Modeling ICT4D: System Dynamics Model of Swedish University Projects

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Foreword

The Swedish Program for ICT in Developing Regions (Spider) was founded in 2004 with a mission to support innovative use of information and communication technologies for development and poverty reduction. In the period from 2004 to 2010, one of the activities was to create a partnership with Swedish universities through collaboration with researchers in the area of ICT for development. Under the umbrella of two programs “ICT Collaboration Projects with Swedish Partner Universities 2007–2009” and “ICT, Development, and Gender, 2008–2010”, a number of projects were initiated, run and completed. Their research was with a different thematic focus, and the implementation took place in a number of developing countries. The program went through external evaluation that provided critical overview of the outcomes and results, aiming to serve as lessons learned for the future work.

In 2011 Spider was restructured as a resource center, with ICT4D research becoming one of the areas of strategic focus. The nature of ICT4D research requires a multidisciplinary approach and systematic work on extracting information from past and current projects, basically in order to improve the execution, the deliverables, and the sustainability of future projects. Indeed, the research results are to be utilized to facilitate knowledge generation and to strengthen monitoring and evaluation (M&E) procedures.

This publication is in line with the strategic focus of Spider and is a reflection of its current direction. It analyses the projects with Swedish partner universities once again, looks at similarities, and offers an alternative way of interpreting the outcomes. The discipline of modeling and simulation is suggested as a complementary or alternative method for the monitoring and evaluation of ICT4D projects, with the System Dynamics model of the projects used as a proof of concept.
1. Introduction

Since its conception in 2004, Spider has supported research to find innovative ways of using information and communication technology (ICT) to increase the efficacy in reaching the millennium development goals (MDG). The program “ICT Collaboration Projects with Swedish Partner Universities” aimed to stimulate research in the area of ICT for development (ICT4D) through combining the expertise of Swedish partners and the needs of the developing world. The program went through an external evaluation (Bråsjö, 2010) with the qualitative approach being used as the main method.

This publication analyzes the program again, looks at the similarities of the research projects, and offers an alternative way of interpreting the results achieved and the recommendations for enhancement. The aim is to present modeling of ICT4D projects as a novel technique to be used as a complementary or alternative method for monitoring and evaluation. The system dynamics approach is selected as the most appropriate one for creating a holistic view of the whole program.

1.1 ABOUT THE PROJECTS

This publication covers seven projects, conducted in different countries in Africa and Asia. All of them involve a Swedish partner university and a counterpart from a developing country. The five projects listed in Table 1 belong to the program “ICT Collaboration Projects with Swedish Partner Universities 2007–2009”.

Acknowledgements

This publication would not have been possible without the effort of the coordinators, facilitators, students and other staff involved in the projects under consideration. Thanks to all of them in providing the necessary information for the central part of this study.

Sincere gratitude for the work done and the results presented in the evaluation of the Swedish university projects, which served as the main reference for validating the model.

My sincere appreciation goes to the Spider staff for the support, valuable comments and constructive suggestions during the whole process of creating the model, verifying the results, and writing the report.

The views expressed herein are those of the author and do not represent the views of Spider, the project teams and/or the beneficiaries.
Table 1: Projects in the program “ICT Collaboration Projects with Swedish Partner Universities 2007–2009”

<table>
<thead>
<tr>
<th>Swedish Partner University</th>
<th>Name of the Project</th>
<th>Developing country</th>
<th>Counterpart from developing country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Örebro University</td>
<td>Agricultural Market Information Systems (AMIS)</td>
<td>Bangladesh</td>
<td>BRAC University, Bangladesh Ministry of Agriculture</td>
</tr>
<tr>
<td>Uppsala University</td>
<td>Expand INFORM in Africa (INFORM)</td>
<td>Tanzania</td>
<td>Several organizations in Africa</td>
</tr>
<tr>
<td>Stockholm University</td>
<td>Language processing resources for under-resourced languages (LPR)</td>
<td>Ethiopia</td>
<td>Ethiopian Languages Research center, Addis Ababa University</td>
</tr>
<tr>
<td>Royal School of Technology</td>
<td>Mobile ATM for developing countries (M-ATM)</td>
<td>Sri Lanka</td>
<td>Colombo University</td>
</tr>
<tr>
<td>Royal School of Technology</td>
<td>Online water quality monitoring (OWM)</td>
<td>Tanzania, Malawi</td>
<td>Malawi Polytechnics, Dar Es Salaam Institute of Technology</td>
</tr>
</tbody>
</table>

Table 2: Projects in the program “ICT, Development, and Gender 2008–2010”

<table>
<thead>
<tr>
<th>Swedish Partner University</th>
<th>Name of the Project</th>
<th>Developing country</th>
<th>Counterpart from developing country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blekinge Institute of Technology</td>
<td>Women’s Digital Baskets (WDB)</td>
<td>Rwanda</td>
<td>Handicraft co-operative Duhuzimbaraga</td>
</tr>
</tbody>
</table>

The other two projects, listed in Table 2, belong to The “ICT, Development, and Gender, 2008–2010” program, which originated in a Spider thematic workshop held in March 2008. All seven are referred to as Swedish University Projects and are included in the external evaluation.

The thematic area is different for all seven projects. The research spans from developing technical solutions in ICT4D to dealing with gender issues. Being research projects, they all have in common elements of originality and their development component had to deal with sustainability of what was implemented. The dissemination of the results was done through progress reports and final reports submitted to Spider, web pages created for the projects, articles published via scientific channels, conferences, and workshops. A significant number of PhD and/or master students, often from the particular country where the project was conducted, were engaged in some of the projects.

1.3 MODELING, SIMULATION AND ICT4D

Advancements in information and communication technologies facilitated rapid development of modeling as a discipline with its own theory, research methodology and tools. At the core of the discipline is the notion that models are simplified representations of real world systems (Banks, 2009).

Modeling is often associated with mathematical methods for representing natural, engineering, social and other domains, and investigating their performance under specified conditions. The variables describing the model can be deterministic (predetermined values) and/or stochastic (probabilistic values). In general, models might not change with time (static), or the interactions among variables might take in consideration the time (dynamic). Models are created whenever it is either impossible or inconvenient to analyze and inspect actual systems in another way (the system is non-existent, cannot be approached without significant disturbance, analytical solution of the mathematical model cannot be obtained or it is too costly and time consuming to work with reality).

Simulation involves execution of the model aiming to discover its behavior through the possibility of repetitive observations. Typically, models that undergo simulation are dynamic (the variables describing the model change with time). Through simulation, the operation of the model can be visualized and the complexity of the system understood. The analysis of complex systems through experimentation helps evaluate the performance of the system and predict system behavior under various circumstances.

There are currently three main techniques used in modeling and simula-

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1 The evaluation is enclosed as annex.
1. Introduction

The emergence of the user-friendly software with visual interfaces brought changes in how modeling and simulation are used. A typical software package today provides graphical modeling environment, built-in simulation objects, and many other modeling, execution and support tools (Pidd & Carvalho, 2006), creating opportunities for non-computer experts to build models representing certain aspects of some specific problem that exists in reality. Even more, the problems analyzed often include a social component. The expert in the field needs only to have good understanding of the problem and to be able to select and apply the appropriate technique. Once the model is created, simulation can be performed many times either to experiment with behavior of the model, inspect changes with respect to different scenarios or to deal with the randomness in case it is a part of the model.

Modeling and simulation has been widely used in engineering design, emergency planning, transportation, medical systems, as well as for project management. However, there is very little experience with modeling and simulation being associated with ICT4D. SD models of ICT4D projects, mainly those where ICT is used to improve education, were created by Grange and Kyner (Grange–Kyner, 2008) where modeling is implemented to evaluate two examples of computing technology intended for wide-scale deployment in education in developing countries, and by Murthi (Murthi, Gujrati, & Iyer, 2010) where an SD model of a distance education program at a leading engineering institute in India is presented. Oyo (Oyo, Ddembe, & Barendsen, 2008) developed a conceptual SD model to present the research practice in Ugandan universities. It is used to demonstrate the effects of research funding on new research resources, staff development, quality of graduate outcomes, and demand for graduate training.

