at CIDA, an assessment model that could somehow quantify some of the key variables in medical technology projects could act as this kind of supporting tool to decision-makers. More details about decision-making processes can be found in Appendix D.

Therefore, the literature review performed in this research concentrated on use of medical technologies in developing countries, decision-making tools and existing models used for assessing technology.

4.2 The case study method

Willcocks and Margetts believed that the strength of case study analysis was that "it can demonstrate the linkages and mutual influence of categories in their model." [33]

Because a risk assessment model on medical technologies in developing countries did not already exist, the research strategy here was to focus on the relationships among the variables of a developing country's health and ICT sector. Two polar cases were proposed. It is assumed that by examining two extreme cases, I was able to capture these relationships and that they could be used to assess a developing country's readiness to adopt and maintain medical technologies. The data collection methods were from both primary and secondary sources such as reports and observation. The evidence was both qualitative and quantitative.

4.2.1 Description of cases

The selection of the countries resulted from consultations with both my advisor and the CIDA health specialists. These professionals consolidated numerous years of experience and extensive knowledge about the health sector of developing countries. They were asked to recommend two developing countries that were situated at two extremes in terms of medical technology advancement. The group recommended Mali and Brazil for the least and most advanced respectively.

4.2.2 Objective

The objective was to identify attributes from the data to develop a model on the ability and capacity to sustain medical technologies in developing countries.

4.2.3 Data Source

The sources were both primary and secondary. Primary sources included country policies and plans. Secondary resources included reports and observations from key development agencies. Large volumes of data in some key areas⁸ specific to the two selected countries were collected.

4.2.3.1 Epidemiology

Epidemiology has been defined as “ the study of the distribution and determinants of health-related states or events in specific populations, and the application of this study to control the health problems”.[17] It is a basic medical science with the goal of improving the health of populations. Epidemiology is not only about death, illness and disability, but is also concerned with more positive health states and the means to improve health. In the broad field of public health, table 4.1 shows that epidemiology is used in a number of ways:

Uses of Epidemiology	Method
Causation	Relating genetic and environmental factors to ill health
Natural history	Relating sub-clinical disease to death or recovery
Description of health status of populations	Relating ill health to trends, age, location etc.
Evaluation of intervention	Effectiveness and efficiency of health services

Table 4.1 – Uses of epidemiology [17]

Statistics is a very important tool in epidemiology. The ultimate goal of epidemiology is to develop a rational process for setting priorities and allocating scarce health care resources.

⁸ These areas have been determined primarily based on my own experience at CIDA in analyzing health-related projects.

Epidemiologists work alongside a variety of other specialists who together provide the community and its decision-makers with information so that policy choices can be made based on a reasonable knowledge of likely outcomes and costs. Epidemiological research results should influence public policy, including health policy.

4.2.3.2 Government Stewardship

The governments in a stewardship role and the population through their demand and market influence these functions. Government stewardship affects the service delivery, which ultimately lead to either good or poor health system performance. [I]

4.2.3.2.1 Policy

Public policy is the sum of the decisions that shape society. It directly influences the environment and patterns of living. Health policy usually refers specifically to medical care issues such as responding to trends in disease prevalence. However, a broad range of policy decisions, not just those in the medical or health field influences health. A health policy should therefore provide a framework for health-promotion actions in the general economy of a community as well as in agriculture, industry, labour, energy, transportation and education. [17]

Figure 4.1 - The health care planning cycle [17]

Figure 4.1 demonstrates the cyclical nature of the health care planning cycle and indicates the importance of monitoring and evaluation to determine whether the interventions have had the desired effects.

Figure 4.2 - Healthy public policy [17]

A healthy public health policy enables people to increase control over and improve their health. To achieve this, it is essential to include the elements cited in figure 4.2. Epidemiology is often an important factor influencing public policy but rarely the only factor doing so. Developing countries often have to rely on research done in other countries since it is usually impossible, and probably unnecessary, for major studies to be repeated. However, policy-makers often have to make difficult decisions regarding the relevance of these studies in their country. Some local evidence is usually required before a strong case can be made for a policy change or costly intervention.

4.2.3.2.2 *Technology Assessment*

Technology assessment combines analytical techniques with policy-making logic and can be defined as the art of applying scientific know-how and technical and economical information to assess and anticipate the needs of a particular country, in order to select the most effective technology for the task at hand. [3] In practice, technology assessment synthesizes unit costs, feasibility, efficacy, efficiency, effectiveness, safety, social, legal, and ethical aspects, and whenever possible, uses one or more scientific methodologies.[29] It also requires collaboration among the public sector, private industry, not-for-profit organisations and other health sector stakeholders.[28]

The information gathering process presents a difficult challenge in most developing countries where information, if at all available, may be biased by national policies and/or social attitudes. [29] As a result, the initial step dealing with the incidence, distribution and control of the disease is usually not done. This leads to the fact that most purchases of medical equipment

in the budget-limited developing country are usually biased by political-social logic, or at best, based on common sense and intuition rather than on research and fundamental analyses of the issues involved. [29] Another problem for developing country health system personnel is the lack of opportunity for formal training in technology assessment. [28]

Based on the limited medical resources of developing countries, a technology assessment process was proposed in 1997. It was a framework for analysis of the major parameters involved: stakeholders, boundaries and constraints, goals and objectives, criteria to be met, performance measures, and measurement of performance. [29] It concludes that the approach to technology assessment in the developing countries must be judged by the particular needs of the country.

4.2.3.2.3 *Regulatory Framework*

Classically, regulation exists due to market failure in providing the adequate level of public health and safety assurances. [2] In the health sector, regulation includes quality and performance standards but also safety and efficacy requirements for pharmaceuticals. Regulation for medical equipment should focus on performance standards and safety requirements. Regulation is required to reduce disease caused by health industry. In fact, the weakness of national regulatory agencies in developing countries has been cited as a major factor contributing to the environmental and health hazards. [2] The regulator needs the necessary independence and authority; and an appropriate infrastructure to enable it to carry out its tasks.

4.2.3.3 Connectivity

Connectivity addresses the overall availability and reliability of the infrastructure. Key elements include availability of communication services, affordability and reliability of network access and the underlying infrastructure (reliability of electrical supply for business-critical computer operations, and ease of importing and exporting goods and of transporting them within a country). [21] Proper functioning of technology is also dependent upon local conditions that may affect how it performs. Such factors as heat and humidity, dust or exposure to other elements can render many technologies unusable.

A vibrant market with numerous hardware and software options can encourage more specialized usage of technology, including solutions that are tailored to local needs. [6] The quality and number of technical support professionals are essential factors in maintaining technology and providing service in the hi-tech sector in general. [6]

4.2.3.4 Organizational Capabilities

We need to assess the health care facilities' capability in terms of people and process. When considering any technology, we often forget that it does not make organisations work. It is people who put their skills to work, create and deliver services for patients they need to serve. [22] Their education and level of skills needed to use the technology and their capacity for change or to adopt technology are very important. When looking at the process, we need to assess the level of technological sophistication. It means looking at the diversity of the hardware devices used in the health care system such as office automation systems, human-computer

interface devices, storage and data compression devices, data distillation systems, and connectivity devices. [26] We also need to assess the degree in which computer-based applications is integrated both internally via common database and externally via an electronic communications link. [26]

4.2.3.5 Health Technology Diffusion and Acquisition

Medical services offered will be used to gauge the type of medical technology available in the country:

Figure 4.3 – Medical services pyramid

An overview of medical technology used at each level can be found in the table 4.2 below:

Stage	Examples of Types of equipment
Basic Service	Mostly supplies with little equipment Stethoscope Sphygmomanometer Poster and radio for public education
Basic Diagnostics & treatment	Electrocardiogram (ECG) Ultrasound X-Ray Basic Operating room Equipment Basic Lab Equipment Monitor Defibrillator Spirometer Television and VCR – based applications
Advanced Diagnostics and treatment	Electroencephalogram Electromyelogram Electro-surgery Equipment Advanced Lab Equipment Intensive Care Unit Equipment Tele-education Geographic Information Systems Patient Administration Systems Web-based applications
Specialized Diagnostics and treatment	Magnetic Resonance Imaging (MRI) Angioplasty Lithotripsy Fiber-Optic and Laser equipment CAT Scanning Automatic Test Equipment Nuclear Medicine Specialized Intensive Care Equipment Tele-health

Table 4.2 – Medical technologies used at the different levels of service

An underpinning element in the sustainability of the technology is equipment maintenance.

Thanks to advances in new technologies, mean time between equipment failures has increased resulting in a reduction of maintenance needs. This has made medical equipment more reliable in

remote areas and developing countries. However, the growth of maintenance services is not keeping pace with the rate of diffusion of health technologies. [9] Appropriate resources such as biomedical engineers and technicians as well as testing equipment and spare parts must be allocated. Ultimately, the objective is to ensure the country has trained people with the latest relevant techniques and adequate means so that they are able to meet all the needs related to equipment management. This important aspect is often forgotten or underestimated when considering the cost of technology. [29]

These areas described above will be closely scrutinized when reviewing the two case studies.

4.2.4 Investigators

The work was conducted by a single investigator. The investigator used the services of CIDA's international development resource centre. This centre is staffed with people that are knowledgeable about where to find data on international development.

4.2.5 Output

From the two case studies, I analyzed, compared and searched for cross-case patterns in the data to identify the enabling and constraining attributes of absorbing and sustaining medical technologies in developing countries. Using the data and insights from the cases, an assessment model was developed.

4.3 Strengths of the case study methodology

The strengths of the case study method are summarized as follows: [44]

1. Likelihood of generating a novel model.
2. The emergent model is likely to be testable with attributes that can be readily measured and hypotheses that can be accepted or rejected.
3. The resultant model is likely to be empirically valid.

4.4 Limitations of the case study methodology

The limitations of the case study method are summarized as follows: [44]

1. Use of a single investigator provides less confidence in the findings and decreases the likelihood of surprising findings.
2. Multiple data collection (interviews, observations) and triangulation⁹ of those various sources would have provided a stronger substantiation of constructs and hypotheses.
3. With fewer than 4 cases, it is often difficult to generate theory with much complexity and its empirical grounding is likely to be unconvincing

⁹ Defined as a method of cross referencing multiple sources of data

4.5 Strengths of my model

The strengths of the methodology did not necessarily translate into the strengths of my model.

Indeed, the second and third ones were found to be inapplicable to my model. However, there are strengths to using the case study methodology to develop my model:

1. It did generate a novel model.
2. It provided a basis for cross-sectional analysis, using past to see future successes.
3. The resultant model is likely to increase success of durability of projects and investments.

4.6 Limitations of my model

The limitations of the case study methodology translated into the following limitations for my model:

1. Data triangulation was sometimes impossible because data on developing countries is very limited and difficult to find.

Due to the time constraints and rarity of data, 2 case studies were conducted. But based on discussions with my advisor and CIDA health specialists, it appears that the health technology advancement for developing countries has a bimodal distribution. By using two extreme cases, the limits of the model were established. Future work could use the model to assess all other developing countries that are situated between Mali and Brazil from a medical technology advancement point of view.

This was an exploratory thesis. No medical technology assessment models have been found in the literature. This was a first attempt at developing this type of decision tool. When considering

how valuable such a model will be for CIDA, the strengths and potential benefits far outweigh the limitations. In addition, it is not suggested to use uniquely this model, it is a complementary tool to CIDA's current decision-making. The last chapter suggests ways of improving the output from this case study method.

Chapter V: Case study of Mali

5.1 Background

Mali, a landlocked country in the Sahel, is one of the poorest countries in the world. Most of the population engages in rain-fed cultivation of subsistence crops, but the country's climate is harsh and unpredictable, with an ever-present threat of drought. The adult literacy rate is less than 20%, among the lowest in the world. Education services are poorly developed, particularly at the primary level. School enrolment among girls is less than one-third the Sub-Saharan average, and up to 80% of school age children in rural areas do not attend primary school. These indicators are important because poor economic conditions and low income depress demand for health services, and foster conditions that make the population susceptible to disease and ill health. The low level of education, particularly among girls, exacerbates health and nutrition indicators for children and contributes to low contraceptive use and high fertility rates.

As in most other Sub-Saharan countries, the main health problems are infectious and parasitic diseases, and the leading causes of death are such preventable diseases as malaria, measles, tetanus, acute respiratory infections, and diarrhea. The burden of disease falls disproportionately on children and women of reproductive age, and health indicators are worse in rural areas than in urban centres. Malnutrition is a severe problem; one-third of children under age 5 and one-fourth of infants under 6 months of

age are stunted. And the emerging problem that must now be targeted is the spread of the HIV virus, which currently infects 5 % of the population, a figure that is on the rise. [38]

Experience with ICT is not yet widespread in the Malian health sector. In most organisations, ICT facilities are implemented top-down. This means that if there is a computer, it is most often installed in the director's room, where other staff do not have access. [11]

5.2 Epidemiology

Table 5.1 indicates what the Malian Health Information System reported as the principal causes for registered mortalities.

Disease	Percentage
Meningitis	21%
Malaria	19%
Diarrhea (dehydration)	14%
Respiratory (pneumonia)	14%

Table 5.1 – Burden of disease, 1996 [23]

Mali is a member state of the UNDP/World Bank/ WHO Special Program for Research and Training in Tropical Disease (TRD). Through this fund, Mali participates in various workshops and meetings such as using remote sensing and geographic information systems for research and

control of infectious diseases, training for good laboratory practice in Benin, and strengthening research capacity on malaria in Burkina Faso. Other benefits of the TRD funds included:

- i) Research capacity building grants;
- ii) Public/private partnership for research training in Belgium;
- iii) Research training grants (3 at the PhD level);
- iv) An exchange program for research and clinical training with the University of Maryland School of Medicine;
- v) The establishment of an international malaria research training program for drug resistance, clinical trials, epidemiology and vector biology; and
- vi) Hosting an international course on vector borne diseases in Africa.

Mali also collaborated and published in the areas of schistosomiasis, malaria, onchocerciasis (river blindness), asthma and chemotherapy of leprosy. Based on TDR funding priorities, epidemiologists in Mali continue to have a primary interest in malaria. Other areas of research include other parasitic diseases, tuberculosis and respiratory infections, borreliosis and enteric diseases. [39] But despite advances in these areas, the current epidemiological pattern stems from the limited capacities to organize, integrate, and deliver priority preventive and curative care packages. [40] The World Bank believes that “ from an epidemiological perspective, the major un-addressed issues in Mali are child malnutrition, health education, and behaviour change. Without improvements in these areas, the curative services offered in the community clinics are unlikely to achieve significant impact on health outcomes.” [39] In addition, when it comes to health issues, traditionally, the population is accustomed to tending to its own needs with the guidance of indigenous practices and beliefs. [38] Currently, many single purpose disease control programs are administered through separate vertical administrative structures, but

are delivered at the most peripheral level by the same providers with little attention paid to workload and skill development needs. [40] There exists a health information system managed by the Health Statistics section of the epidemiology division, which manages the health information system by collecting data via periodical reports from community centres. In addition, certain health programs have also implemented their own manual data collection systems. There is no integration of the various statistic collection systems. It is stated in the Ten-year Plan that the strengthening of the epidemiologic surveillance system will play a vital role in the fight against endemo-epidemic diseases. Projected in the Plan is the establishment of five surveillance systems linking most health stakeholders in Mali.

5.3 Government Stewardship

5.3.1 Background

In the 1980s, the country had a centralized health care system that was unresponsive to the population. Government policy was biased towards urban, curative health care, leaving a splintered and inaccessible system for the majority of the rural population. A state-owned monopoly controlled the distribution and cost of drugs, rendering them inaccessible to all but a few. When the government guaranteed employment for medical school graduates in the mid-1980s, it opened up the sector to private practice but fixed fees at rates that most could not afford. This created a pool of unemployed practitioners.