The SD model presented here is created for the purpose of evaluating Swedish University Projects. It incorporates the main characteristics of all seven projects and makes it possible to create graphs presenting their main strengths and pitfalls, as well as the changes that could have occurred if the projects were conducted differently. The diagrams obtained are interpreted in words and compared with the recommendations available in the external evaluation of the program (Bråsjö, 2010). The conclusions are nearly identical which confirms the validity of the model.

The model of Swedish University Projects is only a single example of how modeling and simulation can be used in ICT4D. It should serve as a starting point for future research on how any of the three modeling and simulation techniques, or a combination of all three, could be used for the monitoring and evaluation of ICT4D projects. Each project is a separate case and can be treated as a complex dynamic social system. The complexity depends on the scope; spatial, temporal or thematic aspect; the content; the number of partners; local environment and other issues. The changes with time make the system dynamic and the involvement of humans defines it as a social system. Hence, a suitable model for this kind of system can be designed before the start of each project. The modeling process will help stakeholders better understand different aspects (endogenous and exogenous) of the endeavor they are starting, address issues that they did not think of previously, and help them make important decisions.

1.4 DISPOSITION

This text focuses on showing that modeling and simulation can be employed as an alternative or complementary method for the monitoring and evaluation of ICT4D projects. For this purpose a comparative analysis between the external evaluation (Bråsjö, 2010) and the SD model created for the same projects is performed. The results presented prove that same conclusions are obtained in both cases. Hence, the model serves as a proof of concept for the future use of modeling and simulation in ICT4D projects.

The next chapter presents a short overview of System Dynamics as a method for analysis of social dynamic systems, followed by a chapter with a short description of the projects and illustrated with pictures.

The last part is dedicated to presenting the reasoning behind creating the structure of the model, the data used, and the diagrams obtained. This is followed by the comparison of the conclusions based on some of the diagrams from the simulation with the recommendations given in (Bråsjö, 2010). The complete documentation about the model is available as Appendix 1 and the external evaluation of the project (Bråsjö, 2010) as Appendix 2.
2. System Dynamics Overview

System Dynamics emerged as a discipline in the late 1950s with Jay W. Forrester widely considered as the father of this new field (Lane, 2007). The idea was to create a way of thinking that looks at the problem in an endogenous manner and tries to find hidden relationships that determine the behavior of a complex system. The term “system” refers to reality, “dynamic” means “changing with time”. Hence, System Dynamics is a modeling technique where the variables describing the system undergo changes in time.

Real systems are often very complicated. Dynamic complexity arises because of the constant changes, tight coupling of the variables where frequently feedback loops exist (one variable affects another one with this chain propagating to the first variable), non-linearity of the system, and counterintuitive behavior (Sterman, 2001). Simplification or abstraction is necessary to obtain a manageable model. The structure includes only the aspects that are important for the problem observed. It consists of a set of relations between model variables represented in the form of mathematical equations, including differential equations with the time being the independent variable. The variables needed to create the model are called system variables. Fluctuations of the system variables in a system dynamics model are continuous. It means that changes occur in constant time intervals (minutes, hours, days, months, years). The modeler usually determines the most convenient time unit for the particular model.

2.1 STOCK-AND-FLOW MAPS

Stock-and-flow maps representing the accumulation and dispersal of resources are central to the dynamics of complex systems (Sterman, 2001). Stocks are variables showing the level of the accumulation. Flows go in and out of stocks and increase or decrease their values with a certain rate. When the value of the stock is represented using certain units (for example persons), then the flows have the same rate unit (persons/time unit for the model). The other elements of an SD model are the constants (variables which do not change their values with time), auxiliary variables (all other variables) and their causal relationships (the manner in which the change in values of one variable influences other variables).

In essence, the purpose of System Dynamics study requires that the model consist of causal relations between the variables. They show how they affect one another; hence the term “cause-effect sequence” is also used (Lynneis & Ford, 2007). The causal relation is considered to be positive if the change in both variables is in the same direction (when the cause increases, the effect increases; when the cause decreases, the effect decreases). The negative causal relation has the opposite effect, namely when the cause variable increases the other one decreases and vice versa. Two or more causal relations can create a feedback loop. It is a circular causal relationship where the same variable is the cause for the first causal relation and the effect for the last one. Feedback loops can be positive or negative depending on how they influence the behavior of the system. Positive feedback loops are also called reinforcing since they usually cause exponential increase or decrease of the crucial variables in the model. Negative feedback loops are considered as balancing because they stabilize system behavior.

User-friendly software packages for creating SD models, such as Stella2 and Vensim3 use Graphical User Interface (GUI) for creating and presenting the structure of the models. They provide tools for drawing stock-and-flow maps and entering necessary equations. Stocks are presented as rectangles and they have some constant value at the start of the simulation. The symbol used for flows is an arrow with a valve showing that flows are regulated. The cause-effect sequences are presented with arrows directed from the variable that is the cause towards the affected variable. The sign “+” or “−” beside the arrow shows the polarity of the cause-effect sequence. Feedback loops consist of two or more cause-effect sequences including the flows. Positive (reinforcing) loops have an even number of sequences with negative polarity, while the negative (balancing) incorporate odd numbers of them. The symbols used for feedback loops are rounded arrows with “+” or “−” sign in the middle, often with the red color used for the positive polarity and the blue color for the negative one. The feedback loop is usually associated with one of the variables in it.

A simple example of SD model is the one presented on Figure 1. The model is constructed to show the changes in the size of population in a city. The system variable called “Population” is represented as accumulation (stock) and it is assumed that the increase and decrease in population is only due to births and deaths. The size of the population is affected by the rate in which it increases/decreases. Hence, there is an inflow called “increase rate” and outflow called “decrease rate”. The time unit usually used in this type of model is a year. There are two feedback loops in this model, one that is reinforcing (positive) and the other that is balancing (negative).

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2 http://www.iseesystems.com/softwares/Education/StellaSoftware.aspx
3 http://www.vensim.com/

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2. System Dynamics Overview

2.2 STEPS IN MODELING

Problem identification and definition is the first step of the modeling process. This includes examining the dynamic behavior, determining the time horizon (into the future and into the past) and the variables to be included. Much of the art of system dynamics modeling lies in discovering and representing the feedback processes and other elements of complexity that determine the dynamics of the system (Sterman, 2001).

According to (Pejic-Bach & Ceric, 2007) there are several approaches to the development of SD models, with the most recent concept being component strategy. This approach concentrates on the formulation of stock-and-flow maps and generating the variables and their associated interactions simultaneously. In addition, the parameters to be varied and the levels of these parameters are defined. The goal is to speed up the process in obtaining a computer model that can be simulated. Experimentation with the model often suggests areas where adjustments can be made and helps in adjusting factors necessary to obtain logical results.

All modeling and simulation methods have the validation of the model as an obligatory part of the model development. This is a process that proves that the model is a factual representative of the problem addressed. There is no universal concept or original procedure that could be applied to all cases. This is particularly true of the system dynamics method. Moreover, it is assumed that validation of the model is often performed in parallel with constructing its structure and quantifying the variables. Hence, system dynamics has often been criticized for not having strictly developed validation methods. According to Quadrat-Ullah (Qudrat-Ullah, 2005) validation of SD models draws on two fundamental assumptions about the SD modeling process. The first is that SD models are built to fulfill a purpose, and the second is that the structure of the model drives its behavior.

The births and deaths are represented as two separate variables. Each of them changes with time and depends on the size of the population and the birth/death rate which are assumed to be constant in the period in which the system is observed. The population (number of persons) increases with an increase rate equal to BIRTH RATE x Population (persons/year) and decreases with an decrease rate equal to DEATH RATE x Population (persons/year).