A national health policy was then developed to establish a framework for expanded access to rural health services and increased availability and affordability of essential generic drugs. However, the urban bias still remained with an inappropriate share of expenditure to

primary health care of the rural sector. The government created a workable community-based health care system that extended coverage to rural areas, but use remained low. The main reason was inability to offer a clear career path for health care professionals. This resulted in difficulty to recruit practitioners. [38]

In 1990, the national health policy and the World Bank's programming sought to promote decentralized district planning and community management of health services in a country with a tradition of centralized administration, which was emerging from decades of dictatorial rule. This called for significant changes in the relationship and responsibilities of the stakeholders. Unfortunately for the sector, decentralization within the Ministry of Health has occurred ahead of the government's overall decentralization program. Not surprisingly, although responsibility for planning had been decentralized, budgets were still mostly controlled centrally. [39]

5.3.2 Policy

5.3.2.1 Government Spending

The World Bank recommended in 1994 (publication *Better Health in Africa*) that African countries spend, on a yearly basis, US\$9-12 per capita to provide a minimum package of primary health care. With a GDP per capita of US\$250 in Mali, this would require the equivalent of one-third to one-half of all government revenues to be spent on basic health care alone – clearly an unrealistic level. The total health spending from all sources amounts to about US\$7 per capita per year.

Government spending for health services in Mali has ranged from 4 to 9 percent of the national budget. Table 4.2 details the various sources of health financing.

Source of Health Financing (1997)	Percentage
State	17.5%
Others (NGOs)	5.8%
External Aid	25%
Household	51.5%
Total	100%

Table 5.2 – Sources for health financing, 1997 [39]

As Table 5.3 shows, the allocation of government health spending also has not been efficient or equitable. Most of it is allocated to administration. The donors have concentrated their efforts on health and environment education. Most strikingly, primary health care and health education programs were entirely funded by donors in 1997. [39]

Source	Government (%)	Donor (%)	Total (%)
Primary Care	0	0	0
Secondary Care	10	15	13
Tertiary Care	0	0	0
Training	9	0	4
Central Administration	48	0	18

Decentralized Administration	23	0	9
Health/Environment Education	0	67	41
Vertical Programs	0	17	10
Logistics	10	1	4
Total	100	100	100

Table 5.3 – Distribution of health expenditure by source, 1997 [39]

In response to the lack of rural health services in Mali, the international donors and nongovernmental organisations attempted to fill these gaps. These resulted in a proliferation of projects and procedures, vertical programs that were poorly integrated and excessive emphasis on new investments at the expense of recurrent costs. This resulted in limited capacity on the government's part to coordinate these various efforts, and most government spending resulted in inefficient and inequitable health services. [39]

5.3.2.2 Strategic Plan

In 1998, the government of Mali completed a 10-year strategic plan for the sector, together with a 5-year investment program, which are to guide both government and donor programs.

The “Plan decennal de developpement sanitaire et social (1998-2007)” has the general objective to improve the health and social status of the population and allow them to participate better in the economic and social development of the country. Results that are more specific include [23]:

1. Ensure financial and geographic access to quality social health services to the population;
2. Reduce morbidity and mortality related to primary diseases;
3. Fight extreme poverty and social exclusion;
4. Promote the development of communities with local participation;
5. Performance growth of health services and social action; and
6. Guarantee an equitable and sustainable financing of health systems and social action.

Lack of a comprehensive action plan for human resource development and other health workforce related issues, such as recruitment and career development, remain a major challenge that the Government is attempting to address more systematically under its new health strategy. [40] In addition, there exists a “Programme de développement sanitaire et social (PRODESS) 1998-2002”. [24] This program details various planned interventions to meet the ten-year plan. These two documents (ten-year plan and PRODESS) are guiding international donor funding and development programming. The time period is expiring for PRODESS and Mali is behind in its implementation schedule.

5.3.3 Technology Assessment

There is little documentation on technology assessment activity in Mali. The only record was in collaboration with neighboring countries in a collective technical assessment for subjects such as malaria transmission blocking vaccines, utilisation of genomic information for tropical disease

drug and vaccine discovery and ultrasound in schistosomiasis. These were funded by the UNDP/World Bank/ WHO Special Program for Research and Training in Tropical Disease.

5.3.4 Regulation

At a central level, the shift in the role of the Health Ministry's administrative units from direct control to more normative, regulatory and evaluative functions is still at the inception stage and needs further consolidation. [40] The Plan also mentions that regulatory enforcement is insufficiently respected [23]. They describe a strengthening of this function in two ways: application of regulation and improvement of the control system.

5.4 Connectivity

5.4.1 Telecommunications Sector

Mali has one of the least developed telephone networks in Africa. The telephone infrastructure is old, overloaded and only provides access to 230 of 701 communities via landlines or via a domestic satellite. This service is poor and even impossible to access at peak hours because landlines are often damaged by traffic or heavy winds. [11] Between major cities, there is a system of radio transmission, though with a limited capacity. The rest of the country has recourse to satellite telephone communications but because this service is very expensive, it is beyond the reach of most Malian citizens, institutions and organisations.

The “Société des Télécommunications du Mali” (SOTELMA) is the sole operator in the sector. SOTELMA also provides a cellular phone and Internet service. A telecommunications regulatory commission has been created to ensure application of the regulation. Until it becomes

operational, the “Ministère de la culture et de la communication”, assisted by SOTELMA, is in charge of regulating the telecommunications sector.

5.4.2 Information and Communication Technology (ICT) Sector

Besides SOTELMA, there are four Internet Service Providers in Mali but none offer point of presence outside of the capital city, Bamako. As a result, there is a big connectivity gap between the capital region and the rest of the country. Regional users need to dial into Bamako in order to connect to the internet. This method proves to be costly and unreliable because of the outdated telephone network. [11] Another obstacle to connectivity is that the use of privately run satellite links is still not allowed in the country. There is no formal national policy on ICTs, national information infrastructure planning or scientific and technical information networking. The “Ministère de la culture et de la communication” is responsible for national policy on telecommunications, libraries, archives, and document centres. Due to the low priority given to the public financing of documentation, and other information centres, very little investment has taken place in ICTs and most of the activities in this area have been financed through internationally assisted development projects. [A] The United Nations – “Benchmarking E-government: A Global Perspective Report” rates Mali 185th amongst its 190 UN Member states. [32] This rating is based on Web presence, ICT infrastructure, and human capital measures.

5.4.3 Energy Sector

Power supply for Mali is provided by a recently privatised enterprise. The production of energy in the country is not enough to deliver electricity to all areas of the major cities at the same time. [11] Therefore, power cuts are frequent and most organisations that can afford to have generators use them frequently. The greater parts of villages, towns and smaller cities in Mali are not connected to the power grid. There is also a limited use of solar energy in rural areas.

5.5 Organisational Capability

5.5.1 Workforce

The latest WHO statistics on health personnel for Mali are: [J]

Category	Mali
Physicians / 100 000	4.7 (1994)
Dentists / 100 000	0.1 (1994)
Midwives / 100 000	3.0 (1994)
Nurses / 100 000	13.1 (1994)

Table 5.4 – Health Personnel in Mali

At a glance, the number of health professionals in the public sector is not responding to the needs of the health policy. [23] The public service is itself adversely affected by the lack of a comprehensive action plan for human resource development with the resulting mismatch between health school enrollments and staffing needs. [40] Government health workers, along

with other civil servants, were relatively well-paid and politically influential [39] but they are not adequately trained to meet the challenge of administrative reform and the process of decentralization of the budgeting and management functions. This process has been gradually implemented from 1993 to 1998. It is still an unfinished agenda largely because of managerial weaknesses and the lack of operational monitoring and evaluation systems. As a result, decision-making authority and accountability over staffing, budget allocations and fundraising for investments have yet to be fully delegated to the regions and health districts. The health system is also constrained by inefficiencies in the management and organisation of secondary and tertiary-care facilities, which in turn, negatively affect change at lower levels in the health structures. [40] There is absence of a good legal framework for private and community health workers. [40] Table 5.5 demonstrates that one workforce problem is a distribution gap of general practitioners and nursing personnel between regions and between urban and rural centres.

Region	Doctors	Nurses	Midwives	Nurse Aids	Other Health Staff	Administrators	Total
Rural	230	931	123	354	402	306	2346
Urban	313	663	220	218	490	527	2431
Total	543	1594	343	572	892	833	4777

Table 5.5 – Personnel allocation, 1997 [23]

More than half the health professionals of the country are concentrated in Bamako. Another problem is current workforce issues in urban areas, that some specialists such as pediatrics and gyneco-obstetrics are not available. For the technicians, there is a void in specialties such as radiology, anesthesiology, ophthalmology, kinesotherapy, public health, hospital hygiene and nutrition. There are also shortages of laboratory technicians. [40] Technicians trained in cardiology, medical imaging, neonatology, parodontology are expected to be provided by international donor community as these do not exist currently in the country. [23]

5.5.1.1 *Community Level*

At the community level, most sub-districts have a health dispensary, typically staffed by a three-person team (a nurse, an aide, and a rural midwife) serving 20 to 40 villages. [39] But these have enormous difficulty attracting and retaining qualified health staff because they currently offer no job security, pension plan, or opportunity for career advancement, and the centres are often located in remote areas. Most health professionals therefore express strong preference for government service. As a result, the vacancy rate for professional staff is high; some centres have remained without a nurse for more than a year. Since the communities determine the salaries, urban areas or better-off regions attract more staff. In addition, professional training emphasizes curative services rather than public health promotion. Staff training and health workforce issues are therefore a major challenge at the community level. [39] As for future workforce requirements at the community level, the Government's ten-year plan outlines the minimum requirement in each community centre as: one state nurse, an aide and a manager of the drug depot. By 2007, five percent of them would evolve to: one doctor, one state nurse, one obstetric nurse, one manager of the drug depot and one lab technician.

5.5.2 Formal Education

There exists one medical school in Mali. [42] The duration of the degree is 7 years. [42]

There also exist a limited number of other training facilities. The “École Nationale de Médecine, de Pharmacie et d’Odonto-Stomatologie” in Bamako graduates approximately 70 physicians and 40 pharmacists per year. This school also offers, in partnership with French universities, the possibility to specialize and a centre for epidemiological research. There is an “École Secondaire de la Santé” that trains auxiliary nurses, midwives, and lab technicians. The two “École d’infirmiers du Premier Cycle” train about 60 nurses per year with specialization in health, obstetrics or pharmacy. The “Centre de Spécialisation des Techniciens de Santé” trains specialized technicians.

The Plan does mention that there is an important spread of expected competency amongst the various schools. This would imply that a revision of curriculum is required. Although the ten-year Plan proposes to offer Malians advanced and specialized services in tertiary hospitals, the current public training facilities cannot supply the future needs of specialized resources in health. In fact, current medical specialization programs such as ophthalmology, public health, and surgery have funding problems. Other specialties will not be trained locally because of high costs. Mali’s current health training capabilities are considered a major obstacle in the successful adhesion to the ten-year Plan.

5.5.3 Training

The primary health care services to be provided at that level are defined by government in a two-page statement of curative and preventive services to be offered. Although the list of the services

is appropriate, it does not provide guidance as to how these services are delivered. [40] There is virtually no means to maintain or update or learn new skills once employed.[11]

5.5.4 Process

The Plan has an aggressive agenda to modernize the health sector processes. This would include a billing and budget management system, a biomedical maintenance team in each secondary and tertiary hospital, a networked hospital management system (internal and external), a hospital information system. [23] The Plan identifies that the current health system needs efforts to ensure quality and sustainability of services include better management of human resources, better accessibility to drugs, biomedical consumables and fluids, and a permanent supply of water and electricity. A recent feasibility study conducted by the Africa Telehealth Project to investigate existing ICT facilities and explore possibilities for implementation of telehealth centres, concluded that the Malian health sector lacks many basic facilities in terms of staff and materials. [11]

5.5.5 Workforce Ability to Adopt Technology

For the workforce ability to be able to adopt new technology, no conclusive statement has been made. Both sides were expressed: "... expect to find resistance among medical and health care personnel to use tools they are unfamiliar with." [11] On the contrary, others thought that if the Malian custom of remunerating for attending courses was used, "...new technology will work as an incentive and will be embraced by all concerned" [11].

5.6 Health Technology Diffusion

5.6.1 Medical Services

At a glance, less than one fourth of Malians (23%) have access to a health facility within a five-mile radius and at every level of the health system, many facilities are still poorly equipped, poorly managed, and usually underused. [40]

5.6.2 Primary Health Care

The primary health care services to be provided at the community level are defined by government in a two-page statement of curative and preventive services to be offered.

Activities include [23]:

- Curative activities – diagnosis and treatment of common ailments (including local endemic diseases).
- Preventive activities, including vaccinations for children and pregnant women, pre- and postnatal consultations and assisted deliveries, healthy child services, hygiene and

sanitation activities, information / education / communication on contraceptives, and community development activities.

- External clinical activities – urine and sputum tests.
- Management activities, including distribution of essential drugs; holding of regular community association meetings; collection, analysis, and transmission of health information; referral to district level of cases requiring further attention.

Although these services are appropriate for a country with such high levels of infant, child and adult mortality related to preventable diseases that have low-technology, low-cost solutions, some of the most important interventions – including health education, information, communication, family planning, and outreach – are provided rarely or are ad hoc. [39]

In addition, the community centres have few resources and materials for information, education, communication, and health education activities, and staff lack incentive to carry out these activities. [39] Most community health centres are able to fully cover recurrent costs through user charges and drug sales. However, these revenues are insufficient to cover all long-term costs, including replacement of equipment and building maintenance. [39] There is also no provision for the government to provide the long-term requirements of sustaining and expanding the community health system. In fact, the government has been reducing support for rural services with the expectation that these will become increasingly self-sustaining. [39]

5.6.3 Secondary and Tertiary Care

All regions have an 80-bed hospital. The district health centre is self-contained, capable of providing emergency surgery and most types of basic care. The centre staff also provides

technical support to the primary care facilities and the volunteer village health workers, although shortages of vehicles, medical equipment, and drugs, and lack of an operating budget makes this more theoretical than real. [39]

Secondary care in Mali includes internal medicine, surgery and gyne-obstetrics. [23]

Table 5.6 shows the tertiary care offered by Mali's 4 national hospitals:

Hospital	Service
Gabriel TOURE	Pediatrics
Kati	Trauma
Point G	Psychiatry, pneumo-physiology
Centre National Odonto-stomatology	Odonto-stomatology

Table 5.6 – tertiary services [23]

These hospitals are under-equipped and have poor facilities. They have a lack and inadequate structure of personnel, weak functional resources, absence of preventive maintenance and poor sanitary conditions. [23] The health system is constrained by inefficiencies in the management and organisation of secondary and tertiary-care facilities which in turn negatively affect the lower levels in the health structure. [40] In fact, the provision of village-level primary health care requires a credible district and subdistrict support system, but in some regions, the system is ill-equipped to meet the challenge. [39] In addition, the growing dependence on donor aid in the Malian health sector has created problems such as difficulties in funding recurrent costs. [39] In 1997, only 6.5% of the National Health budget was spent on equipment. [23] Table 5.7 details plans for secondary and tertiary care as projected in the ten-year Plan:

Type of hospital	Number for 2002	Number for 2007	Services to be offered
Secondary care (1 bed / 7500 habitants)	6 (1395 beds)	8 (1866 beds)	<p>1. Administrative and public health including management of general services, sectorially decentralized planning, personnel training, epidemiologic surveillance, inspection of health establishments, supervision of activities at community level, supply of drugs and promotion of health in the communities.</p> <p>2. Curative, preventive and promotional interventions and techniques such as medical, surgical, obstetrical, odonto-stomatology and ophthalmology consultations, hospitalization, surgery, risky deliveries, dental care and paraclinical investigation (lab, radiology and ultrasound).</p>
Tertiary care (1 bed / 10,000 habitants)	3 (1050 beds)	3 (1400 beds)	<ul style="list-style-type: none"> * gastro-enterology * emergency traumatology * gyneco-obstetrics * university hospital * severe burns * anti-poison centre * specialized blood lab * mental health * cardiology * nephrology * neurology * medical imaging with scanner * urology * general surgery * surgical resuscitation * neonatology * child surgery

Table 5.7 – Planned secondary and tertiary care [23]

It is also planned that secondary and tertiary care facilities will be equipped for the treatment of easily treatable diseases, such as tuberculosis, diarrhea, wasting syndrome and malnutrition, of persons living with AIDS. [40] The Plan mentions the need for new equipment to diagnose early and more advanced technologies to offer new services.

5.6.4 Private Sector Services

Authorized only since 1985, table 5.8 indicates that the private sector services are mostly concentrated in Bamako:

Type	Quantity	Located in Bamako
Medical consultation	31	17
Medical clinic	9	8
Birth clinic	3	3
Surgery clinic	3	2
Dentist	8	7
Nurse care	36	14
Pharmacy	152	110
Pharmacy warehouse	93	3
Import establishment	6	6
Analysis laboratories	2	2

Table 5.8 – Private sector health services (1996) [23]

It is presently recognized that there is no coordination between the private and public service both at the preventive and health statistics level. [23]

5.6.5 Opportunities for Health Technologies

At a recent workshop on tele-health in Mali, ways to use ICTs for better services in hospitals and medical centres were discussed. The identified opportunities based on stakeholder needs are listed in table 5.9.

Opportunity	Importance
Training	1
Communications and networking	2
Policy and public financing of health	2
Personnel Management	3
Health Web Site	4

Table 5.9 – ICTs opportunities in the Malian Health Sector [14]

Client financing, control and follow-up, statistics, population education, better information, improved patient referral were considered less important. Treatment standardisation, epidemiology mentoring and better communications between hospitals and rural centres were not considered important at all.

A summary of the findings on Mali can be found in section 7.2.

Chapter VI: Case study of Brazil

6.1 Background

“The Federal Republic of Brazil is the largest country in South America with an estimated population in 2000 of 166,112,518 and an area of eight and a half million square kilometers. Brazil shares its borders with all of the countries in South America excluding Chile and Ecuador. The country consists of 26 states, a federal district and 5,561 active municipalities. Five major geographical regions are recognized in Brazil. The North is the largest region, occupying 45% of Brazil’s landmass but just has 7.5% of population. Both the Northeast and the Central-West each occupy 18% of the territory, but have 28% and 7% of the population respectively. The Southeast has the greatest concentration of the population – 42.5% but only 11% of the territory and the South has 7% of the territory and 15% of the population. Seventeen percent of the population lives below poverty level. According to the World Health Organisation 2000 Healthy Life expectancy ratings, the average life expectancy in Brazil is 59.1 years of age. Chronic and degenerative diseases are the leading causes of death in Brazil. However, communicable diseases still represent a major cause of mortality, especially in the North and Northeastern regions of the country. Inequalities in health status can be related to different factors, including lack of access to health services, socio-economic status, lifestyles, environment and education. Based on this information, the challenges that the health sector in Brazil faces include the provision of comprehensive health care services

to all who need them... and the improvement of overall health conditions, especially in the Northern regions of the country.” [41]

6.2 Epidemiology

6.2.1 Burden of Disease

“Brazil under-performs other countries of similar income levels, and continues to face long-standing problems in public health. Infant mortality, child malnutrition and maternal mortality among the poor are still high. Brazil is a target for TB reduction due to its high prevalence, especially among the urban and rural poor. Malaria and other endemic diseases threaten the North and Northeast regions. There are relatively new concerns, including AIDS and the sharp increase in injuries and chronic and degenerative diseases such as cardiovascular diseases and cancer among all income groups. Cardiovascular diseases, injuries and cancer (stomach and lung cancer for male, breast and cervical for female [G]) are the leading causes of deaths in Brazil, accounting for about 60% of all deaths.” [34]

6.2.2 Epidemiological Systems

Brazil has both an Epidemiological Surveillance System and a Statistical Information in Health System. There are two epidemiological surveillance systems: epidemiological surveillance, National Health Foundation (FUNASA) and Health situation Room, coordination of Health Information. There is also an epidemiological Bulletin by the National Health Foundation. There are six statistical information systems in Health: Health Information DATASUS, Inter-agency Network for Health Information (RIPSA), Health Information Systems (FUNASA), Health Information Ministry of Health, Core Health Indicators and Data, Brazilian institute of Geography and statistics (IBGE).

These systems have a Web presence with searchable databases by different categories (region, disease, etc.)

6.2.3 Epidemiological Publications

There also exists numerous published articles referring to various health subjects. An example of the epidemiological advancement are two studies found on surveillance methods in public hospitals such as nosocomial infection in pediatric hospitals and neonatal intensive care units. These studies support advances in the implementation of cross-infection prevention and control policies. “With regard to Brazilian scientific output, records from LILACS (Latin American and Caribbean Literature on Health Sciences) database for the 1981-1992 period show that more than half the indexed publications were Brazilian. According to the database of the Institute of Scientific Information, the number of citations with one or more Brazilian authors increased

from 1,317 in 1981 to 2,841 in 1992, totaling 23,975 publications for the period in 1,429 specialized journals; only nine of these journals were published in Brazil.” [G]

6.3 Government Stewardship

6.3.1 Background

The first steps towards health sector reform in Brazil took place in the 1960s when academic teams began to analyse the health status, its socioeconomic determinants, and the characteristics of the health services system. Between 1979 and 1986, associations of health professionals, academic groups, leaders of public agencies, and parliamentarians formed a growing movement to support health sector reform. [G]

In the first half of the 1980s, a concept emerged which came to be known as Integrated Health Measures (AIS). This concept was based on a series of factors, including: [G]

- i) The universal right of access to health services and measures guaranteed through sectoral and intersectoral public policies;
- ii) Regulation of relations between the public and private sector;
- iii) Decentralisation with unified command at each level of government;
- iv) Elimination of the separation between privately financed care to individuals and prevention and collective services; and
- v) Democratization of decision-making for policies and priorities.

Based on AIS, the Unified and Decentralized Health System (SUDS) was implemented in the second half of 1980s.

6.3.2 Policy

The Brazilian Federal Constitution of 1988 mandated the establishment of a universal health system. This system was created with the objective of forming a regionalized system of service provision by the public sector – complemented by the private sector- with the following principles:

- i) Universality: Health care for all citizens is guaranteed;
- ii) Equity: Actions and services are offered for those most in need, reducing inequalities; and
- iii) Integrality: All preventive and curative measures are covered. [34]

In addition to other duties, as set forth by law, the SUDS' role is also: [G]

- i) To supervise and control proceedings, products and substances of interest to health and to participate in the production of drugs, equipment, immunobiological products, blood products and other inputs;
- ii) To carry out actions of sanitary and epidemiological vigilance as well as those relating to the health of workers;
- iii) To organize the training of personnel in the area of health;
- iv) To participate in the definition of policy and in the implementation of basic sanitation actions;
- v) To foster, within its scope of action, scientific and technological development;
- vi) To supervise and control foods, including nutritional contents, as well as drinks and water for human consumption;

- vii) To participate in the supervision and control of the production, transportation, storage and use of psychoactive, toxic and radioactive substances and products; and
- viii) To cooperate in the preservation of the environment, including that of the workplace.

In summary, the health policy in Brazil requires the SUDS to be universal, decentralized, regional, comprehensive and equitable. It consists of federal, state and municipal facilities and contracted private establishments, under the management of the municipal and, in exceptional cases, the state governments, subject to the same standards throughout the country. [41] It also integrates the role of technology (underlined above). Despite the numerous accomplishments of this decentralized system, there remains significant issues to be addressed. In fact, a recent case study of the health sector reform in Brazil argued that “the implemented policies have not guaranteed the equity rights” [1]. That same study documented that people in lower income groups experience more difficulties in getting access to health services and that utilisation rates varied greatly by type of service among income groups, position in the labor market and levels of education. Additionally, The SUDS is also accused of acting “... as a floor available to all but used primarily by the lower class.” [37] Aside from inequities in health outcomes, another main sector issue for the Government is that improving the performance through decentralization depends on improved management and fiduciary capacity at the municipal level.

These include: [34]

- i) Mismatch between delegated responsibilities and existing institutional capacity of many municipalities;

- ii) Unclear division of responsibilities between states and municipalities particularly in terms of planning, supervision and financial and information flows;
- iii) Weak municipal capacity to organize and manage health service delivery, in part due to the dearth of trained management professionals;
- iv) Absence of systematic monitoring and evaluation;
- v) Tendency of municipal managers to focus on inputs rather than results and outputs; and
- vi) Inability of many states and municipalities to implement functional referral systems.

The Government of Brazil as well as other observers recognise that the reforms in the financing of health services are advancing but remain incomplete. Currently, the Brazilian health system is still characterised by: [34]

- i) Instability in funding flow, and large but decreasing differentials in per capita health care resources across states and municipalities, reflecting in part the persistence of historical financing patterns but also uneven levels of commitment to health;
- ii) Persistent bias towards high-cost hospital services and, correspondingly, slow improvements in the quantity and quality of basic care;
- iii) Insufficient linkage between financial mechanism and health priorities;
- iv) Poor incentives for managers of primary care units and hospitals to use public resources efficiently;
- v) Management weaknesses at the municipality level in applying resources to purchase effective service delivery, in using information for monitoring and evaluating performance, and for taking strategic corrective actions; and

- vi) Absence of rigorous analysis of resource use.

Recently, consensus for Brazil's six defined health priorities includes: [34]

- i) Reduce maternal and infant mortality;
- ii) Control priority diseases;
- iii) Improve management, access and quality of health actions and services;
- iv) Re-orient the health care model towards primary care;
- v) Development of health professionals; and
- vi) Enhance social control.

To address the issues and priorities mentioned above, current key policy and institutional reforms for Brazil include: [34]

- i) Transformation into a preventive, outreach-oriented model of care;
- ii) Decentralization of health system management responsibility to the municipal level;
- iii) Regionalization of health systems, to optimize hospital and other high-level resources over a defined geographic area;
- iv) Introduction of performance-based financing mechanisms for primary care services; and
- v) Development of a culture of evaluation, quality and performance-based management.

6.3.2.1 Financing of the Health Care System

Annual public health expenditure was approximately \$100 US per capita in 1998. The government plans to increase this expenditure to \$125 US per capita in 2004. Currently, between

17-25% of the total expenditure is on primary health care. [36] In 1996 about 26% of the federal resources went to primary care, 61% to secondary care and 16% to tertiary care, while the municipal and state levels were mostly spending their funds on primary health care. [G] All three levels of government are responsible for financing the public health system in Brazil. Table 6.1 illustrates that the main sources of income in 1997 came from:

Source	Percentage
Federal	72%
Fiscal Stabilization Fund	19%
National Treasury Bonds	3.6%
Direct collection (fines, etc.)	2.8%
Regular taxes	0.9%
Others	1.7%

Table 6.1 – Main sources of income for the Brazilian health care system, 1997 [41]

Despite the sector's adequate financing resources, "the health care system does not effectively deliver services to the people of Brazil, not primarily because spending in the sector is too low but because resources are not well allocated and utilised." [35]

6.3.2.2 Functions

Table 6.2 shows that each level of the health system performs specific duties:

Entity	Responsibility
Municipalities	Managing the primary and secondary care facilities Planning, organization, monitoring, and evaluation of health measures and services
State	Coordinate, monitor, and evaluate the referral units and the tiered service systems in their jurisdiction <u>Provide complementary measures, technical and financial cooperation with the municipalities</u> Manage tertiary care referral facilities Coordinate the regional referral and back-referral network
Federal	Formulate, issue standards for and evaluate national health policy Ensure the uniformity of the system Regulate relations between private and public sectors Establish standards and patterns for the quality control of products and services <u>Evaluate technologies and promote their adoption</u> Cooperate technically and financially with the states and municipalities
Municipalities, State and Federal	Conduct health promotion campaigns with intensive media support and for the early detection of disease

Table 6.2 – Responsibilities of the three spheres of government [G]

Note: Roles relating to technology are underlined.

With the implementation of SUDS, the public sector began to show inadequacies in keeping up with the demand of the population for health services, due to lack of appropriate funding and management. As such, the private sector was transformed from a supplementary health system to a complementary source of health care services. [41] The private health sector market now

represents over 25% of health care provided to the population. [41] In terms of the different levels of care, table 6.3 shows that the market is shared in the following way:

Level of Care	Percentage SUDS (Public together with private health services under contract by government)	Percentage Private
Primary	95%	5%
Secondary	70%	30%
Tertiary	90%	10%

Table 6.3 – SUDS and Private sector market share for each level of care [41]

6.3.3 Technology Assessment

This role falls under federal responsibility. No formal technology assessment was found during the search. However, many documents pertaining to technology in the health care system were found.

6.3.4 Regulation

As mentioned in the Policy section, regulation is an integral part of the SUDS and is housed in the Ministry of Health. However, a recent case study suggests “ despite regulatory measures to increase efficiency and reduce inequalities, delivery of health care services remains extremely

unequal across the country.” [1] There also exist many other regulators acting in specific but health-related areas. These include: “authorisation to practice of various health professions is granted by the respective professional boards to candidates who hold a degree from a university or technical school. These boards are autonomous public entities created by law, and entrusted with regulation and monitoring the practice of professionals in their respective areas of specialization throughout the country. The health regulations of drugs, equipment, cosmetic and hygiene products are enforced by the Health Surveillance Secretariat within the Ministry of Health” [G]. In addition, “the National Health Quality Control Institute serves as a national reference and quality control laboratory for an integrated network of state and university institutions.” [G]. The “control of agricultural toxins is regulated by intersectoral legislation and involves the Ministries of Health, Agriculture, and Environment. The health sector is responsible for toxicology assessments”. [G] The “food control is a component of the national health surveillance system. Specific legislation establishes basis regulations for the registration, control, standards, monitoring, and related administrative procedures.” [G]

6.3.4.1 Private Insurance Plans

With the growing popularity of private health and insurance plans, a law was passed in June 1998 to regulate these plans. In that role, the National Supplemental Health Agency began operating in April 2000. Some of this regulator’s responsibilities include: [F]

- i) To improve the capacity and the participation of the members of the private health and health insurance plans, guaranteeing the improvement in coverage, and limiting

or impeding the setting of prices and the type of coverage based on the health condition and age of the members;

- ii) To guarantee the uniformity of information of the participants of the private sector, characterising them as users, operators, caregivers and the unified health service;
- iii) To guarantee the uniformity and to maintain the stability of the private sector, establishing conditions to enter, leave and operate in the private market; and
- iv) To ensure that all users have access to services, the right to receive care and to defend their interests

6.3.4.2 National Accreditation Organisation

The National Accreditation Organisation was founded in 1998. This commission's eventual goal is to accredit hospitals at three progressive levels: [25]

1. Accredited (reliable and organized);
2. Fully accredited (reliable, organized with quality practice); and
3. Accredited with excellence (reliable, organized with quality and emphasizing standards of outcome).

The commission will also recommend improvements and updates of standards and new training material for hospitals.

6.4 Connectivity

6.4.1 Telecommunications Sector

Brazil's highly competitive market comprises more than 50 large corporations, both Brazilian and foreign, operating 27.8 million fixed telephone lines, 15 million mobile phones and 870,000 public telephones. [E]

The 1997 Brazilian telecommunications law established the privatisation process for the telephone system and instituted the national telecommunications agency (Agência Nacional de Telecomunicações - Anatel) to regulate the new telecommunications market. The agency also has regulatory powers over television, radio and postal services.

The privatisation increased competition and the introduction of new technologies.