Vensim conventions for labeling variables are used (constants with all capitals, flows with all small letters and capital first letter for the stocks). If the birth rate is 2% per year and the death rate is 1% per year, then the births (number of newborns each year) and the deaths (number of persons who die) are defined as:

\[
\text{Births} = 0.02 \times \text{Population}; \quad \text{Deaths} = 0.01 \times \text{Population}.
\]

If at the start of the system the population is 100,000 persons, than in one year’s time there will be 2000 births and 1000 deaths; hence the population will increase to 101,000 persons after one year. In a similar way the increase in the second year can be calculated taking now in consideration that the population has a new value.

Each simulation run requires simulation settings such as starting and ending time, the method for the numerical calculations, and the step of the simulation. Once the simulation is over, a diagram showing the change of the population in the interval of time set is obtained. This type of diagram is known as a behavior over time graph (BOTG). The shape of the curve depends on the initial population, the birth rate and the death rate. If the birth rate is greater than the death rate, the population will increase with time and opposite effect will be obtained when death rate is greater. The graph obtained with Vensim for our simple model is shown on Figure 2.

Figure 1: Simple SD model for population growth

![Simple SD model for population growth](image1)

Figure 2: The graph of the population obtained with Vensim

![The graph of the population obtained with Vensim](image2)
2.3 SD MODEL OF SWEDISH UNIVERSITY PROJECTS
The structure of the model uses the facts and observations of the results achieved by the seven Swedish university projects. It is constructed to present the system behavior already known from the reports and the evaluation of the projects. The focus is on three main issues: the research, the distribution of the budget and the sustainability of the project. Modeling the research is based on the data about the size and the structure of the team involved and the research results expressed through the number and quality of the papers published and the other ways of disseminating the results. The portion of the time the researcher dedicated to the project, and the budget used for this research is also taken in consideration. This data is extracted from the project reports and available web pages and is presented in Chapter 4 of this publication.

When modeling sustainability, the statements made by the participants are mainly used. Occasionally, the author of this publication introduced her own conclusions based on the information gathered either from direct contacts or through the analysis of the evidence available. These statements are emphasized as framed text in the next chapter.

Detailed explanations about the process of constructing the model, the results obtained, and the comparative analysis with the conclusion from the external evaluation (Bräsjö, 2010) are presented in Chapter 4.

3. The Projects
Although very different by the nature of research pursued and the country where results were implemented, there are still a number of similarities between these seven projects. The descriptions of the projects in this section are entirely based on the reports submitted to Spider and the project web sites. The illustrations (pictures) are obtained from the participants in the projects and their reports with consent for use in this publication.

To give the reader an insight into the distinctiveness of each project, they are all described separately with the text having the same subsection structure. For all seven projects, the needs of the developing country as the rationale for the project are portrayed, followed by the objectives and results achieved. The last subsection presents the project team, some of the peculiarities of the project, the duration, the research results and budget distribution. These data are relevant for developing the system dynamics model.

The first five sections provide detailed description of each project from the program “ICT Collaboration Projects with Swedish Partner Universities 2007–2009”. In (Wamala, 2012) the details and the gender prospective for the two projects in the “ICT, Development, and Gender, 2008–2010” program are covered. Hence, the overviews of these two projects are rather short.

3.1 AGRICULTURAL MARKET INFORMATION SYSTEMS – BANGLADESH
Rationale
Bangladesh is an agricultural country where rural development is a very important issue. However, the agricultural market is volatile due to manipulation and uninformed actions. Farmers’ participation in market and transport management is poor. Not having relevant information on time, farmers are forced to sell their products to local middlemen at dumped prices. The government in Bangladesh has taken a number of steps in order to disseminate agricultural market information to the concerned stakeholders, specifically farmers, traders, policymakers and the media. In a project funded by the
Food Agricultural Organization (FAO), during the period between June 2002 and December 2003, the Department of Agricultural Marketing (DAM) of the Ministry of Agriculture initiated a computer-based ‘Agricultural Market Information Improvement (AMII)’ program for collection and dissemination of various kinds of agricultural market information. However, due to the lack of computer maintenance at the district levels, as well as the low computer literacy level, the use of the system was difficult and very slow. As a consequence, the information, not available in a timely manner, was useless for local farmers.

Similar to other developing countries, penetration of mobile phones in Bangladesh has been much faster than that of computers. Compared to 1.5 million PCs in 2006 there were 16 million mobile phones in operation, and they were increasingly being used in rural areas. Grameen’s Village Phone project has helped expand the rural mobile phone base, especially among women. Mobile phones have proved to be a viable alternative both for data collection and data dissemination of agricultural market information.

Objectives
This project addresses the difficulties encountered in the existing agricultural market information system in Bangladesh and suggests the use of low-cost SMS infrastructure to create a viable local organization for information collection and dissemination. The specific objectives are listed here:

a) Introduce mobile phones, SMS and local information staff for feeding into and getting information from the existing agricultural market information system;
b) Test the updated system with local farmers;
c) Create a network of users by bringing together the Ministry of Agriculture and local market organizations to make the system act as a platform with full-scale implementation.

Results
The proposed system, locally branded as PalliNet or RuralNet, uses actual agricultural data and takes into account both the low literacy levels of the farmers, as well as the limitations of the mobile screens and text capacities of an ordinary mobile phone. The database design uses simplified codes for the agricultural produce and market operation in Bangladesh. The proposed commercial system collects up-to-date market information (via cell phone or computer) and feeds the data into a database managed on a SMS Server, which would then be accessible to clients requesting price information for agricultural products via text messaging. Hence, text messages are used for both requesting and receiving price information. Figure 5 presents the schematic view of the system.
3. The Projects

Project team, duration, research results and budget distribution
The Informatics department of the School of Business at Örebro University provided the leading role in the transfer of technology from Sweden. BRAC University was involved in local project management, testing the system and offering technical expertise in maintaining and updating technical solutions. Other local partners were also involved in the project due to problems that arose during the project.

The technical work was later shifted to Soft-ED, a Dhaka-based software company, and local project management was shifted to Daffodil University, Dhaka.

– Excerpt from the final report

The main researcher in the project engaged four PhD students and a number of master’s students, enthusiasts in the mobile government issues. They produced a rich web site for the project, six publications in scientific journals and relevant conferences. Dissemination of the project was also made through other information channels, such as various workshops, research seminars, interviews and presentations (nine events in total).

Figure 6: Fieldwork of a PhD student

We have discussed potential large-scale implementation of business models with actors such as Grameen Phone, Telenor, Muhammad Yunus personally, and the NGO ASA. However, it is beyond the scope of the project to engage in a business setup.

– Excerpt from the final report

1 http://www.electronicgovernment.se/AMIS/about.htm

The prototype was tested both for data collection and data dissemination of 50 agricultural items and showed that the bargaining position of farmers with traders was improved and the transaction cost was reduced. Farmers were able to get timely and reliable information and the ability to interpret it and decide to which market they should send their produce to maximize returns or, indeed, whether to send their produce to market at all.

By contributing to more efficient marketing, particularly with improved spatial distribution, market information should be beneficial for consumers as well as farmers and traders. In addition, the information on retail prices may also, under certain circumstances, assist consumers to bargain. The system created was not only to be of use to the farmers and consumers, but also to the government by bringing the agricultural economy to a more equitable level.

Although objective c) was supposed to address the sustainability issue, there were difficulties in achieving large-scale implementation.
3. The Projects

between librarians and health professionals and fostering collaboration between the groups. Two specific objectives were the following:

a) Encourage communication and collaboration at the regional and national level among medical and health researchers, librarians and ICT experts;
b) Create sustainable national and regional capacity in accessing and applying health information systems.