Brazil's telecommunications market is divided into regional concessions for both fixed-line and mobile services, covering the entire nation but following different criteria for each type of service. There are two providers in each region for each type of service. In addition, there are two competing national providers for long distance and international services. In the case of fixed-line services, the geographical limitations will be lifted in 2003 and existing concessionaires will be free to offer services throughout the country. The company which meets its 2001 targets ahead of time will be authorized to expand services at an earlier date. There is a free market for provision of specialized services: business and limited access services, trunking, fiber optic connections and data transmission. Although the privatisation improved the sector performance, the Communications Ministry still estimates that current unsatisfied demand for

fixed-line services is in the order of 25 million users, given that 98% of rural households do not have a line. [E]

6.4.2 Information and Communication Technology (ICT) Sector

Brazil was among the first developing countries to put in place policies promoting the development of a national ICT industry. Because that policy was pursued over two decades, Brazil is poised today to become a major production centre. Brazil offers a large market, manufacturing capabilities, installed industrial base and access to other South American markets with which it has trade agreements. Several major computer hardware firms have located regional production centres in Brazil, and this has slowly begun to attract component suppliers as well as major parts distributors and specialized contract manufacturers. Brazil has a tradition of excellence in IT-related research and large university trained workforce which, taken together with the size of its domestic market, provide good opportunities to create both demand for and production of software and services aimed at local users. However, with the current income distribution, growth of the internal market is limited and skill shortages are emerging. In addition, the focus on developing ICT as a sector has resulted in limited impact on development goals. Aware of these issues, the government launched the "Information Society Program" in December 1999. The Program's scope includes: promoting business competitiveness, universal access for citizens, education, e-government, research and development of key technologies, local content development, and basic infrastructure deployment. [H] In a United Nations report on e-government advancement of Member states, Brazil ranked 18th highest in the world.[32] In that same report, Brazil's single entry portal is given as an example of an excellent e-government enhanced site. When compared with its regional counterparts, the report indicates that Brazil's

ICT infrastructure and human capital measures are above the average. However, when compared with other countries in the high e-government capacity, surprisingly, it reports that for Brazil these measures are the lowest in most categories. Another report on Partnership Leading the Global Economy [21] recommends improvement in Brazil's connectivity, information security, human capital and e-business climate to support e-business and e-government. However, the report also considered that the innovation and impact of current public-private partnerships would lead to promising future e-business markets. [21]

6.4.3 Energy Sector

Brazil is unique among major world economies in that hydropower stations generate around 93% of the country's electricity. By way of comparison, in Europe the hydro share is around 13%, and in Japan and the United States roughly 8% each. Of Brazil's 74,000 MW of installed capacity at the end of 2000, approximately 66,000 MW was hydro. [E] Brazil is privatising the energy sector. Most local distribution is now operated by private concessionaires, which have been investing heavily to upgrade antiquated systems. Most generation and virtually all transmission remain public. The government remains firmly committed to further energy privatisation, but the question is a matter of growing political debate. The sector is thus in a state of flux. [E] Because total 2000/2001 rainfalls was much below average, hydropower reservoirs in the Southeast and Centre west stood at 35% of capacity, while those in the Northeast were at 37%. This forced the government to impose rationing in June 2001. In general, residential consumers were required to cut consumption to 80% of their average registered in the months of May/June/July in 2000, while industrial consumers faced cuts of 15% - 25%, depending on the sector. [E] In early July 2001, President Fernando Henrique Cardoso announced plans to accelerate investments and

ensure the 2001 shortages were not repeated. These came on top of previously announced measures to reduce taxation on energy investments and speed up environmental licensing procedures - without in any way relaxing environmental standards. Solar power is increasingly used in Brazil for water heating, typically with installations in individual houses. As the cost of solar generation becomes competitive with conventional electricity sources, there will be expanding scope particularly in the Northeast region that enjoys very high year-round sunshine rates. The government has programs to promote solar power usage in smaller, remote communities that are not served by the nation's major grids or by stand-alone thermal or hydro plants. [E]

6.5 Organisational Capability

6.5.1 Workforce

The latest WHO statistics for health personnel are: [J]

Category	Brasil
Physicians / 100 000	127.2 (1996)
Dentists / 100 000	85.1 (1996)
Midwives / 100 000	N/A
Nurses / 100 000	41.3 (1996)

Table 6.4 – Health personnel in Brazil

Brazil has 513,338 health professionals of whom 40.1% are physicians, 26.8% are dentists, 13.2% are professional nurses, 10.1% are pharmacists, and 9.8% are veterinarians. [G] There are about three doctors for every nurse in Brazil. This leads to problems of efficient utilisation of

scarce resources in areas where less medicalised care is needed. In addition, this problem could be responsible in part for the high c-section rate in Brazil. [35] On the administration side, when taking into account the local government's wide responsibilities in the decentralized model, "it becomes apparent that they do not necessarily have the capacities and incentives to deliver coordinated and cost-effective services." [38] Another workforce problem at the community level staff is that between one-third to one-half of them do not have formal or signed contracts with their employers. [34]

6.5.2 Formal Education

There are 82 medical schools throughout Brazil. [42] The duration of the degree is 6 to 9 years. [42] There exist human resource problems in terms of quantity and quality at the municipality level. The problem is that medical schools train few generalists, and students do not demand such training because the labor markets do not reward general medicine. Family medicine training programs at medical schools are scarce and specialized curricula have yet to be developed. Only seven university hospitals offer family health residency programs, graduating about 25 specialists annually. That is below the supply required by the government to expand the primary care service in Brazil. The shortage of generalists is such that in one of the municipalities of Brazil, the generalists there were originally trained in gynecology, cardiology, anesthesiology, and plastic surgery. [35]

Some states have made special arrangements with the government of Cuba to import physician generalists to Brazil. About 200 Cuban physicians are working in Brazil. [35]

6.5.3 Training

“Currently, the Family Health teams receive an introductory training course as a group. The Community Health Agents receive one-week introductory courses and sporadic in-service training of shorter duration, conducted by the nurse or a contracted trainer. The government complements this training with in-service training through on-site specialization courses and long-distance training. Finally, the government also offers post-graduate training and residency in collective health and family health.” [34]

Other initiatives for training include a Ministry of health initiative to establish training institutions, in partnership with existing medical and other training institutions of higher learning, to deliver new programs ranging from pre-service, in-service and specialty training in family health and using many different training methods, including on-site and distance learning techniques. [34] The Ministry of Health did take the initiative to sponsor the development of training facilities to supply the Family Health Program teams. These training centres provide training courses and continuing education to teams on a large variety of health-related themes and care practices. [34]

6.5.4 Process

The Family Health Program teams are provided with equipment (medical, transport and basic information technology), a standardized system of work and reporting requirements. [34]

6.5.4.1 National Health Card

In 1999, Brazil initiated the National Health Card program in 44 municipalities involving approximately 13 million people. There were plans to expand this program to 130 million people by the end of 2001. The national health card is individual and contains the basic information of the user. Table 6.5 indicates each level of government's responsibility for this project.

Level	Responsibility
Municipality	Registering the user Giving people their cards Updating the database
State	Coordinating municipalities Implementing the system Updating the database
Ministry of Health	Regulates, coordinates and finances the project nationally

Table 6.5 – National health card system operation and maintenance responsibilities [41]

An article describes the Brazilian experience in the development of a nursing information system as “the general lack of knowledge about IT was the principal constraint, which severely hindered meaningful nursing participation in the information system development process”. [8]

This 300-bed hospital has limited computerized information provided by a centralized mainframe computer. It has developed and implemented a patient registration system in one medical unit of the hospital and intends to deploy it to all units.

6.6 Health Technology Diffusion

6.6.1 The Health Industry

Health technology diffusion in Brazil starts at the education stage where “medical training encourages specialization and high-technology care”. [38] In 1995, consumption of medical and hospital equipment and materials in Brazil totalled close to US\$2,000 million, which represents 1.7% of the world market for these products. [G] Domestic industries met about 60% of internal demand, with equal participation by the public and private sectors. [G] Brazil is one of the world’s 10 largest consumer markets for drugs, with a 1.5-2% share of the world market. Gross receipt in the domestic drug market totaled US\$ 9,700 million in 1995, a 15% increase with respect to the previous year. [G] The pharmaceutical industry directly generated 47,100 jobs in 1996, with the overall investments of US\$200 million in that year. The sector comprises some 500 companies, including drug producers, chemical-pharmaceutical industries, and importers. There are 45,000 pharmacies selling 5,200 products in 9,200 different forms. [G] It is important to mention that the numbers above probably provide an overestimation of the industry because the structure of the health system in Brazil is accused of providing weak incentives for quality and cost-effectiveness. [38]

6.6.2 Medical Services

Brazil has more than 6 000 hospitals, with 400 000 beds. [25] Table 6.6 shows that although both private and public facilities offer services, most of the facilities for advanced and specialized treatment are private.

Type of facility	Public	Private	Total number of facilities
Health Care	55%	45%	49,676
Outpatient Care	65%	35%	24,016
Hospitals	28%	72%	7,415
Emergency Care	38%	62%	8,440
Specialized Diagnostic	25%	75%	16,400
Blood Bank	28%	72%	1,078
Specialized Treatment (Radiation therapy, chemotherapy)	28%	72%	7,050
Psychiatric Care	20%	80%	429

Table 6.6 – Capacity of the health sector in Brazil [G]

6.6.2.1 Primary care

At the community level, there is a Ministry of Health's Family Health Program initiative.

Although it is a municipal plan, the federal government subsidizes 30-50% of the costs of each team. In 2001, there were 13,000 primary care teams serving 3,000 municipalities or 25% of the total population. [41] This multi-disciplinary team composed of at least one physician, a nurse and nurse's aides serve as a link between the families and the health services. They visit each

home at least once a month to address needs and motivate the communities to adopt practices that help improve their quality of life. Dentists, social workers and psychologists may be added to the teams based on local necessities and possibilities.

The minimum services they deliver include: [34]

- i) Control of tuberculosis;
- ii) Elimination of leprosy;
- iii) Control of hypertension;
- iv) Control of diabetes;
- v) Activities of oral health;
- vi) Activities in child health;
- vii) Activities in women's health; and
- viii) Actions in health promotion.

6.6.2.2 Secondary and Tertiary Care

Services offered under the SUDS range in complexity and cost. Services such as organ transplant and anti-retroviral therapy for HIV/AIDS are offered and covered by SUDS in Brazil. [35]

Higher level service available in the country include emergency care, high risk pregnancy treatment, intensive care units, drugs for transplantation, breast and prostate surgery. [35] As an indicator of health technology diffusion, table 6.7 shows the services offered in a 122-bed Sao Paulo tertiary care hospital complex.

Department	Services
Children's Institute of Sao Paulo University College of Medicine	Intensive care unit, pediatric surgical care (except cardiac and trauma)
Obstetric	Intensive care for premature infants
Heart institute	Pediatric cardiac surgery, acute pediatric non surgical cardiac care
Surgical Emergency Department	Pediatric trauma

Table 6.7 – Example of neonatal care in a tertiary level hospital [27]

Other indicators of the technology diffusion of advanced medical services include:

- i) The heart valve bank in Brazil supplying hospitals that conduct aortic homografts;
and
- ii) About 18 hospitals use radio nucleide as a radio pharmaceutical for thyroid diagnosis.

A summary of the findings on Brazil can be found in section 7.2.

Chapter VII: Insights from the two case studies

7.1 Ease of gathering data

Most of the data is readily available from reliable external sources such as the World Bank and the World Health Organization. For triangulation purposes or for data that is more difficult to gather, CIDA has internal resources (both human and financial) to complete the data gathering. Options such as using locally engaged professionals in the developing country or hiring a consultant to gather data are common practice at CIDA.

7.2 Summary of the findings

The following table illustrates the key differences between the two case studies. My aim is to identify a set of attributes that can be used to generate a model for determining appropriateness for medical technology projects in developing nations/regions. Table 7.1 provides a summary of the qualifiers for the two countries.

Qualifier	Mali	Brazil
Epidemiology	Current surveillance systems are inefficient and non-technology based. Most epidemiologic advances are directly related to donor driven activities. No means to deal with high epidemic potential. Weak epidemiologic function in the public health policy cycle. Small epidemiology community	Brazil's scientific base and epidemiology is well established and well documented. Various systems and data bases collecting and reporting health sector issues.
Government Spending	US\$7 per capita Large proportion of health funding comes from the donor community	US\$100 per capita
Strategic Plan / Policy	It falls short when it comes to budget, training of staff, and acquisition of engineers and technicians for the management, maintenance, and support of proposed new medical services.	Policy and programs demonstrate the country's proactive views on the role of technology in the medical sector. Decentralized model doesn't

	In the process of decentralizing health services. Not much evidence of technology assessment	necessarily have the capacity and incentives to deliver coordinated and cost-effective services. Many technology assessments conducted by various stakeholders in the sector.
Regulation	Function needs to be enforced. Private sector not regulated.	Regulator of health exists but services remain unequal across the country. Various other regulators for health-related areas i.e. equipment
Connectivity	Mali has one of the lowest infrastructure measures in the world. Inadequate basic infrastructure throughout the country except for the capital city. Little investment taking place on infrastructure.	Low infrastructure measures for its economic development. Inadequate infrastructure in some rural areas.
Organizational capability	Workforce not responding to the needs of the health policy. Workforce distribution gap between urban and rural centers. Workforce does not seem receptive to adopting new technologies. The statistics, management and services have little technical sophistication in their approaches. Limited number of health training facilities and wide spread of quality and competency among them. No means to maintain or update new skills once employed.	High rotation of personnel and job dissatisfaction at the community level. Human resource problem at the municipality level. Training courses and continuing education provided to community level. Government encourages the use of technology for training the workforce and continuous education. It also provides incentives to use technology in the provision of services. Uniform information system at all three levels of government.
Health technology diffusion	Little to no technology at the community level. Medical services are curative. Little attention given to preventive medicine. No services for specialized diagnostic and treatment. Services in advanced diagnostics and treatment are very limited.	Education encourages specialization and high-technology care. Vibrant health industry. Some preventive services provided at the community level. Advanced and very specialized services are provided.

Table 7.1 – Comparison Mali and Brazil

7.3 Insight for the case studies

The following key areas show many interesting similarities and differences. These similarities and differences can point us to what qualifiers are significant for assessing the medical technology readiness of a country:

Epidemiology: There is a difference in the advancement of epidemiology for the two countries both in the scientific base and data systems. Mali is at one end of the spectrum with inefficient, non-technology based surveillance systems and a small epidemiology community. Brazil, on the other hand, has Web-based, searchable data systems with a large and very active epidemiology community. This qualifier is considered significant.

Government spending: There is a large difference in the per capita spending of both countries: US\$7 per capita in Mali versus US\$100 per capita in Brazil. The donor community largely funds the health sector in Mali. Brazil has a large budget to promote the use of technologies in the health sector. This qualifier is considered significant.

Strategic Plan/Policy: Both countries have a strategic plan and policy. One could argue that Mali's documents are purely idealistic and questionably achievable. Brazil's documents integrate medical technologies. This qualifier is considered insignificant.

Regulator: There is a large difference in the regulatory function of both countries. In Mali, the health regulatory body is poorly resourced which results in enforcement that is insufficiently respected. On the contrary, Brazil's health regulatory environment is composed

of several active and specialized functions such as regulation and monitoring the practice of professionals, hospitals, drugs, equipment, cosmetic and hygiene products, laboratories and food control. This qualifier is considered significant.

Connectivity: Mali's connectivity measures are amongst the lowest in the world. Brazil's are considered low for its economic development. The infrastructure measures in Brazil and Mali compare as follows: PCs/100 habitants 4.41 vs 0.1, percentage of population on line 7.1 vs 0.2, telephone/100 habitants 18.18 vs 0.25, mobiles/100 habitants 13.63 vs 0.04. Although Mali's infrastructure is inadequate throughout most of the country, Brazil's is inadequate only in some rural areas. This qualifier is considered significant.

Organizational capabilities: There is a big difference in the quantity and quality of health care in Mali and Brazil. In fact, Brazil's physician community is approximately 25 times larger than Mali's while the nurse community is only 3 times larger. There exist 82 medical schools in Brazil but only one in Mali. The Government of Brazil is taking several steps to support continued education and specialized training. Contrary to Mali where there is virtually no means to maintain or update or learn new skills once employed. In Mali, the process has low technical sophistication. The opposite is true for Brazil where there exists a National Health card system, distance learning and computerized hospital systems. The same gap exists in the level of care available in country. This qualifier is considered significant.

Health technology diffusion: There is a large difference in the level of services available in each country. Mali is predominantly curative whereas Brazil includes preventive with

curative services. Tertiary care is limited and only in four hospitals in Mali while Brazil's health care system offers a large number of highly specialized and sophisticated services. This difference also exists in the list of services to be provided at the community level. Brazil's list of services is more comprehensive. Its delivery team consist of at least one physician, a nurse, a nurse's aide, a dentist, a social worker and psychologists. In addition, little to no human and financial resources are allocated to supporting medical technologies. This qualifier is considered significant.

7.4 Conclusion from the insight for the case studies

Because most of the pre-selected attributes demonstrated a large difference in health-related advancements, they will be considered as technology enablers/constraints for the assessment model.

7.5 Presentation of the medical technology assessment model

Using the qualifiers identified above, the following medical assessment model is proposed:

1. Epidemiology

Factor Question 1a) What is the current epidemiology capacity of the country?

Answer rating: No epidemiologist capacity – High
 Limited number of epidemiologists – Medium
 Community of epidemiologists – Low

Factor Question 1b) How is the epidemiology data used?

Answer rating: No epidemiology data available – High

Studies and projects based on local data – Medium

Results influence the public and health policy - Low

2. Government Stewardship

Factor question 2a) What is the current yearly per capita spending on health in the country?

Answer rating: Less than US\$9 – High

More than US\$9 – Medium

Factor question 2b) Describe the role of the health regulator:

Answer rating: Regulator doesn't exist – High

Regulator exists but does not enforce policy – Medium

Regulator enforces health policy – Low

Factor question 2c) Are there adequate budgets dedicated to technology acquisition?

Answer rating: No – High

Yes – Low

3. Connectivity

Factor question 3a) Describe the country's infrastructure (telecommunication, ICT and energy):

Answer rating: Very poor country wide – High

Adequate in urban areas mostly – Medium

Adequate including to rural areas – Low

4. Organizational capabilities

Factor question 4a) Describe the formal health education sector (quantity and quality)

Answer rating: Very few health training establishments providing basic services level training – High

Some health training establishments providing advanced services level
training - Medium

Many health training establishments providing highly specialized level of
skill and education – Low

Factor question 4b) Describe the continuous training situation of the employed workforce

Answer rating: Little to no opportunities for continuous education – High

Workforce participates in some forms of continuous education – Medium

Continuous education is an integral part of working philosophy – Low

Factor question 4c) Describe the health system processes

Answer rating: Mostly manual – High

Some processes are computerized or automated – Medium

Most or all processes are computerized or automated – Low

5. Health technology diffusion and acquisition

Factor question 5a) What level of services is available in the country?

Answer rating: Basic service – High

Some advanced diagnostics and treatment – Medium

Specialized diagnostics and treatment – Low

Factor question 5b) Are there financial and human resources allocated to the equipment?

Answer rating: No – High

Yes – Low

7.6 Assessment of the questionnaire

Count the number of low, medium, and high risk answers from the questionnaire. The table 7.2 below will give you a recommendation based on the answer that you got most often.

Majority of answer rating:	Result
High risk	Medical technology implementation and sustainability are considered very risky. Favour simple, low technology, basic service equipment for this country. May consider some advanced equipment with great caution.
Medium risk	Medical technology implementation and sustainability are considered medium risk. Country may be ready for specialized equipment.
Low risk	Medical technology implementation and sustainability are considered low risk. Country is ready for any complexity of medical technology.

Table 7.2 – Assessment card

In addition, answers that are high indicate suggested areas for future programming in the country.

7.7 Using the medical technology assessment model to assess Mali and Brazil

Table 7.3 outlines the results when applying the medical assessment model to Mali and Brazil.

Factor Question	Mali	Brazil
1 a)	High	Low
1 b)	High	Low
2 a)	High	Low
2 b)	Medium	Low
2 c)	High	Low
3 a)	High	Medium
4 a)	High	Low
4 b)	High	Low
4 c)	High	Low
5 a)	Medium	Low
5 b)	High	Low
Results	9 High risk / 2 Medium risk Medical technology implementation and sustainability are considered very risky. Favour simple, low technology, basic service equipment for this country. May consider some advanced equipment with great caution or with time and improvement of the above.	10 Low risk / 1 Medium risk Medical technology implementation and sustainability are considered low risk. Country is ready for any complexity of medical technology.

Table 7.3 – Questionnaire result for Mali and Brazil

7.8 Guiding principles for the implementation of the medical technology assessment model

The model should:

1. Describe when to use it. It is suggested that it should be used at the feasibility stage for a ‘quick and dirty’ assessment. “The earlier you assess risk, the harder it is to know the risks accurately. The later you assess risk, the harder it is to do anything about it”. [D].

2. Be used by the project team members consisting of a mix of different stakeholders.
Keeping a manageable number of stakeholders involved ensures you minimize the chance of missing an important risk.
3. Provide measurements for the range of factors that influence sustainability of medical technologies in developing countries.
4. Describe what these measurements could be used for.
5. Clearly describe how to use the model.
6. Indicate how to use the results, including identifying potential difficulties with implementation.

7.9 Presentation of the process

It is suggested that the health specialist and the ICT specialist collaborate to fill out the questionnaire during the “determine feasibility” stage of a health-focused initiative that includes a technology component. The recommendation of the tool would then guide or orient the brainstorming sessions at the project planning stage.

7.10 Discussion around the medical technology assessment model

1. Depending on availability of information, answering the questionnaire requires approximately five days of analysis and research. This is a reasonable level of effort when considering the high dollar values of CIDA projects, the complexity of issues

around medical technologies in developing countries, and the time allocated to analyzing projects in the present environment. To reduce this time, specific sources of information could be identified in the model itself (e.g. The World Bank and World Health Organization's websites are particularly useful for determining the epidemiology and government stewardship attributes.)

2. Because it is difficult to find information on the services offered in a specific country, CIDA would probably need to rely on its local partners to gather this information.
3. The model is a useful tool for quick initial screening. However, for durability, the user needs to consider local environment and conditions of the site where the medical technology will be implemented.

7.11 Summary of findings and contribution to new knowledge

The medical technology assessment model presented in this thesis is a first step to a proposed approach for assessing a developing country's readiness to acquire and sustain new medical technologies. The medical technology assessment model is particularly useful for CIDA in the pre-planning stages of countries with a health focus. It addresses the lack of tools available today for decision-making in the international donor communities on programming for medical technology-based projects. The medical technology assessment model identifies enablers for acquiring and sustaining medical technologies in developing countries. These attributes should be treated as necessary but not sufficient conditions within that context. The thesis also presents a tool that allows decision-makers to assess these enablers.

The medical technology assessment model has also identified areas that Mali and Brazil should address to improve their medical technology readiness assessment. In the case of Brazil,

support in connectivity for rural areas would support further deployment of medical technologies. In the case of Mali, the need is pressing in all qualifiers/enablers. These areas requiring improvement could become the object of future donor programming in the country.

Another use for the tool is in the use of the assessment results. Based on those, the decision-maker should pay particular attention to the enablers that scored high as they relate to the implementation of the initiative. For example, when considering an initiative related to medical staff certification in Mali, it is important to consider that the regulatory function is weak. The team should then include components that address these identified high risks in their design. These high-risk areas are where particular attention should be given by concentrating efforts and resources to adequately address these shortcomings that may ultimately cause the project to fail. It is understood that further analysis is required to establish a successful project implementation plan.

The application of the medical technology assessment model to Brazil and Mali are very encouraging. Indeed, it provides a simple framework that eliminates certain technologies because these countries would not be ready to adopt and sustain them. That, in itself, will be useful information during health project planning stages at CIDA and in the international donor community.

An observation from this thesis is the trade off between complexity and benefit. Indeed, medical technologies stand to have the best health benefit at the primary care level. Paradoxically, that is where its implementation and sustaining is the most difficult.

Another observation is that there probably exists a correlation between a country's medical technology readiness and the focus of health. An assumption would be that countries

focusing on curative health are less likely to absorb and sustain new medical technologies than the ones that include a preventive focus.

7.12 Current uses of the medical technology assessment model at CIDA

People and process meet similar challenges when faced with adopting a new technology. The difference in developing countries is that there are fewer resources available to support and manage this change. Reflecting on Dr. Frize's 1989 doctoral thesis suggesting "future researchers should develop a model for developing nations, to address their specific problems **which are certainly at a level of magnitude larger than those of the developed nations**". [10] Fifteen years later, I would say that this statement still holds true, and that it is the reason why this thesis had to zoom out of the specific hospital setting to consider country- specific issues and context that affect medical technologies. This change of lens resulted in a new model, one that looks at national and very global enablers to provide a quick assessment tool to assist in CIDA's decision-making.

The medical technology assessment model presented in this thesis has already been used to assess several multi-million dollar medical technology-based projects at CIDA. You will find below a list of projects, identified by cycle stage, along with a brief description of the results of the model assessment and impact on CIDA's decision. Some of this information is of a sensitive nature and, as such, must remain incomplete in certain areas:

7.12.1 Feasibility stage

Regional tele-medecine project in Africa: This was an unsolicited proposal to CIDA to invest several million dollars over several years. The model was used to provide a qualitative

assessment. While the request proposed the use of specialized equipment, the majority of answers rated “high”, suggesting that medical technology implementation and sustainability were very risky. A qualitative assessment of the eleven questions was prepared. It supported the CIDA Project Manager’s decision to refuse this “technology-push” proposal.

7.12.2 Planning stage

South Africa HIV/AIDS program (\$30 million): In my role as a resource person reviewing the South Africa proposal on HIV/AIDS programming for the next 5 years, I used the medical technology model to assess if the proposed technology was appropriate for the country. It turns out that South Africa scored low in the majority of the risks yielding a recommendation that the country was ready to absorb and sustain the technology as proposed in their program.

Support to Health Centre of Excellence in two regional communities of Nigeria: In my role as a technical resource for this \$20 million project, I used the seven attributes to direct a Canadian technical consultant as he collected information locally in Nigeria. Upon receipt of this consultant’s report, I then used the medical technology assessment model and found the majority of answers rated “high”. As a result, I provided targeted observations and recommendations at the next Project team meeting, where we will be discussing technological solution options, objectives of the next technical visit in Nigeria, and mitigation measures for the implementation of this project. All these issues need to be addressed before CIDA initiates a request for proposal to select the executing agency for this project.

7.12.3 Implementation Stage

Regional health tele-education project for auxiliary nurses in rural areas of Central America (four countries): In my role as a technical resource for the project team, I used the model at the planning stage to provide country-specific recommendations for the selection of the technological solution of this project. To mitigate risk and improve the chances of success, the project team used the qualitative assessment of the eleven questions. As a result, additional activities were integrated into the project implementation plan. These included organizational capability support and training and upfront commitment from the developing country for recurrent costs of the technological solution.

While it is too early to tell if the assessment tool developed in this thesis and put into use for measuring risk on the above projects has helped increase the durability of medical technology projects in developing nations, current use at CIDA shows that the tool has been very useful thus far for project assessments.

7.13 Suggestions for future work

7.13.1 Annual medical technology assessment review and monitoring

The limits of the model were established by selecting two extreme cases in medical technology advancement. Future work would include using the model to assess the medical technology readiness of *all* developing countries. This could result in a comprehensive annual review. Based on that data, improvement of a country's rating could be monitored over time. When analyzing

this type of data, patterns and factors that contribute to the fastest improvement of a country's rating could be examined.

7.13.2 Basis to develop a technology assessment model in other sectors

This medical technology assessment model could be developed as a generic technology assessment tool to be used in other sectors of developmental interest such as education, agriculture, enterprise, and water & sanitation.

7.13.3 Testing the medical technology assessment model

The medical technology assessment model can be tested using CIDA historical data and maybe other donor data where available. The suggested process would be as follows:

1. Use the model to assess a specific country.
2. Find projects with a medical technology component in that country.
3. Assess the level of complexity of the particular technology (basic, advanced, specialized) for each project.
4. Find the appropriate way of inquiring about the technology's status 2 years after the project's completion date. This could be done through a questionnaire, contracting local staff to audit the site or interviewing the project managers. The questions would revolve around the following issues:
 - i. Is the technology still being used today?
 - ii. Is the technology being used according to its intended use?
 - iii. What is the impact on health care delivery?

5. Use statistical tools to compare the results of the project findings to test the medical technology assessment model. The last step would be to modify/refine it accordingly.

In the case where the technology is not in use, information could be gathered about the reasons why. This could be used to develop critical success factors and critical failure factors of an implementation tool.

The testing of the medical technology assessment model will occur as CIDA collects more data specific to medical technology-based projects. It is suggested that this process be housed in CIDA's Evaluation Branch because of their corporate role.

7.13.4 Improving the medical technology assessment model

Reframing the model

According to Hoch and al., frames are crucial because they simplify and focus our attention on what we deem most relevant, making it possible to decide more quickly and efficiently than with distributed attention. [12] They structure our thinking.

But sizing up a situation based on past patterns can also be disastrous if there have been significant changes in the decision context. Because we accept these simplifications as reality, frames can also create blind spots and be very hard to challenge.

We must constantly challenge our frame. Hoch and al. outlines three tactics for effective frame challenge: [12]

1. Is the frame effective? There is a list of 14 questions to help assess the effectiveness of your frame.
2. Observe the symptoms of frame misfit: poor results, surprises, inconsistencies and difficulties communicating with others are indications of a weak frame.
3. Question our reference points: where do they actually come from?
4. Recognize the key assumptions: as technology evolves, becomes cheaper and more robust, changing several assumptions would create entirely new scenarios for developing countries.

Once it has been identified that the frame may no longer be effective, Hoch and al. suggests a 12-step toolkit for better framing.

Continuous improvement efforts

Using existing data, a cross sectional analysis by attributes can be conducted. This will help improve / validate the model with relevant data in the future.

The tool proposed in this thesis is in the initial stages of implementation. As it becomes operational, CIDA's Evaluation Branch should collect results from projects that were assessed with this tool, the information will be used to evaluate the effectiveness of the tool. It will become evident that the tool needs reframing if durability of the projects is not improved over time.

In conclusion, the answer to my research question “What are a model, tool and process for assessing developing countries’ readiness for acquisition and diffusion of medical technology to ensure durability?” is:

The model developed is a framework that consists of 11 choice questions gauging the risk of 5 country-related attributes. This framework will be complementary to CIDA’s current risk assessment tool, the Logical Framework Analysis.

BIBLIOGRAPHY

Books, reports and articles

- [1] Almmeida C., Travassos C., Porto S. and Labra M.E. "Health Sector Reform in Brazil: A Case Study of Inequity". International Journal of Health Services, Volume 30, Number 1, 2000, p.129-162.
- [2] Ambrose, E. Wasunnam and Wyper, D. Y. "Technology for Health in the Future". World Health Statistic Quarterly, 51 (1998), pp 33-43.
- [3] Banta, H. D. and Luce, B.R. Health Care Technology and its Assessment: an International Perspective. New York, Oxford University Press, 1993.
- [4] Bergeron Pierre. Modern Management in Canada- Concepts and Practices. Nelson Canada , 1987. 907 pages.
- [5] Canadian International Development Agency. "Health, HIV/AIDS and Information and Communication Technologies: a Needs Assessment". Report, May 21, 2002, 52 pages.
- [6] Centre for International Development at Harvard University. "Readiness for the Networked World: a Guide for Developing Countries". www.readinessguide.org, 18 pages.
- [7] Chandrasekhar and Ghosh. "Information and Communication Technologies and Health in Low Income Countries: the Potential and Constraints". Bulletin of the World Health Organisation, 2001, pp 850-855.
- [8] Filho J.R. "The complexity of developing a nursing information system: a Brazilian Experience". Computers in Nursing, Vol 19, No.3, 2001, pp. 98-104

- [9] Frize, M and Cheng, M. "Technical Services for Healthcare Facilities: a Model for Developing Countries". Medical and Biological Engineering and Computing, 32 (1994), pp 335-337.
- [10] Frize, M. "Evaluating the Effectiveness of Clinical Engineering Departments in Canadian Hospitals". Doctoral thesis, 1989, 277 pages.
- [11] Heijke, Lotteke and Julien, Simon. "The African Telehealth Project Feasibility Study Mali 2001". Report, KIT / Royal Tropical Institute in Netherlands, 2001, 24 pages.
- [12] Hoch, Stephen, Kunreuther, Howard and Gunther Robert. Wharton on Making Decisions. John Wiley & Sons, 2001. 339 pages.
- [13] Hoch, Stephen and Schkade David, "A PSYCHOLOGICAL APPROACH TO DECISION SUPPORT SYSTEMS" *management science* (January 1996). Pp. 51-64
- [14] Institut International de Communication et Developpement (IICD) and Centre National d'Appui a la Lutte Contre la Maladie (CNAM). "Workshop on telehealth in Mali: Utilisation des NTIC pour des Meilleures Prestations des Services pour les Hopitaux et les Centres Medicaux". Report, April 2002, 17 pages.
- [15] Jeffcott M, Johnson C. The use of a formalised risk model in NHS information system development. Department of Computer Science , University of Glasgow
- [16] Jonhson C.W. Representing the Impact of Time on Human Error and Systems. *Interacting with Computers*, 1998; 11: 53-86
- [17] Last, J.M. A dictionary of epidemiology. Oxford, Oxford University Press, 2nd edition, 1988, pp.42.
- [18] Marinopoulos, James. "Credit Scoring Development and Methods". Retail Decision Models presentation. 52 pages.