Results

The activities were focused on creating an INFORM training compendium for Tanzania by incorporating suggestions about the content and format from local actors. The document was to be copyright-free, and produced under Creative Common Deeds in various formats (CD, files to be downloaded via WWW, printed copy). The distribution was accompanied by Power Point presentations and a number of workshops for training future trainers. Assessment of the results achieved through interviews with different trainers followed each of the workshops.

3.2 EXPANDING INFORM TRAINING IN AFRICA – TANZANIA

Rationale

High-quality professional information is critical to the health sector in all countries and is prerequisite to improved public health. Thanks to the advances in ICT during the past several decades, doctors and other health professionals have easy access to a wealth of information resources to support policy formulation, clinical practice, health services management, research, and teaching. Online information resources available include full-text journals and e-books on all medical specialties, as well as nursing and pharmacy. In addition, there are other allied health information, such as clinical best-practice guidelines, policy statements from national and international organizations, courseware and tutorials for use in university-level courses and continuing professional education.

Accessing the information resources in lower-income countries (LICs) is complicated due to a work culture that does not encourage sharing of information, the lack of experienced searchers, deficiency in trained mentors, technical difficulties, the lack of functional infrastructure and procedures for its efficient use, inadequate ICT support, inappropriate training and role of librarians, etc.

Objectives

INFORM5 (International Network for Online Resources and Materials) provides onsite training in lower and middle-income countries in accessing free, high-quality information through the web. The idea of the project was to train Tanzanian trainers (medical librarians, other information specialists, and medical professionals), who would then train a thousand Tanzanian doctors and other professionals in the sector. This approach, sometimes referred to as “saturation” training, was supposed to promote usage of valuable online information resources in part by breaking down barriers between librarians and health professionals and fostering collaboration between the groups. Two specific objectives were the following:

a) Encourage communication and collaboration at the regional and national level among medical and health researchers, librarians and ICT experts;
b) Create sustainable national and regional capacity in accessing and applying health information systems.

The project was conducted during the period of July 2007 until December 2009. The budget of SEK 1 000 000 was distributed into salaries for the Swedish researchers, travel expenses, consumables and overhead, as shown on Figure 7.

Figure 7: Distribution of the budget for AMIS

The findings at the start of the project indicated an extremely low level of training performed by the trained trainers. Among the reasons commonly given was lack of time, inadequate training facilities, and a lack of interest by the potential users. However, the primary problem was actually a lack of confidence. Almost all of the interviewed trainers said they did not feel sufficiently familiar with the online resources to stand in front of a group and teach about them. Everyone requested yet more training for themselves before they trained on their own. The request was addressed by organizing additional workshops and individual tutoring.
3. The Projects

Further activities included the creation of country-specific training materials on health information resources, the provision of training workshops and collaboration with Tanzanian partners in developing a detailed plan for a national “saturation” training program in health information based at the Ministry of Health’s zonal training centers.

Many health professionals at universities and official health agencies were trained in how to access free, high-quality information resources for their work, and some went on to provide their own training workshops at their home institutions. Materials produced by INFORM for the workshops were made available free-of-charge to a wider audience through the web.

The discussions and planning for a national training program in Tanzania progressed in a highly productive manner. The local partners took charge and invested great energy and significant time in developing a detailed program plan. Verbal and written commitments were obtained from the leadership of all local stakeholder institutions and agencies. The directors of the zonal health centers, where the program was to be based, not only approved the plan but appeared enthusiastic about it.

Despite the enthusiasm and hope for creating a nationwide training program, it appears that key players needed to be involved for that to occur during the lifetime of the project.

Nevertheless, the national training program failed to materialize during the project period. The primary reason seems to be the retirement of the key focal point.

– Excerpt from the final report

A core group of dedicated trainers emerged. They arranged training sessions at their own institutions and started sharing problems and solutions. Further funding for these and other activities was left primarily in the hands of the local collaborators. One university library raised 15,000 USD for more workshops, and the Ministry of Health proposed modified INFORM training to be offered at the new zonal centers throughout the country. The contacts with other active nodes were maintained with the hope that the Tanzanian group would grow and become increasingly competent in providing training about valuable online resources.

The training sessions to be financed and organized by local institutions and conducted by the trainers were realized only by two local champions. In both cases, the groups were very enthusiastic about what they learned and requested further training sessions.

– Excerpt from the final report
3. The Projects

The research within the project was mainly focused on how to make health and medical resources available to East African countries, as well as assessment of their quality. It involved finding efficient ways to identify and search various databases, research articles, and clinical guidelines available online, as well as determining strategies to reach even those that were not openly accessible. The team used this research to create various kinds of guidelines and teaching materials, hence this research was made available only through a single conference contribution and no students were involved. In addition, the dissemination of the results was mainly made through the rich INFORM website where potential end-users and trainers could download the materials free-of-charge and without any copyright infringement in distributing them further.

3.3 Language Processing Resources for Under-Resourced Languages – Ethiopia

Rationale

Languages on the African continent are “under-resourced” in the sense that they have very few computational linguistic tools or corpora (such as lexica, part-of-speech taggers, parsers or tree-banks) available. This problem has proven to be a bottleneck when it comes to promoting the use of computers and the Internet in a local language. The lack of language tools (spell checker, thesaurus, grammar controlling tool, etc.) makes it difficult to easily develop well-written web pages in Amharic.

Amharic is spoken by about 30 million people as a first or second language, making it the second most spoken Semitic language in the world (after Arabic), probably the second largest language in Ethiopia (after Oromo, a Cushitic language), and possibly one of the five largest languages on the African continent. It is currently the working language of the Ethiopian government. Written Amharic (together with the closely related Tigrinya language) uses a unique script which has originated from the Ge’ez alphabet (the liturgical language of the Ethiopian Orthodox Church).

Several computer fonts for Amharic have been developed, but for many years the language had no standardized computer representation. Amharic was incorporated into Unicode only in the year 2000. There are a number of Amharic word processing software packages available on the market; however, none support language-specific utilities like spell-checking, grammar support, on-line thesaurus, translation into another language, etc. Hence, the ability to use features usually included in word processing software for the language is limited.

Objectives

The project aims to contribute towards building necessary resources that will make possible creation of the above-mentioned utilities. The primary goal is to investigate how well existing linguistic knowledge can be transferred between languages and to develop resources, tools and techniques...
that support such knowledge transfer. In this particular case the transfer is from English to Amharic language. The specific objectives were the following:

a) Investigate methods for efficiently using computational linguistic resources for new languages based on the existing tools;
b) Develop such resources for processing of Amharic.

Results
Activities in the project were focused towards compiling Amharic corpora and annotating the words with linguistic tags (noun, verb, etc.). About 3.5 million words were collected from the Ethiopian News Headlines (http://www.ethiozena.net/). Another corpus was compiled from the Walta Information Center (http://www.waltainfo.com/). Two Amharic-English parallel corpora were compiled from the web pages of the Ethiopian Ministry of Information (www.moinfo.gov.et).

The project was conducted in two stages. The results achieved in both of them are the following:

- About two million words of news text, three books, and a parallel Amharic-English Bible of about 100,000 words were collected electronically
- The collected text has been made available in XML format in both Amharic script and in transliterated format SERA (System for Ethiopic Representation in ASCII)
- The corpus was morphologically analyzed and POS (Part Of Speech) tagged by staff at the Ethiopian Research Center at Addis Ababa University
- Morphological analyzer and stemmer for Amharic were developed
- Morphological analyzer and POS-tagged corpus were used to develop two POS taggers for Amharic
- Preliminary performance of the POS taggers was made
- The collected corpus was “cleaned” semi-automatically: non-tagged items were tagged and double tags were removed
- Three POS taggers based on publicly available systems originally developed for English language were tested and their performance compared
- Morphological analyzer was improved and tested showing satisfactory accuracy
- A set of experiments to investigate how well text classification could be carried out on Amharic texts was performed

The manually annotated corpus for Amharic (although rather small) has been made publicly available to stimulate further development of language tools (http://corpora.amharic.org/resources/tagged-corpora/wic-tagged-news-corpus/).