- [19] Maynard, A. and Bloor, K. "Health Care Reform: Informing Difficult Choices". International Journal of Health Planning and Management, 10 (1995), pp 247-264.
- [20] Mays, Elizabeth. Credit Risk Modeling- Design and Application, Glenlake Publishing Company,ltd. 1998. 257 pages.
- [21] McConnell International. "Ready? Net. GO! Partnership Leading the Global Economy". Report, 2001, 23 pages.
- [22] McMahon, Ed. Bricks to Clicks. Stoddart Publishing, Toronto, 2000, 260 pages.
- [23] Ministère de la Santé des Personnes Agées et de la Solidarité. "Plan Décennal de Développement Sanitaire et Social 1998-2007". Report, Government of Mali, 138 pages. pp 17 – 115 passim.
- [24] Ministère de la Santé des Personnes Agées et de la Solidarité. "Programme de Développement Sanitaire et Social 1998-2002". Report, Government of Mali, 1998, 118 pages. pp.37.
- [25] Novaes H. and Neuhauser D. "Hospital Accreditation in Latin America". Panam Salud Publica, 7(6), 2000, p. 425-430.
- [26] Pare G. and Sicotte C. "IT sophistication in Hospitals: A field Study in Quebec". 2001.
- [27] Reis A. and others. "A Prospective Investigation into Epidemiology of In-hospital Pediatric Cardiopulmonary Resuscitation Using the International Utstein Reporting Style". Pediatrics, Vol 109, No. 2, Feb 2002, pp. 200-209.
- [28] Sadasivan, Sivalal & others. "A Training Course in Health Technology Assessment in Malaysia". International Journal of Technology Assessment in Health Care, 1998, pp.809-817.

- [29] Sideman, Samuel and BenDak, Joseph D. "Assessing Medical Technology in Less-developed Countries". International Journal of Technology Assessment in Health Care, 1997, pp 463-472.
- [30] Slovic Paul, Finucane Melissa, Peters Ellen, MacGregor Donald. "Risk as Analysis and Risk as Feelings: some thoughts about affects, reason, risk and rationality". Decision Research Organization. Paper presented at Annual meeting of the society for Risk Analysis, New Orleans Dec 10 2002.
- [31] Thomas L.c. Ho J. Scherer W.T. "Time will tell: Behavioural and dynamics of consumer credit assessment" Paper produced in collaboration between universities of Southampton, Edinburgh and Virginia. 33 pages
- [32] United Nations. "Benchmarking E-government: A Global Perspective". Report, May 2002a, 74 pages.
- [33] Willcocks L, Margetts H. Risk assessment and information systems. European Journal of Information Systems 1994; 3 (2): 127-138
- [34] World Bank. "Project Appraisal Document: Family Health Extension Adaptable Lending Program". Report no. 23353, 2002a, 157 pages. pp. 10 – 84 passim.
- [35] World Bank. "Brazil Maternal and Child Health". Report no. 23811, 2002b, 88 pages. pp. 37 – 49 passim.
- [36] World Bank. "Addressing Health Inequalities: The Brazilian Experience". Conference, April 10-11, 2001.
- [37] World Bank. "Health Insurance Reform in Four Latin American Countries: Theory and Practice". Policy Research Working Paper no. 2492, 2000, 49 pages.

- [38] World Bank. "Investing in Health: Development Effectiveness in the Health, Nutrition, and Population Sector". Report, 1999, 71 pages.
- [39] World Bank. "The World Bank and the Health Sector in Mali". Report no. 18112, 1998a, 46 pages.
- [40] World Bank. "Project Appraisal Document on a Proposed International Development Association Credit to the Republic of Mali for a Health Sector Development Program". Report no. 17744, 1998b, 23 pages.
- [41] World Health Organisation. "Health Sector Reform and Equity: Bolivia and Brazil Study Cases". Technical Reports Series No. 78, Pan American Health Organisation, 2001, 45 pages.
- [42] World Health Organisation. "World Directory of Medical Schools". Seventh Edition, Geneva, 2000.
- [43] World Health Organisation and UNICEF. "Appropriate Technology". Report, 1999, Alma Ata Conference.
- [44] Yin, Robert K. Application of Case study research . Applied social research methods series; v. 34, 1993. page 19

Web Site

- [A] Bellanet. “National ICT profile for Mali”. www.bellanet.org.
- [B] Bridges. “Comparison of E-readiness Assessment Models”. Report, 2001,
www.bridges.org.
- [C] Canadian International Development Agency. www.acdi-cida.gc.ca
- [D] e-Development Exchange. “Risk assesement in e-government projects”. Report 2003,
www.e-devexchange.org/eGov/riskassess.htm
- [E] Government of Brazil. “Infrastructure”. <http://www.infraestruturabrasil.gov.br>.
- [F] Ministry of Health. “A Regulamentacao do Setor de Saude Suplementar”.
www.portal.saude.gov.br/saude/.
- [G] Pan American Health Organisation. “Country Health Profile 2001: Brazil”.
www.paho.org.
- [H] United Nations Development Programme. ”Digital Opportunity Initiative: A Public
Private Partnership of Accenture”. Report, with Markle Foundation, www.undp.org.
- [I] World Bank Group. “Health Systems Development”. www1.worldbank.org.
- [J] World Health Organisation. “WHO Statistics – Health Personnel”. www3.who.int.

APPENDIX

Appendix A (Sourced from [B])

A. Ready-to-Use Tools - Questionnaires

a) CSPP's Readiness Guide for Living in the Networked World

Who created the tool?

The Computer Systems Policy Project (CSPP) developed this guide. It was published in 1998, and is available at www.cspp.org. CSPP is a "public policy advocacy group...comprised of the Chairman and Chief Executive Officers" of US information technology companies.

What is the tool's goal?

This self-assessment tool is designed to help individuals and communities determine how prepared they are to participate in the "Networked World."

What does it measure?

The guide measures the prevalence and integration of ICTs in homes, schools, businesses, health care facilities, and government offices, with additional focus on competition among access providers, speed of access, and government policy. Measurements are divided into five categories:

1. infrastructure
2. access
3. applications and services
4. economy; and
5. "enablers" (policy, privacy, security, ubiquity).

How does it define 'e-readiness'?

An 'e-ready' community has high-speed access in a competitive market; with constant access and application of ICTs in schools, government offices, businesses, healthcare facilities and homes; user privacy and online security; and government policies which are "favorable to promoting connectedness and use of the Network."

How is the assessment carried out?

The CSPP Readiness Guide provides a series of 23 questions, for community members to ask about the community itself. For each question, the users choose from a set of answers, which represent four progressive "stages" of development. The 23 questions are divided into the five categories listed above. For example, "chose the level of access to network services provided in homes in your community. a) 25 % of homes have a computer / access device..."

What result does it produce?

The assessment produces a rating that indicates which of four progressive stages of development the community is at for each of the five categories listed above. "An overall 'score' for the community can be estimated by simply averaging the scores across the criteria."

Are there existing reports that have used this assessment tool?

Yes. See <http://206.183.2.91/projects/readiness/assessments.htm>

b) CID's Readiness for the Networked World: A Guide for Developing Countries

Who created the tool?

The Center for International Development at Harvard University developed this guide. It was published in 2000, and is available at www.readinessguide.org. It draws from the earlier CSPP guide, described above.

What is the tool's goal?

"The guide...systematically organizes the assessment of numerous factors that determine the Networked Readiness of a community in the developing world." This assessment is meant to serve as a basis for further analysis and planning.

What does it measure?

This guide measures 19 different categories, covering the availability, speed, and quality of network access, use of ICTs in schools, workplace, economy, government, and everyday life, ICT policy (telecommunications and trade), ICT training programs, and diversity of organizations and relevant content online.

How does it define 'e-readiness'?

An 'e-ready' society is one that has the necessary physical infrastructure (high bandwidth, reliability, and affordable prices); integrated current ICTs throughout businesses (e-commerce, local ICT sector), communities (local content, many organizations online, ICTs used in everyday life, ICTs taught in schools), and the government (e-government); strong telecommunications competition; independent regulation with a commitment to universal access; and no limits on trade or foreign investment.

How is the assessment carried out?

The guide provides a grid with descriptions of four stages of advancement in each of 19 categories (placed into five groups). Communities estimate their current stage of development in each category. No prescription is given on how that estimate should be made.

What result does it produce?

The guide rates the 'stage' a community is in for each of the 19 categories, and descriptions are given of what is required to be in a particular stage. "The Guide does not offer prescriptions for improved Readiness."

Are there existing reports that have used this assessment tool?

Yes, many. See <http://www.readinessguide.org/examples.html>.

Other Notes:

A new, more comprehensive, version of the guide is in development and is expected soon. The guide is currently available in six languages. Detailed descriptions of each category and their place on the grid are given.

c) APEC's E-Commerce Readiness Assessment

Who created the tool?

The Asian Pacific Economic Cooperation (APEC) Electronic Commerce Steering Group developed this guide. It was published in 2000, and is available at <http://www.ecommerce.gov/apec/>, and http://www.ecommerce.gov/apec/docs/readiness_guide_files/readiness_guide_5.pdf. More detail on the measurements can be found at: http://www.ecommerce.gov/apec/docs/readiness_background.html.

What is the tool's goal?

"To help governments develop their own focussed policies, adapted to their specific environment, for the healthy development of e-commerce."

What does it measure?

Six categories are measured for "readiness for e-commerce:"

1. basic infrastructure and technology (speed, pricing, access, market competition, industry standards, foreign investment),
2. access to network services (bandwidth, industry diversity, export controls, credit card regulation),
3. use of the Internet (use in business, government, homes),
4. promotion and facilitation (industry led standards),
5. skills and human resources (ICT education, workforce), and
6. positioning for the digital economy (taxes and tariffs, industry self-regulation, government regulations, consumer trust).

How does it define 'e-readiness'?

A country that is 'ready' for e-commerce has free trade, industry self-regulation, ease of exports, and compliance with international standards and trade agreements.

How is the assessment carried out?

Participants are asked 100 multiple-choice questions grouped into the six categories listed above. The possible answers indicate progressive levels of e-readiness for a country. No overall scoring occurs.

What result does it produce?

The product of the assessment is the answers to the 100 questions. Countries are supposed to work on areas with less than optimal answers, since they are "impediments...to the deployment of e-commerce."

Are there existing reports that have used this assessment tool?

Yes, but there appears to be no central listing of the reports. The report for Hong Kong is available at: http://www.info.gov.hk/digital21/eng/ecommerce/ec_assessment.html.

B. Third Party Surveys & Reports**a) McConnell International's Risk E-Business: Seizing the Opportunity of Global E-Readiness****Who created the tool?**

McConnell International prepared this report in collaboration with World Information Technology and Services Alliance (WITSA), and it was released in August 2000. See <http://www.mcconnellinternational.com/ereadiness/default.cfm>.

What is the tool's goal?

To assess a national economy's e-readiness, or "capacity to participate in the global digital economy."

What does it measure?

The report measures five areas:

1. connectivity (infrastructure, access and pricing),
2. e-leadership (government policies and regulations),
3. information security (intellectual property, privacy, electronic signatures),
4. human capital (ICT education, available skilled workforce), and
5. e-business climate (competition, political and financial stability, foreign investment, financial infrastructure).

How does it define 'e-readiness'?

An 'e-ready' country has extensive usage of computers in schools, businesses, government, and homes; affordable reliable access in a competitive market; free trade; skilled workforces and training in schools; a culture of creativity; government-business partnerships; transparency and stability in government and an evenly enforced legal system; secure networks and personal privacy; and regulations allowing digital signatures and encryption.

How is the assessment carried out?

For each country and each category, the report performs a "dynamic evaluation of the relevance and accuracy of available quantitative data with an understanding of myriad cultural, institutional, and historical factors." These general ratings and their narratives can then be used as a starting point for further planning.

What result does it produce?

Countries are rated in the five categories listed above on a scale of one to three ('blue,' 'amber,' 'red'), and extensive analysis and recommendations are given.

Are there existing reports that have used this assessment tool?

The report rates 42 countries, and analyzes the results by region of the world. Overall, the report describes a complex picture of e-readiness: most countries are reasonably 'ready' in some categories, but not in others.

McConnell International creates similar country specific reports as part of its private practice.

b) Mosaic's Global Diffusion of the Internet Project**Who created the tool?**

The Mosaic Group created this framework. Mosaic's framework has evolved over time, and there are a number of variants. For clarity, this report will examine one use of the framework: a case study of Turkey and Pakistan, available at http://mosaic.unomaha.edu/TurkPak_2000.pdf. For more information on the Mosaic Group, and other versions of its framework, see <http://mosaic.unomaha.edu/gdi.html> and <http://som.csudh.edu/fac/lpress/gdiff/>. A questionnaire version is available at <http://som.csudh.edu/fac/lpress/gdiff/question.htm>.

What is the tool's goal?

"To measure and analyze the growth of the Internet throughout the world."

What does it measure?

"The research ... [captures] the state of the Internet within a country at a particular point in time," by measuring six dimensions:

1. pervasiveness (per capita usage),
2. geographic dispersion,
3. sectoral absorption (usage within major sectors of the economy),
4. connectivity infrastructure,
5. organizational infrastructure (the state of the Internet service market), and
6. sophistication of use.

A country's movement along these dimensions is shaped by a set of determining factors that includes such metrics as teledensity, PC density, per capita GDP, foreign and domestic investment, geography, educational system, and government policy. The analyses focus on major social, economic, and political events, and the legal and regulatory environments as they affect the countries' Internet.

How does it define 'e-readiness'?

The framework does not describe an 'e-ready' society *per se*, but the reasons behind and readiness for growth of Internet infrastructure and usage (which are, by most accounts, requirements of an e-ready society). Unique interactions among the government and businesses, aided by market competition, help cause the growth and distribution of the Internet.

How is the assessment carried out?

The report uses a combination of statistics, narrative description and comparison to explain the growth of the countries' Internet, focusing on the six Internet statistics described above. The two countries (in this case, Turkey and Pakistan) are compared and contrasted for each variable to provide a deeper understanding of their Internet growth. The report also gives detailed descriptions of the political and economic factors that have affected Internet growth and usage, and forecasts future Internet developments.

Note: other Mosaic reports may conduct their assessments differently. Some include a questionnaire, and others focus more heavily on charting change over time. All reports use the same basic assessment of six Internet statistics and a range of factors that influence them.

What result does it produce?

The framework is used to describe, in depth, the relative growth of the Internet in the given countries. If the questionnaire is used, it also indicates the 'stages' of the country's Internet growth and usage.

Are there existing reports that have used this assessment tool?

The framework has been applied to over thirty countries. See mosaic.unomaha.edu/gdi.html.

c) WITSA's International Survey of E-Commerce**Who created the tool?**

The World Information Technology and Services Alliance (WITSA) conducted this survey in

2000. The assessment survey and the resulting recommendations are available at <http://www.witsa.org/papers/EComSurv.pdf>.

What is the tool's goal?

To gather "the results of an international survey of the views of information technology industry associations...on the best ways to encourage the growth of electronic commerce. The aim of the research was to find out how aware businesses and consumers are of electronic e-commerce and to identify potential action areas."

What does it measure?

The survey focused on the direct experiences of companies with e-commerce and their subjective views of what is needed to promote e-commerce. The questions cover a range of issues, including: barriers to technology industry, role of consumer trust, problems with e-commerce technology, internal business practices that support e-commerce, workforce problems, taxes, public policy issues, and resistance from consumers.

How does it define 'e-readiness'?

The report of the survey states that an 'e-ready' country requires consumer trust in e-commerce security and privacy; better security technology; more trained workers and lower training costs; less restrictive public policy; new business practices adapted to the information age; and lower costs for e-commerce technology.

How is the assessment carried out?

The survey asked technology companies a series of questions on their experiences with barriers to using e-commerce technology and recommendations for e-commerce, and charted the responses.

What result does it produce?

A final report was published that compiled answers from survey participants. The report has charts and a narrative account of the answers.

Are there existing reports that have used this assessment tool?

The WITSA report summarizes the answers to a survey of WITSA members in 27 countries (i.e. the recommendations of the participants for supporting e-commerce). Specifically, they recommended working on consumer trust, technology, lack of a skilled workforce, public policy (e.g. trade, taxation, encryption), new business models for ICT integration, and high cost of e-commerce solutions.

Other Notes:

The survey questions given in the report may only be a subset of the survey. The full survey was not found on the WITSA website.

d) Crenshaw & Robinson's Cyber-Space and Post-Industrial Transformations: A Cross-National Analysis of Internet Development

Who created the tool?

This report was authored by Kristopher Klye Robinson and Edward M Crenshaw, Ohio State University Department of Sociology. It was published in December 1999 and is under review. Contact robinson.47@osu.edu, Crenshaw.4@osu.edu for more information or a copy of the report.

What is the tool's goal?

To test current theories of technological development and the authors' hypothesized interaction

of numerous social, political, and cultural factors. To understand the "deeper sociological processes" beneath the distribution of telecommunications technology.

What does it measure?

The report focuses on the role and interactions of the following factors in ICT development: level of existing technological development, political openness / democracy, mass education, presence of a sizable services sector, teledensity, foreign investments, ethnic homogeneity, sectoral inequality, population density, and the quantity of exports.

How does it define 'e-readiness'?

This tool does not describe an 'e-ready' society *per se*, but instead proposes the reasons behind and readiness for growth of Internet (which is, by most accounts, a requirement of an e-ready society). The authors hold that a complex set of interactions involving the factors listed above cause the growth and distribution of the Internet.

How is the assessment carried out?

The authors use a statistical analysis (OLS regression) on existing data for each of the above factors by country (primarily from World Bank's World Development Indicators, and Internet domain surveys). The authors then test their hypothesized model of technology development with these statistics. They also provide detailed descriptions of other, existing, models of development for comparison.

What result does it produce?

Statistical metrics stating the probable relationship between the variables, and a narrative explanation of how these factors are likely to shape technology development.

Are there existing reports that have used this assessment tool?

The authors analyzed 75 developed and developing countries and included the results in their report. They found "Internet capacity is not in fact a simple linear function of economic and political development, but rather has been driven by complex interactions."

e) CIDCM's Negotiating the Net Model

Who created the tool?

The Leland Initiative Telematics for Africa project at the Center for International Development and Conflict Management (CIDCM) at the University of Maryland has developed this tool over the past year and will publish case studies and a book on it in 2001. An outline of the forthcoming book and the draft framework can be found at www.bsos.umd.edu/cidcm/projects/neo.html.

What is the tool's goal?

To help advance the diffusion of ICTs in developing countries, especially Africa, by helping decision-makers improve the processes of negotiation through which ICTs are diffused by governments, NGOs and the private sector.

What does it measure?

The framework measures four categories of information for each country:

1. Background and history – structural context (economy, education levels, existing infrastructure), political structure and culture (type of government, policy making style), cultural norms (religion, etc).

2. Key players in Internet development – responsibilities and objectives of relevant players in government, local and foreign businesses, universities, NGOs, international financial institutions, research groups.

3. Internet development and ICT policy over time – access, regulation, competition.

4. Negotiations between players in developing the country's Internet - each aspect of Internet development and ICT policy is categorized into one of four stages (pre-commercial, commercial, competitive, and consolidated).

'Negotiation' between players is the focus of the framework – the rest is supporting information.

How does it define 'e-readiness'?

An 'e-ready' society has an ISP market that has passed through three phases of development: (1) pre-commercial (access limited to a pioneer community), (2) commercial (access is sold to consumers), and (3) competitive (the ISP market has multiple competing actors). The negotiations between actors should be transparent, conclusive, speedy and inclusive of the major players in public, private and NGO sectors.

How is the assessment carried out?

The assessment is conducted through interviews with key actors in the relevant institutions and draws upon a range of background statistics and information as outlined above.

What result does it produce?

A detailed narrative describing the processes and outcomes of negotiations between key players over the phases of development, identifying major contentious issues likely to remain problematic in the future.

Are there existing reports that have used this assessment tool?

Three in preparation: Senegal (available April 2001), Ghana (available May 2001), and Kenya (available June 2001). A similar method is being applied for China and Brazil.

C. Other E-Readiness Assessment Models

In addition to the formal tools and surveys described above, there is a range of other frameworks that can be similarly used for e-readiness assessment. This section describes how the ideas expressed in digital divide reports, position papers and other kinds of models can be used to evaluate a society's readiness to adopt and use ICTs. In most cases, these are not ready-to-go assessment tools nor completed surveys, but they could provide rich criteria for assessing e-readiness with some adaptation. [3] Consideration of the various concepts outlined below and the standards they set add depth to this discussion, especially where they include elements that are missing in traditional assessment tools.

a) Digital Divide Reports

Another way of looking at e-readiness is through the lens of who is *not* benefiting from information technology, and which societies are *not* 'e-ready.' In the last year, numerous reports have come out that study the 'digital divide' and propose solutions. Many of these reports have the same components as the e-readiness tools described above: assessments of current technology and policy, and recommendations for making a society or community e-ready. Also like the tools described so far, digital divide reports use a range of methods and standards for evaluating e-readiness. Unlike e-assessment tools though, digital divide reports are more concerned with the distribution of the technology throughout society and its impact on the lives

of people. [5] Since there are many reports on the digital divide, and they are not directly usable as e-assessment tools, this paper only sketches out how these reports could be used.

There are four main perspectives and models of e-readiness described in these reports:

1. *e-readiness equals computers and access* – computer hardware and network access are required to be e-ready and bridge the digital divide, and government and private initiatives should supply them;
2. *e-readiness equals computers and access, but the problem will solve itself in time* – computer hardware and network access are required for e-readiness, but the market will solve this problem on its own;
3. *e-readiness equals computers, access, and effective usage of computers* – hardware and access are not enough for real e-readiness, there must be extensive training programs, locally relevant content, and a local ICT sector; and
4. *e-readiness requires basic literacy, poverty, health and other social issues to be addressed first* – computers are useful, but nothing will make a society e-ready and bridge the digital divide until basic literacy, poverty, and healthcare issues are addressed.

These four models are necessarily simplifications and exaggerate some of the differences for clarity and brevity. Using the outline employed on the other assessment tools, these digital divide models are described generically below (since many of the answers are the same for each of the models, only the first sketch includes the duplicative questions):

1. E-Readiness equals Computers and Access

What is the tool's goal?

To assess the digital divide and advocate for increased equity and e-readiness in disadvantaged communities.

What does it measure?

Statistics of existing telecommunications and network infrastructure such as teledensity, availability of access with a focus on regional and socio-economic disparities.

How does it define 'e-readiness'?

A society with universal computers and access, supplied by a combination of the government and the market.

How is the assessment carried out?

The assessment involves heavy use of statistics of technology use.

What result does it produce?

It generates comparisons of network density and usage in different communities or socio-economic groups, with narrative descriptions of what actions should be taken for improvement.

2. E-Readiness equals Computers and Access, but the problem will solve itself in time

What is the tool's goal?

To demonstrate that the digital divide is a transitory problem, and that e-readiness improves through market forces.

What does it measure?

Varies.

How does it define 'e-readiness'?

An 'e-ready' society has affordable computers and access, diffused over time throughout society by market forces. In other words – given basic conditions, all societies will be e-ready in time.

How is the assessment carried out?

Varies.

What result does it produce?

Narrative and / or statistical analyses of computer usage and access, and forecasts of future growth.

3. E-Readiness equals Computers, Access, and Effective Usage of Computers**What is the tool's goal?**

To demonstrate that the digital divide is a wider problem than simple physical access to computers and connections, and to advocate for continued vigilance to promote ICT integration in the broader social and economic context.

What does it measure?

Statistics of existing telecommunications and network infrastructure such as teledensity, availability of access, actual usage of computers, relative quantities of local language content, workforce and school training, job availability and pay distribution, government policies for each of these issues, ICT use in local communities for commercial and non-commercial purposes, strength of local ICT sector, e-government services; all with a focus on regional and socio-economic disparities.

How does it define 'e-readiness'?

An 'e-ready' society has reasonable equity in affordable access to ICTs, training, locally relevant content, and employment; a political environment that encourages ICT use through e-government and e-commerce services, and provides mechanisms for local input into (national and international) ICT policy-making; and an understanding at the community level of how ICT use can improve peoples' lives.

How is the assessment carried out?

Varies.

What result does it produce?

Comparisons of the large suite of factors listed above indexed by community or socio-economic groups.

4. E-Readiness Requires Basic Literacy, Poverty, Health and Other Social Issues to Be Addressed First**What is the tool's goal?**

To demonstrate that other issues – namely basic human needs – are more important than, and are prerequisites for, technology use.

What does it measure?

Basic human needs statistics such as poverty rates, malnutrition, infant mortality, and life expectancy.

How does it define 'e-readiness'?

An 'e-ready' society must have basic literacy, health, and workforce issues addressed sufficiently for people to have the time, energy, and money to use ICTs.

How is the assessment carried out?

Varies.

What result does it produce?

A call for increased effort and investment into basic human needs before technology.

b) Position Papers

There are a large number of position papers with recommendations for how a country can become 'e-ready' and effectively use and benefit from ICTs. These perspectives range from a focus on business and export-oriented growth with industry self-regulation, to strong government consumer protections and equitable access programs, to local content and cultural reception of ICTs. These underlying models could easily be turned into assessment tools. In fact, many of the models have corresponding assessment surveys (for example, a business / export / self-regulation focus underpins APEC's survey). This report does not analyze them further, however, since there is such a range of position papers and they are not immediately usable as tools.

Two sample papers worth examining are:

The Networking Revolution: Opportunities and Challenges for Developing Countries at

<http://www.infodev.org/library/NetworkingRevolution.pdf>

G8's Okinawa Charter July 2000 at <http://www.g8kyushu-okinawa.go.jp/e/documents/it1.html>

A more detailed list can be found in the "resources" appendix to this report

Appendix B [sourced from [D]]

The ITPOSMO dimensions of e-government project design-reality gaps

Appendix C – [sourced from [D]]

Assessing the Success/Failure Factors

1. Drivers

Factor Question 1a. How strong is the drive for change from outside the public agency (e.g. from central government, or from an aid donor, or from citizens, etc.)?

Answer Rating: from 0 for 'non-existent' through 5 for 'moderate' to 10 for 'intense'.

Factor Question 1b. How strong is the drive for achievement of e-government goals from key agency officials?

Answer Rating: from 0 for 'non-existent' through 5 for 'moderate' to 10 for 'intense'.

2. Strategy

Factor Question 2. Is there a clear, long-term strategy for e-government that sees IT as a means to achieving broader reform objectives?

Answer Rating: from 0 for 'no strategy at all' through 5 for 'partial strategy' and/or 'only partly clear' and/or 'somewhat unstable' and/or 'sees IT more as an end than a means' to 10 for 'strategy that meets all the stated criteria'.

3. Management

Factor Question 3a. How good is project management for the project?

Your assessment should cover at least the following six sub-points as examples of good practice: the presence of clear project responsibilities; consideration of risk; good monitoring and control; good organisation of resources (including staff); good management of partnerships (with private suppliers and with other public agencies); and effective procurement.

Answer Rating: from 0 for 'very poor' through 5 for 'moderate' to 10 for 'very good'.

Factor Question 3b. How good is change management for the project?

Your assessment should cover at least the following four sub-points as examples of good practice: strong leadership from a project champion; support of senior officials and other powerful stakeholders; use of incentives to create commitment and ownership among stakeholders (including operational staff); and strong stakeholder involvement that builds support.

Answer Rating: from 0 for 'very poor' through 5 for 'moderate' to 10 for 'very good'.

Factor Question 3c. How much are key players just focusing on personal self-interest and playing politics?

Signs of this that could form a checklist include infighting; resistance where loss of power is feared; "me too" copying of e-government solutions for image purposes; obsession with electoral impacts and short-term kudos; and corruption.

Answer Rating: from 0 for 'very much' through 5 for 'somewhat' to 10 for 'very little'.

4. Design

Factor Question 4. How effective and realistic is the design of the e-government project?

Your assessment should cover at least the following four sub-points as examples of good practice: an incremental/piloting approach; quick and feasible objectives; strong stakeholder involvement ensuring design meets real needs; and an understanding in the design of the 'human factor', including local culture and values.

Answer Rating: from 0 for 'very ineffective and unrealistic' through 5 for 'moderately effective and realistic' to 10 for 'very effective and realistic'.

5. Competencies

Factor Question 5. Are the required competencies present?

Assessment of competencies should at least approximate to a three-dimensional matrix that covers: a) the different categories of competency (skills, knowledge and attitudes); b) the different stakeholder groups (system developers, system managers, organisational managers, system operators, system users, etc.); and c) the different areas of competency (strategic, change/project management, information systems development and management, hands-on, interpersonal, 'intelligent customer' (contracts, suppliers, procurement), etc.).

Answer Rating: from 0 for 'completely absent' through 5 for 'some presence' to 10 for 'all present'.

6. Technology

Factor Question 6. Is the technological infrastructure adequate?

Assessment would cover the presence and resilience of data systems, software, hardware, and telecommunications. Where appropriate, this can include assessing whether systems (data, software, hardware) supposed to 'talk to each other' are actually compatible.

Answer Rating: from 0 for 'wholly inadequate' through 5 for 'moderate' to 10 for 'completely adequate'.

7. Other

Factor Question 7. Are there other factors likely to cause the e-government project to fail?

These might relate to money or timescales as well as other issues.

Answer Rating: from 0 for 'yes' through 5 for 'perhaps' to 10 for 'no'.

Presenting, Analysing and Using the Results

Overall Rating Analysis

The simplest thing you can do is add up all the rating scores and interpret them according to the following table.

<i>Overall Rating</i>	<i>Likely Outcome</i>
0 – 20	Your e-government project will almost certainly fail unless action is taken.
21 – 40	Your e-government project may well fail unless action is taken.
41 – 60	Your e-government might fail totally, or might well be a partial failure unless action is taken.
61 – 80	Your e-government project might be a partial failure unless action is taken.
81 – 100	Your e-government project may well succeed.

Appendix D – Decision-making concepts and processes

For common understanding of decision-making, it is important to recognize all its components and theories.

Decision-making: some key concepts

For the purposes of this paper, Bergeron's definition of decision-making can be a suitable starting point for our discussion: [4]

Decision-making is a process in which a choice is made between two or more alternatives. Essentially, a decision is made after a deliberate and conscious examination of several alternatives in order to choose the one that will be most beneficial and help reach the objective. Decisions are composed of four elements: an objective, alternatives, consequences and a choice. [4]

This is a very basic definition of decision-making that continues to apply to the decision-making process at CIDA today. I would like to emphasize the concept of "conscious examination of several alternatives", as this is a central component of all decisions made in the project assessment and planning cycle at CIDA.