The sustainability issue is not tackled in the project report and it was rather lightly addressed in the objectives. Moreover, the reporting did not follow the template requested by Spider which involved a separate section on sustainability.

– Comment by the author of the publication

Project team, duration, research results and budget distribution
The main actors in the project were the Department for Computer and System Science (DSV) at Stockholm University; The Swedish Institute of Computer Science (SICS), the Ethiopians Languages Research Center, and Addis Ababa University. The center of attention was on the research, with the development seen as a long-term result. A PhD research was also pursued with the thesis being completed after the end of the project. There were seven articles published either as chapters in a book, journal papers or conference contributions. The project obtained total funding of SEK 1 000 000, with 70% disbursed in the first phase and 30% in the second phase of the project. The distribution of the budget presented in Figure 12 refers to the second phase only.

Figure 12: Distribution of the budget for LPR

3.4 MOBILE ATMS FOR DEVELOPING COUNTRIES - SRI LANKA
Rationale
ATMs (Automated Teller Machines) are devices widely used for cash withdrawals. Credit/debit cards are their counterparts when making financial transactions. In Sri Lanka ATMs are supposed to be used for financial operations in the same way. However, less than 300 ATMs have been installed by banks and more than 80% of these machines are located in Colombo and surrounding areas. Very few people can perform these transactions, since the machines are not available where they live. Remote villages and smaller cities in Sri Lanka do not have ATM facilities and people must travel to larger cities in order to withdraw money. Hence, there is a need for an affordable and convenient system that would enable rural people to par-
participate in electronic financial transactions. This service can be used in other developing countries as well.

GSM networks (Global System for Mobile communications) provide their services to remote cities and villages in Sri Lanka. Since fixed telephone lines are not available in these areas, most of the rural people use mobile phones. Several businesses, mainly SIM chip vendors and banks, offer some services for banking transactions. The methods they use do not provide a satisfactory level of security. In addition they create a false impression of their security, thus opening the possibility for their systems’ vulnerabilities to be exploited.

**Objectives**
The main idea of the project was to develop a simple and innovative solution, called Mobile ATM (M-ATM) for providing basic ATM services to people who have mobile phones. With the proposed solution people can withdraw money from M-ATM without going to the traditional ATM machine. Instead cheap mobiles phones are functioning as payment terminals using secure SMS to exchange messages between mobile terminals and banks. People from rural areas can securely withdraw money from their bank accounts with assistance of bank agents without going to their banks or use other means of payment authorization for their daily private or business financial activities. The availability of the service can have a positive effect in encouraging more people to deposit their money in a bank and thus help to develop the rural economy.

The main objectives of the project were the following:

a) Design and develop Mobile ATM for unbanked (population not having easy access to ATMs or bank offices);
b) Deploy the application as a pilot;
c) Extend the application as an online payment system.

**Results**
The three key components in the M-ATM system, presented on Figure 13, are a bank, bank agent and a customer. The bank agent is registered and certified by the bank. A customer has an account with the bank. Both bank agent and customer have mobile phones, suitably modified to perform functions of the M-ATM in a secure way. The bank has an M-ATM server as the front-end, connected to the bank’s back-end financial system. In order to perform a transaction, a customer with a mobile phone comes to the bank agent with a mobile phone. 1) The customer sends SMS to the bank requesting the money, together with his/her PIN and bank agent’s mobile number. 2–3) The bank verifies both and sends confirmations simultaneously to the bank agent and the customer. The bank agent gets an approval, comprising transaction number (a random number) and the customer gets a confirmation number (a random number). 4) The customer tells the confirmation number to the bank agent. 5) The bank agent sends the transaction and confirmation numbers back to the bank. 6) When the bank receives the confirmation from the agent, money will be deducted from the customer’s account and credited to the agent’s account. 7) The customer is informed about the status of his/her account. 8) Finally, bank agent pays the money to the customer, who confirms the receipt and in that way completes the transaction.

The mobile ATM system was designed to support all kinds of financial transactions performed by individuals or corporations. In addition this system could support direct client-to-merchant payments, person-to person transactions, non-monetary transactions and other. The distinguishing feature of the system is its strong security for users, their transactions and applications. Besides designing the system, the objective of the project was to deploy the application as a pilot project with the help of local banks in a rural area and to extend the M-ATM concept as an online payment system.

The system was tested at Boralasgamuwa Sanasa Bank, which has a rural customer community. The evaluation was based on the performance and the scalability of the system. Statistics about the time necessary to carry out transactions were gathered. Times varied between 83 and 105 seconds, not including the time to fill in the data in the application since it was dependent on the individual’s abilities. The measurements showed that the time was not largely affected by the strength of the GSM signal, as shown on Figure 14.
In addition, the time and the cost required by the new system were compared to the traditional banking system. The results obtained were in favor of the new system (shorter time and lower cost). A user study analysis was performed by using a special questionnaire to capture users’ opinions on the new system compared with the traditional one.

Scalability issues were tackled by asking users waiting in the bank to compare the existing and the newly proposed mobile system. The answers showed that 15% were in favor of the new system, 20% did not favor it and 55% would rather have both the old and the new banking system. Analysis of the attitude towards the new system with respect to age and gender was also performed. It showed that men and younger persons were more inclined to use the system. Having in mind that the sample was very small, there are concerns that these conclusions might not be correct. Another obstacle for using the system was the issue of privacy. In a real world scenario the mobile agent would be a villager and in small communities where people know each other, they are not comfortable disclosing their financial matters.

We have planned to deploy the M-ATM system in around fifty (50) rural banks by the end of this year. We are confident that this application would address a major service gap in developing countries that is critical to their social and economic development even though the system has a privacy issue.

– Excerpt from the final report

The report on activities regarding extension of the project application has never arrived. Hence, no information about further developments and extensions of the project are available.

– Comment by the author of the publication

Project team, duration, research results and budget distribution
To provide good cooperation, the team consisted of a project coordinator at the Department of Computer and System Sciences (DSV), Royal Institute of Technology and a project coordinator from University of Colombo, a former PhD student at DSV. In addition, another PhD student and several master’s students from developing countries participated in various research activities. The team at University of Colombo, Sri Lanka consisted of two permanent members and a few master’s students. However, except for the academic institution, no other local counterpart was identified in the partner country.

The research within the project (between October 2007 and December 2009) produced seven articles printed in journals and presented at conferences. More publications were expected to be produced after the project ended (information obtained from the project coordinator in Colombo). The total project funding was SEK 800 000 and a large portion of it was transferred to the academic institution in Colombo.

3.5 ONLINE WATER QUALITY MONITORING – MALAWI
Rationale
Water management plays a key role in the Millennium Development Goals and national strategic plans of all countries to secure reasonable living conditions for their populations. Access to clean water is widely considered as a human rights issue. However, insufficient protection of water sources, non-existent quality monitoring or use of quality monitoring procedures with considerable delays, as well as inadequate treatment, still put communities in developing countries at risk for contracting infectious diseases.

Existing monitoring procedures are entirely manual, based on sampling and subsequent analyses in water laboratories. This often causes considerable delays in the monitoring process. The quality of the monitoring process would benefit significantly if at least some basic parameters would be monitored online. This will enable the monitoring groups to provide an early warning system that can trigger appropriate treatment.
3. The Projects

Results

WSN for water quality monitoring was developed at KTH. The implementation of the system was done during the first six months of the project by a team of master’s students under a master’s level course at KTH (Communication Systems Design). This team designed the first prototype of the WSN. Sun Microsystems was a close partner during the development of WSN. They sponsored the project by donating kits of SunSPOT motes (http://www.sunspotworld.com/) and related accessories. Sensors for measuring water quality were selected, including turbidity, redox potential and conductivity. The properties of the SunSPOT motes, including power consumption, and the quality of the wireless links were explored. Since such sensors are power hungry, a power management system was designed to allow activation only when measurements are made. The nickname adopted for the project was “WaterWell” (http://www.tslab.ssvl.kth.se/).

In Malawi, the Malawi Bureau of Standards specifies the physical, biological, and chemical requirements for water quality. These guidelines include parameters such as turbidity, pH, conductivity, hardness, sulphates, nitrates, total dissolved solids and oxidation-reduction potential (ORP). These water quality parameters are very critical for water quality. Hence, analysis of water samples is regularly done in laboratories using standard methods. This is expensive, laborious and time consuming.

Objectives

The use of sensors to generate water quality data is hoped to make possible online monitoring of the values and faster reaction when monitored parameters’ values are outside of the permissible range. Basic parameters to monitor include turbidity, pH and redox potential. Other parameters could be considered pending the availability of low-power-consuming sensors.

The objectives of the project included the following:

a) Prototype a WSN infrastructure for water quality management;
b) Deploy and demonstrate it at selected sites in Malawi and/or Tanzania;
c) Spread awareness of the results by workshops and courses;
d) Make a feasibility study on how to empower and stimulate local entrepreneurs to establish businesses based on the system.

The Blantyre Water Board (BWB) in Malawi provides drinking water for the city of Blantyre and other urban areas in the vicinity of Blantyre. It has two water intake stations. Mudi Dam is the smaller one and it provides approximately 10% of the water used in Blantyre. The other station is located on the Shire River in the Chikwawa district and accounts for 90% of the total water used in the city. The catchment area of Mudi Dam also houses the main laboratories that monitor physical, chemical and bacteriological parameters to control water quality. This makes the location suitable for installing and testing the prototype system. The sensors were to be placed at the water station at Mudi Dam and the data obtained gathered by the host station located at one of the main laboratories.

For the implementation of the host station a gateway for wireless sensor networks was developed based on an embedded Linux board. It is a low-cost, low-power solution to store data in a database and make them available over wired and wireless networks (Figure 18). It implements open mesh protocols, making it ideal for community-based wireless networks.
The project coordinator and two other researchers from the Royal School of Technology, together with one PhD student and a number of master's students, constituted the team from Sweden. Three researchers from University of Malawi and one teacher from Dar es Salaam Institute of Technology were also involved. The connection with the water authorities in Malawi went through the Malawian academic network and the ISP association. The same technical solution was supposed to be implemented in Tanzania; hence the Ministry of Water in Dar es Salaam was also a partner.

Although planned, the deployment of the same system at some facility in Tanzania did not happen due to lack of interest from the partners and related organizations in the country.

–Comment by the author of this publication

The feasibility study on how to empower and stimulate local entrepreneurs to establish businesses based on the system has been carried out. Analysis of the possibilities to market the developed product was made. A Gartner Hype cycle curve (Figure 19) was used for the analysis. The conclusion was that at the time the report was made, the product was at Peak of Inflated Expectation. Hence, some time will be needed for the product to be made more sophisticated and the interest of the market to increase.

–Excerpt from the final report

After the project ended, in non-formal communication, the coordinator asked the funds left (SEK 10 000) to be used for sending sensors from Malawi to Sweden to be calibrated or repaired.

–Comment by the author of this publication

The academic environment is a great place for creating novel research. The novelty of the topic explored raised much interest and enthusiasm for research. The team of more than 6 master’s students mainly from developing countries took an active part in the project (Figure 20). The results were published in six scientific articles, and disseminated through reach web sites presenting all the phases in the project, video clips from the deployment in Malawi posted on YouTube, and via other media channels.
The project showed that the number of women participating in the ICT field in Vietnam is still low, but trending up. However, Vietnam appears to have a higher than average participation of women in the product development process in the ICT sector when compared to most other countries.

The investigation performed in the ICT companies showed similar results as those in other countries, even developed ones. The number of companies concerned with development of gender-specific products is low and the issue needs to be addressed.

Figure 20: Students working on the project

The project was estimated to last about 18 months and it was finished on time. Distribution of the budget spent (total of SEK 740 000) was similar to the other projects (21% for salaries, 21% for overhead, 22% for travel, 13% equipment, 10% consumables and 13% on scholarship for one of the students).

3.6 PUTTING KNOWLEDGE TO BETTER USE – INDUSTRY RESPONSIVENESS TO GENDER DIFFERENCES IN ICT DEMAND IN VIETNAM

Rationale
Vietnam has emerged as one of the countries in Southeast Asia that has grappled with ICT and everything related to it before the other countries in the region. Women represent about half of the population and among them there is a growing portion of customers inclined to use a myriad of technical solutions. Women use ICT for different purposes and have different demands than their male counterparts. Hence, the speed at which the Vietnamese female population adopts the new technology depends on the responsiveness of IT industry in Vietnam to develop products and services according to women’s needs.

Objectives
This project is devoted to exploring how representatives of the ICT industry in Vietnam are reacting to the challenge of incorporating the women’s perspective in ICT products and services. The general objective of the study is to explore the opportunities for ICT entrepreneurs in Vietnam to develop products and services in response to demand by women and examine whether or not this opportunity could be translated into a competitive advantage for an innovating company. The specific objectives are as follows:

a) Investigate gender differences in the ICT demands in Vietnam;

b) Identify major obstacles to gender-specific technological development in ICT;

c) Explore the viability of business models aimed at women as users of ICT.

Realization
An unexpected result from the project was a reasonably up-to-date database on Vietnamese companies active in the ICT-industry, something that did not exist earlier in Vietnam. Involving local staff in activities of the project had a capacity building side effect. Engagement of young researchers in distributing and collecting questionnaires, as well as conducting interviews produced additional value to the project in terms of training and capacity building. The local team visited over 200 ICT companies and this had as a consequence a capacity building effect for the dedicated investigators.

Figure 21: Employees working at a software company in Vietnam

Language turned out to be more of an issue than we envisaged at the start of the project, especially when translating the wording in the questions from English to Vietnamese. A lesson learned is to put more time on streamlining questions and interviewers.

– Excerpt from the final report
3. The Projects

Objectives
The specific objectives of the project were as follows:

a) Documenting traditional skills and knowledge of handicraft methods and products by creating digital documentation;
b) Using digital video clips and pictures as a training tool for learning traditional techniques of basket making;
c) Preserving traditional skills of basket making as an important tool of the Rwandan cultural heritage;
d) Strengthening women’s participation in ICT development in Rwanda;
e) Creating new business opportunities for rural women and building their confidence in being skillful and knowledgeable users of digital technologies, thus opening opportunities for them to occupy new positions in the societal development and involvement in the growing ICT society.

Realization
The main activities of the project were eleven workshops that provided training in using digital tools and a dissemination conference where the results of the project were presented, as well as twelve visits to the co-operatives in Rwanda aimed at extending the activities to other regions. Eight laptop computers and digital cameras were distributed. The computers were used by rural women to learn basic ICT skills. This was followed by training sessions in using digital cameras to record the basket making process and producing digital documentation using both of these tools. In parallel, the minutes from the training sessions were made using laptops, and various ways of using the Internet explored. The final conference served as a place for presenting the confidence and the skills gained by participating women, as well as for critical questions doubting these skills which were raised by local leaders. This was followed by a reflection on the achievements of the project.

Project team, duration, research results and budget distribution
Three researchers, one from Vietnam and two from Sweden, were involved in the project. One representative of the National Council for Science and Technology in Vietnam and one from the Vietnam ICT Association were also partners. A number of young individuals taking part in the survey can be considered as part of the local team. The researcher from Lund University was the coordinator.

Two publications were produced and project results were communicated at the closing workshop in Hanoi with relevant stakeholders from academia, state administration and the business community being present. The duration of the project was two years and its budget SEK 625 000. Due to delay in some activities, three extra months were needed without going over the budget. The largest portion was spent on salaries.