Classical decision theory

The classical decision theory assumes that a manager is a rational being who makes decisions with complete information and total knowledge of all aspects related to the alternatives and to the decision itself. It assumes that decisions:

1. Are made to achieve the best results
2. Meet the economic welfare of a business

3. Are made in a rational, logical, and objective way
4. Follow to the letter the step-by-step decision-making process [4]

Again, the emphasis here is on the knowledge-gathering, with decisions being based on “complete information and total knowledge of all aspects related to the alternatives and to the decision itself”. This concept in decision-making is relevant to our discussion because of the way it fits into the concept of risk management.

Bergeron gives details on decision-making by outlining the seven steps that must take place in any decision process: [4]

1. Recognize the need and assess the situation
2. Identify the problem
3. Gather the pertinent facts related to the problem
4. Analyze the facts
5. Identify the alternatives
6. Evaluate the alternatives
7. Choose the alternative

Bergeron extends this definition of decision-making with a definition of problem-solving, which essentially follows the same steps as decision-making, and adds two more: [4]

8. Implementation of the decision
9. Follow-up and evaluation

Behavioural decision theory

The weakness in classical decision theory is that it does not take into account the limitations of knowledge. In truth, knowledge can never be “total” or “complete”. The behavioural decision

theory improves on the classical decision theory by presuming that the human mind cannot arrive at a perfect solution, because it cannot assess and process the large quantities of information it would need in order to arrive at a perfect solution. Solutions, then, are ones that have been determined as “good enough” or *satisficing* [4]. Rather than spend time, money, and energy on exhaustive research, the satisficing option is selected. The satisficing model is characterized by:

- Bounded rationality: Simplified models that provide “essential information”. This assumes the natural limitations of managers in processing information.
- Incrementalism: Small improvements are made with each iteration. If past performance is unsatisfactory, the manager considers alternatives that differ in relatively small degree from the choice currently in effect to eventually reach a satisfactory end.

The following section presents the different approaches to decision-making. This helps identify how CIDA approaches decision-making.

Approaches to decision-making

Bergeron argues that there are four basic methods to making a decision. [4] These include:

1. Intuition: based on what the decision maker feels is the best solution. It does not take into consideration all the pros and cons of each alternative.
2. Personal values: based on what the manager has personally witnessed in the past. A good or bad experience can easily sway a decision maker and produce unfavourable consequences.
3. Judgement: based on the decision maker’s knowledge for a particular decision. Although they have some merit, these decisions are not always effective.

4. Rational approach: based on a logical sequence of steps, a systematic analytical process.

It does not rely only on experience.

Presently at CIDA, project assessments tend to rely heavily on intuition, personal values, and judgement. The processes in place attempt to create a rational approach to decision-making, however, because they fail to consistently take into account important influencing factors, decision-making is weighted more heavily to personal judgement.

It is also important to identify the environment in which CIDA makes decisions.

Environmental conditions of decisions

Bergeron discusses three levels of risk involved in the decision-making process [4].

These conditions of risk can be classified as the following:

- **Certainty:** For every alternative, there is enough information provided to permit a prediction of the decision outcome.
- **Risk:** Decision-makers must use their judgement and past experience to estimate the probabilities of each occurrence. Managers can also use models to help them make decisions under conditions of risk. Most decisions are made under this condition.
- **Uncertainty:** Decision-makers either do not have enough information about all the available alternatives or they don't know all the available alternatives, and cannot assign probabilities to the alternatives. In these situations, a decision-maker may have little choice but to use judgement and intuition to make a decision. S/he may also rely on group decision-making techniques to minimize the lack of information. In these scenarios, the outcome of a decision can range from total success to total failure.

Modern theories of cognitive psychology and neuroscience have shown that humans comprehend risk in two fundamental ways: analytic (using an algorithm of normative rules such as probability, formal logic and risk assessment) and experiential (using primarily intuition). Experiential methods of absorbing risk remain the most natural and most common way to respond to risk, and are also the least time-consuming, while analytic methods remain more thorough. In a recent paper, Slovic and al. argued that the analytic and experiential methods should be combined for “a high-level maximization process.” [30] This is what I propose for my model. The model provides some analytic methodology for the assessment process, while the extensive consultation process will continue to employ the experiential method. A combination of both methods will hopefully improve the assessment process.

Decision-making today

Advances in information technology have drastically changed the amount of information available to us, thus affecting our decision-making abilities, especially when it comes to analytic assessments of risk. As Wharton points out, “Rapid advances in information technology have changed decision making, and ... decision-makers who rely on seat-of-the pants intuition ignore vast universes of information.” [12]. The challenge for us today is how to combine effective experiential methods of assessing risk, while maximizing our analytic resources and capabilities, all under conditions of very high risk and uncertainty.

When Ralph Shrader, CEO of Booz-Allen & Hamilton presented at a TechNet conference 2000 in Washington, he said that decision-making in the contemporary world consists of a few key components. These include:

Risk: Decision-makers need to have a higher tolerance and comfort-level for risk. ...

Control: While we need to be comfortable dealing with a higher degree of risk, we also need to be willing to have less personal control. The complexity of issues, operations, and situations today makes it impossible for one person to have a handle on all the relevant facts. So, we have to become more comfortable “not knowing it all” and being able to carry out our decisions through participative leadership, rather than through strict command and control....

Collaboration: The lesson for us as decision-makers is that “going it alone” is unlikely to be successful today.

... Because there are no perfect decisions, it takes imperfect people—people like us—to make important decisions. Not because we have all the answers: We don't. But, because we strive to do the right thing, and care deeply about the outcome.

Schrader's comments are especially relevant here, as they touch on every aspect for the decision-making process at CIDA. There is a high degree of risk that must be absorbed in every project assessment, control must be relinquished in favour of collaboration with all concerned parties if self-sustainability is to be made possible, and finally, there are no perfect decisions. However, we can select the satisficing model, that still meets our main policy objectives and that ultimately strives to do the right thing.

According to The Wharton School, in the light of increasingly complex environments, new decision-making paradigms are emerging. More and more, decision-makers are relying on the interconnectivity of the different forms of available data and access to this data that is just-in-

time. New tools such as data mining, neural networks, artificial agents, and genetic algorithms have created huge, searchable warehouses of data available to support our decision-making.

Data is not the only factor driving complexity. Interaction across multiple system boundaries surrounding a particular decision context creates further complexity in a situation. Finally, the interactions of multiple stakeholders further increase this complexity.

These new tools and approaches are leading to a model of decision-making that focuses on options and flexibility rather than on the precise evaluation of alternatives. Wharton highlights three basic elements to this new approach:[12]

1. Building the information base: provides the basis for a much richer and more precise informational base for decisions.
2. Identifying constraints: not only in options to improve, delay or cancel projects but also in investments to assure a proper constraint set and a reasonable information base for future decisions.
3. Strengthening organizational capabilities: the fact that managers need powerful decision support and data management tools to function adequately dictates that organization as a whole requires new skills and capabilities to design and implement these tools.

As our environments change and information becomes abundant, it becomes increasingly difficult to not only make decisions but to justify them to sophisticated internal and external stakeholders. These new approaches attempt to make use of these new technologies to address this increasingly complex environment.

However, while there may be changes taking place in decision-making strategies, they do not displace the human capability to plan ahead. Rather, the focus has shifted from evaluating

isolated decisions to creating business platforms to enhance and support an entire decision context.

Given the relentless enhancements and new developments in information technology, we can expect that this complexity will continue to increase. Our final endpoints have become, in effect, “moving targets”, and it is up to the modern decision-maker to keep pace with these changes by sufficiently preparing the groundwork and capabilities for the choices we have to make. [12]

Having a common understanding of the decision-making elements and the environment in which CIDA operates, we will continue with the identification of decision-making processes.

Decision-making processes

A critical part of the decision-making process at CIDA involves group decisions. Many of the stages of the project assessment, selection, and implementation involve extensive consultation and discussion among group members. This is because having buy-in from the many different partners, stakeholders, and local beneficiaries is absolutely fundamental to a project’s success. Even while extensive group consultations, which can take place by any of the processes mentioned below, are time-consuming and costly, their benefits far outweigh their cost.

Nominal group technique (NGT)

Nominal Group Technique (NGT) is a useful method for generating creative and innovative solutions or ideas, and for managing decision-making groups. It is particularly effective when group members are afraid of being criticized by others (as may happen during

brainstorming sessions). It keeps interpersonal communication during the session in check and most important, pre-empts antagonism among participants. The NGT approach consists of the following attributes:

1. Participants work alone. They write down ideas or solutions related to the stated problem.
2. Ideas are subsequently read aloud to the group (participants are asked to withhold criticism at this stage).
3. Each idea is recorded on a flip chart or chalkboard as it is read aloud.
4. Group members then discuss the ideas in round-robin fashion, for the purpose of clarification only; evaluative comments are disallowed.
5. Participants then proceed to rank (or vote on) the ideas that have been presented. Differences of opinion may be discussed. The solutions are then ranked according to their relative potential for resolving the problem.
6. Steps 4 and 5 are repeated (if necessary) in order to clarify further any ideas or points that have been brought forward.
7. The participants cast their final vote, or rank the ideas—the option that receives the highest ranking is adopted.

Delphi

Another method for obtaining consensus of informed opinion is the Delphi method. First the views of experts in the specific field being studied are solicited. A series of successive questionnaires are then employed. In each questionnaire after the first round, the respondents receive feedback about the outcome of the preceding round, and are given the opportunity to

modify their answers. The panel members are usually in separate locations and often are unknown to one another. It is essentially a debate without the influence of dominating personalities. It is used successfully to develop scenarios in situations in which objective data are lacking. It is not used widely because of the time it takes to develop the survey instruments and communicate with the respondents.

Appendix E – Scoring models

Historical information

The earliest scoring application dates back to the 1960s, when lending institutions started using the models for evaluating credit applicants. [20] Until the mid-1990s, the process was still determined by decision rules, which were then refined and optimized over several decades. Lending institutions now make 75% of US mortgage loan decisions using scoring models [18]. The first scoring systems were built to reproduce manual underwriting without much consideration of whether the manual underwriting thought process was optimal. This scored-based underwriting is typically the first application explored when scoring technology is introduced to a new product type. [20]

Philosophy behind scoring

The basic premise of scoring is that analytical technology allows us to learn from our past. When using them, we have to assume that there are relationships among the variables available at the time that identify suitable and non-suitable applicants. . We also have to assume that analytical technology can accurately capture these relationships (or an empirical approximation of them).

Finally, we also have to assume that the future will resemble the past and that these relationships can be used to separate suitable from unsuitable. The difference of scoring models is that scores derive their experience from a much larger data set as opposed to the underwriter's past experience. It lends a kind of objectivity to the evaluation process. This objectivity is by no means complete, but it does remove some of the influence of the evaluator from the process.

What are scoring models and what are they used for?

Scoring models are tools used to control risk more effectively, to reduce the cost of decision-making, and remove human bias from decision. They use quantitative measures of the performance and characteristics of past history to predict the future performance with similar characteristics. Therefore, the objective is to predict future performance from past behaviour. To develop a model, analysts collect and analyze two types of data on a large sample of cases: predictive data (data available at the time of the decision) and performance data (data that reflects the history of the sample at least 12 months after predictive data). Since the score derives all its knowledge from past data, one of the most critical components of a score is the data on which it is based. The data is the least recognized yet one of the most important elements of score development [20]. Typically, scoring model development involves statistical analysis of large amounts of data to identify which information available at the time of key decision-making decision correlate most to subsequent performance. The skill of the analyst is paramount in ensuring that the model will produce sound and interpretable results.

Today, many companies continue to rely on dated statistical technology from the 1920s (cross tabulation), 1950s technology (categorization of continuous variables), and inappropriate techniques to manage their businesses. [20]. With the analytic tools available, as well as recent advances in technology, advanced techniques such as predictive and explanatory score modeling are achievable and far more accurate. [20]

Marinopoulos identifies some of the following key variables for setting up accurate scoring models. These include: cultural change, support from top management, operational process, data integrity, and correct establishment of the cut-off score.

The model must then be monitored, to determine accuracy and further refine the model. Monitoring includes operation stability reports and performance analysis. There is a tendency to overlook monitoring (also called *validation*) in favour of attempting to generate the best model possible on the development sample. [20] This thesis proposes follow-up stages to the new scoring model in order to avoid this weak point.

Although scoring models are static, there exists behavioural scoring that updates the assessment of a risk in light of the current and most recent performance of the subject. [31] Application scoring assesses risk once, at the point of application. Empirical results confirm that behaviour scoring tools can successfully risk-rank mortgages at all stages of delinquency. [20] Behavioural scoring is accepted as more predictive than application scoring. [18] Bayesian estimates is a method that combines application and behavioural scores.

Generic or customized

Today, there exist over 30 generic credit scoring systems containing over 100 different scoring models. These models typically include between ten and 40 variables [20]. The applications include bankruptcy, fraud, risk, mortgage, segmentation, revenue, collection, recovery, insurance, home market value, attrition, and segmentation. The vast majority of generic models have been developed by either Fair, Isaacs or Experian. [20]

These models are customized to fit the creditor's lending environment and objectives, resulting in a model that is more accurate than a generic one. There are some common aspects that can be identified, however, among these:

1. *Feasibility*: In lending institutions, the development of a scoring system requires past data that can be analyzed for trends. This includes information that was used to support past

decisions in a usable form, known outcomes of past decisions in a quantifiable form, time (decisions must have aged enough to allow appropriate measurement and classification of the outcome), size (the number of decisions made must have been large enough to allow an appropriate sample size), and a control group (the cost and benefits of a customized model must be compared to those of a generic one). Several hundred cases of data are required for a scoring model to be robust. Such a customized system can cost anywhere from \$30,000 to well over \$100,000. [20]

2. *Development*: Certain key aspects must be identified and defined. These include: the model's objective, the target population, data/sample development, dependent and independent variable definitions, model development procedures, rejected applicants, and development time. It can take from three to 12 months to develop a customized scoring model.
3. *Implementation*: The 'how' of the model. Aspects of how the model will be used, such as information interpretation and entry, computer automation, forecasts of performance, validations/monitoring, adverse action reasons, shared experience and advice, security of the scoring model, and management are articulated. It is critical that the overall evaluation system and its components be closely monitored in order to properly manage the system. Implementation adds time to development, ranging from one month to years. [20]

Generic scoring systems have played a major role in credit evaluation. They can level the playing field between smaller and larger creditors. Many creditors use both customized and generic systems in order to minimize risk. The role of generic scoring is expected to continue to

intensify, and new models and types of applications will emerge. [20] Standardized risk measurements from generic models will have a major impact on credit granting industries. Customized scoring will still have a place; however it will rarely be used without generic modeling. [20]

Credit risk model development

To improve decision-making, many lending institutions are turning to predictive modeling technologies. A common stumbling block for developing predictive models is the technology: there can be a tendency to focus on the computer results and technology used in favour of other, wider issues. It is argued that properly addressing these issues results in a robust model that is uniquely suited to a specific marketplace, and therefore is more accurate. [20]

A series of steps suggested:

1. Define the business objectives and ascertain whether they are attainable through a predictive model.
2. If a model is the answer, determine if data exists for model development or whether you need to gather more from external and internal sources.
3. Analyze which modeling technology will work best to meet your objectives, and develop a preliminary model that, through additional analysis, will enable you to test how it will handle any identifiable implementation constraints.
4. Align implementation with your stated objectives to ensure that it meshes with in-house practices and personnel. [20]

These steps are less about the technology used for developing the model and more about the processes in place to effect its development. An important step in this process is the analysis and refinement of the model. [20]

As a result of the review, scoring models are an effective decision-making tools used to address a specific type of risk. However, they do not consider environmental factors such as political or economic risks. Because international development is highly dependent on environmental factors, scoring models as developed in the financial sector would not be suited for CIDA's decision-making. The volume of data required to develop and validate such a model is not readily available and the volume of projects to that would benefit the model would not warrant the large investments by CIDA to develop, implement and maintain such tools.