3.7 WOMEN’S DIGITAL BASKETS IN RWANDA

Rationale
The government of Rwanda recognizes the importance and the role of women in the socio-economic development of the country and is deeply committed to supporting the benefit of modern technologies, to people in urban areas as well as rural areas, where a large proportion of women are found. Despite the government policies for gender equality and involving women in education, which has opened opportunities for them to become equally eligible for employment, so far there had been no initiative for women in rural areas to receive training in the use of ICT. Empowering women with knowledge on how to use digital cameras and computers is seen as one of the opportunities for rural women to make changes in their lives.
The idea of constructing the model of the Swedish Research Projects originates from the genuine interest of the author to use modeling in the process of monitoring and evaluating the ICT4D projects. However, in this case the projects are all finished and the qualitative evaluation of the program has already been done. Hence, the problem to be addressed consists of determining which factors contributed to the already known project outcomes. The fact that a single model, representative of all seven projects, was to be constructed make the choice of System Dynamics modeling method the most appropriate one, since it uses a holistic approach in representing the main characteristics of the problem under observation. This type of modeling has already been applied to project management in various areas with great success from the academic perspective, and in real-world applications (Lyneis & Ford, 2007). Some examples are the models in the construction industry (Chapman, 1998) and software development (Martin & Raffo, 2000).

The model is built after a thorough analysis of the seven projects based on the information from the final reports, the available websites and some limited communication the author had with some of the project leaders. Having a single model for the whole program was possible due to the similarities found among the projects. However, many assumptions had to be made due to the lack of data. The model presented here is a modification of the previous version (Popova, 2012).

This chapter explains the author’s way of thinking during the modeling process and provides validation of the model. First, the resemblances among the projects and the assumptions of the author are presented, followed by the rationale behind the selection of the state variables and their causal relationships. Then, the diagrams obtained from the simulation are commented on and finally the model is validated. A free version of Vensim, known as Personal Learning Edition (PLE), was the vehicle for designing the model and performing the simulation.
4. SIMILARITIES AND ASSUMPTIONS
While Swedish University Projects are very different by the nature of research pursued, they have many things in common that are addressed below.

• The origin of the research idea
Spider’s policy for allocating funds to Swedish University projects, regardless of the program to which they belong, required partner universities to submit their research ideas of how ICT can be used in the developing country. Consequently, the origin of the ideas was from researchers in Sweden.

• Time frame
The dates when projects started and ended were different. Some of them started in 2007, while others in 2008. However, there are similarities in their duration. Five of the projects lasted two years. Two of them were conducted in two phases with the second phase much shorter and the total time slightly beyond two years.

• The budget
The budget for all seven projects ranged between SEK 525 000 and 1 100 000, considering here the projects in two phases. Funds were used for financing activities within the projects. In addition, the researchers were free to use them for equipment and other materials, travel to the developing country, as well as for salaries to Swedish participants and the personnel in the partner country.

• Proportion of expenditures
The expenditure categories in the final financial reports were similar. All of the projects included salaries paid in Sweden together with the overhead, as well as the travel to the partner country. For the purpose of the model, these expenditures are considered to be made “in the North”.
Some of the projects had expenditures for durable equipment usually used in the developing country, others for a category called “consumables” or “other” which mainly included scholarships or salaries paid to researchers or staff from the developing country. The later were considered as expenditures “in the South”. The proportion of these two categories ranged from 65/35 to 90/10 in all seven projects.

• Human resources
The number of researchers from the Swedish university, as well as from the developing country, was rather small and ranged from one to three not including PhD or master’s students. However, some involved many students studying in Sweden, mainly from developing countries. The inclusion of students brought additional value to the project in terms of the synergy built around the team. For the purpose of the model the human resources are a single category and include Swedish and local researchers, as well as students.

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4.2 VARIABLES AND CAUSE-EFFECT SEQUENCES
From the similarities among the projects three specifics are extracted as common for all of them.

1. They were very successful in terms of the research results achieved
2. The larger portion of the expenditures were made “in the North”
3. The sustainability issue was a problem

Consequently, three aspects of the model are created: research, budget distribution and sustainability.
The fact that all project ideas originate from Swedish researchers is incorporated in the parameter called NORTH/SOUTH of Boolean type. This is the crucial parameter in the model that offers a possibility to observe two scenarios. The first corresponds to the reality (the idea originates in the North), and the second is a hypothetical one (the idea originates from the South or the project is demand-driven).

The variables directly calculated as averages of the values extracted for all seven projects, together with the time units, are presented in Table 3.

<table>
<thead>
<tr>
<th>Name of the variable</th>
<th>Initial time (Days)</th>
<th>Final time (Days)</th>
<th>Total budget (SEK)</th>
<th>Human Resource in Research (human)</th>
<th>Allocated time (1/2/Day)</th>
<th>Published articles (article)</th>
<th>Local ownership counterpart organization (organization)</th>
<th>Local champions (human)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0 740 650 000 75/25</td>
<td>5 0.18 4.5 1 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Data from the projects

A variable called Development awareness is introduced to show to what extent the projects took in consideration the real needs of the locals and the size of the target population. The model takes a simplistic approach and assumes that this was directly proportional to the way the budget was distributed. Hence the variable Development awareness is affected by the NORTH/SOUTH parameter and obtains a value of 0.25 or 0.75, depending on the chosen scenario. This variable is present in all aspects of the model.

The efficiency in achieving research objectives is modeled through the variables Planned research activities, Performed research activities, Research activities, Human resources for research, Allocated time and Enthusiasm for research. The first two are stock variables with the flow of research activities moving from the first stock to the second. The rate at which the research activities flow is affected by the last three variables. The values for Human resources for research and Allocated time are taken from the project. The Enthusiasm for research variable is introduced by the author to model the fact that all research activities were accomplished on time. Enthusiasm for research is assumed to be genuine for all researchers and stimulated by the planned research activities. The scaling constant was introduced to obtain already known outcomes.

The results from the research are modeled by the variables Research results, Published articles and Research results for sustainable development. The last two are in a positive cause-effect sequence with the first one, which is in turn affected by the Performed research activities. The purpose of Research results for sustainable development variable is to express the fact that not enough attention was dedicated to the research necessary to sustain the project; hence it is affected by the Development awareness variable and takes lower values in the real scenario. This variable on the other hand affects sustainability.

The part of the model showing the distribution of the budget has three stock variables. The Budget variable has an initial value equal to the budget for the project. It is reduced as the expenditures are made. The Research budget and Development budget correspond to the parts of the budget spent in the North and South, respectively. The flows show the rates of the spending. The Budget constant is introduced to adjust the proportion of expenditures to the values obtained from the projects.

The last and arguably the most difficult aspect to model is the issue of sustainability. The main idea when modeling was to show that sustainability was the Achilles’ heel for the projects and to find the reasons behind it. The lack of deeper insight into the details of negotiations with local partners and unknowns regarding the necessary preconditions and possibilities to create “living labs” from the project results is the main reason for the simplicity in the approach towards this part of the model. The focus was on showing the probability of the project to endure after the end of the funding. Even though the final reports were written by the leaders of the projects, the perception obtained was that none of them fully achieved sustainability due to the lack of local ownership counterpart defined at the very beginning of the projects. The author assumes that the small number of local champions in the projects was yet another reason.

The central variable in the sustainability aspect of the model is Prospect for sustainability. It is assumed that it was affected by four factors in the case of Swedish Research Projects. Two of them are represented with the variables Local ownership counterpart and Local champions. They are in a cause-effect relationship with the crucial NORTH/SOUTH variable. In the real scenario they take the values extracted from the projects. The values for the hypothetical scenario are larger. The constants Potential local ownership counterparts and Potential local champions are introduced to keep the probability for sustainability not exceeding a value of 1 and at the same time to have these two variables represent the real impact of these factors instead being only numbers.

Two additional variables in a cause-effect relation with Prospects for sustainability are Research results for sustainable development and Local ICT readiness. Both of them are introduced by the author. With the latter, it is assumed that sustainability for an ICT4D project depends on the level of ICT readiness in the environment of implementation. Without using the appropriate technology that takes into consideration the local culture and capacity of the population, the ICT4D idea cannot sustain. According to Heeks (Heeks R., 2010) ICT readiness comprises the infrastructure, the skills and the policy, and is a starting point for ICT contribution to development. This perception is modeled in a fairly simplistic way through the stock Local ICT readiness. Due to the lack of data for the localities in the projects ICT readiness levels for the partner countries are used in the model. The initial value for Local ICT Readiness is the average of the levels for the year 2007 (Mia, Dutta, & Geiger, 1972). The value of the constant Target ICT readiness is slightly higher than the average for 2012 (Dutta, Bilbao-Osorio, & Geiger, 2012). The ICT readiness levels are derived by taking into account political and business environment, infrastructure, affordability and skills, usage, economic and social impact (Dutta, Bilbao-Osorio, & Geiger, 2012). In the model all the factors are not included. Instead, a variable called ICT
consciousness is introduced. The idea with this variable is to express the consciousness of the project related to the spending contributing towards the growth of the local ICT readiness.

4.3 STOCK-AND-FLOW MAPS
The model is built using the component strategy (Pejic-Bach & Ceric, 2007). The final structure of the stock-and-flow maps for the research and the budget distribution aspect are presented on Figure 25 and 26. Figure 27 shows the sustainability aspect. The three parts of the model are created on separate views in Vensim. The variables from one view are present as the so-called “shadow variables” in the other two views. The distinction from the other variables is shown through the faded font and the brackets.

Vensim’s convention is used for the labels. The stocks are presented in boxes, the flows with arrows and valves and all small letters, the constants with all capital letters and auxiliary variables with the capital first letter. To preserve the clarity of presentation, no labels are used for the signs of the causal relationships and for the feedback loops. It is assumed that the description offers enough information for them to be discovered intuitively.

4.4 BEHAVIOR OVER TIME GRAPHS
The output from the simulation of the SD model is a set of line graphs with time on the X-axis and the variables in the model on the Y-axis. The diagrams show the changes over time. The behavior of the variables of interest can be observed and compared to the real system.

In the research aspect it is interesting to check the following variables: Research results, Research results for sustainable development and Published articles. Figure 28 shows the graphs for these variables under the real and the hypothetical scenario.
Figure 29 presents the graphs for the budget. The upper part shows the real and the lower part the hypothetical scenario. As expected, in both cases the whole budget is spent. The difference is only in the amount spent for research and development.

It is not surprising that the trend of the curves in the diagrams is the same. This comes due to the positive cause-effect relationship between Research results and Published articles, as well as between Performed research activities and Research results. On the diagram showing research results, the blue and the green line cannot be distinguished, and the same is the case with the red and blue line for the diagram showing published articles. This means that the curves for Research results and Published articles have the same shape under both scenarios leading to the conclusion that the origin of the idea or the demand driven research does not necessarily need to be less successful in achieving the results. The number of published articles at the end of the project is 4.5. Having in mind the low value for the Allocated time (18%) and the Human resources for research (five persons), the produced results are high and show a significant level of effectiveness of the project.

While the behavior for the Research results and Published articles under both scenarios is the same, the Research results for sustainable development variable approaches a higher value under the hypothetical scenario, when the idea originates from the South. In other words, the demand-driven projects would not create a hindrance to achieving the same amount of research results; on the contrary, they will also contribute to the larger portion of them being used for development.
In the sustainability aspect of the project the graph for Local ICT4D readiness and Prospects for sustainability have the behavior shown on Figure 30.

![Figure 30: Sustainability aspect of the project under both scenarios](image)

Both diagrams have different shapes under the two scenarios. The Local ICT readiness grows in both cases. However, the gradient is different. The value reached at the end of the project in the case of the real scenario is lower than in the case of the hypothetical one.

The Prospect for sustainability is close to zero when the idea originates in the North and shows a trend of increase in the demand-driven scenario. Note that the curve for the hypothetical scenario on Figure 30 is obtained by keeping the same values for Local ownership counterpart and Local champions as in the real scenario.

In order to check their influence on the Prospect for sustainability several simulations were performed with different values for Local ownership counterpart and Local champions, with the scenario SOUTH_0 corresponding to the curve on Figure 30 and scenario SOUTH_4 to the situation when the full potential for both of them is used. The diagrams obtained are presented on Figure 31. Note that it is assumed that Prospect for sustainability is actually the probability of the project to be sustainable. The curves show that it is higher when the potential of the local partners is increasing and is going over 70% when it is fully exploited. The margin that is left is assumed to be due to very different risks the ICT4D projects usually encounter.

4.5 VALIDATION OF THE MODEL

Numerous techniques are available for verification and validation of simulation models (Sargent, 2008). For the SD model presented here, a combination of techniques is used. The model is actually validated by fulfilling the two fundamental assumptions in (Qudrat-Ullah, 2005). The modeling process already described applies the knowledge gathered from the projects, and the structure of the stock-and-flow maps drives the behavior presented in the diagrams generated through simulation.

This section provides additional validation using the statements in the qualitative evaluation of the projects (Bråsjö, 2010) and the conclusions obtained by observing particular graphs. This technique is known as historical data validation (Sargent, 2008).

In this section three pairs of conclusions and statements are presented as framed text. Each conclusion based on the SD model is written in the upper part of the frame. The corresponding statement from the qualitative evaluation is placed in the lower part of the frame. Note that in his evaluation, Brosjö uses the term “ICT collaboration program” for the Swedish University Projects.
5. Concluding Remarks

The challenge with creating the model for the Swedish research projects is to show the power of the System Dynamics approach in capturing the main features through diagrams, and also generating a very clear picture of the findings, especially if they are to be shared with a wider audience. However, a separate model could have been created for each project before its initiation. It would incorporate the project’s own characteristics and specifics so that deep understanding of many issues could be gained well in advance. For this purpose other modeling techniques and more sophisticated simulation platforms are in place. For example, commercial software such as AnyLogic® offers the opportunity to combine the three modeling techniques for dynamic systems.

The aim with developing and studying this model was to draw attention of the ICT4D project managers to the potential and power of modeling and simulation tools for monitoring and evaluating current and/or future projects. Moreover, there is the potential to inspect in advance other possible outcomes resulting from different choices and directions when planning and conducting the project. The models can often assist in discovering unexpected outcomes that might be harmful. Definitely, their use either as an alternative or as a complement to other evaluation methods will improve the iterative process of the monitoring and evaluation of ICT4D projects, including their successful completion and long-term benefits.

Conclusion-Statement Pair 1:

The curve for research results and published articles in Figure 28 under the real scenario has steep rising trend which shows a high level of effectiveness.

– Conclusion based on the SD model

Assessing their goal attainment (through examination of the outcomes achieved so far) leads to the conclusion that the ICT collaboration Program provides a high level of effectiveness.

– Excerpt from (Bråsjö, 2010)

Conclusion-Statement Pair 2:

Through the NORTH/SOUTH variable and the diagrams obtained for the hypothetical scenario presented on Figure 30, the model proves the need for the projects to be demand-driven. Figure 31 shows the big role of the local ownership counterpart and the local champions.

– Conclusion based on SD model

Ensure that the projects are demand-driven, which means real needs and commitment exists in the partner country.

– Excerpt from (Bråsjö, 2010)

Conclusion-Statement Pair 3:

The curves on Figure 31 confirm that sustainability is ensured by providing local partners that can take ownership and continue the project after the funding is over.

– Conclusion based on SD model

Make sure that every project has a tentative implementation plan at the start and that a sustainability plan exists.

– Excerpt from (Bråsjö, 2010)

For further experimentation with the model, VENSIM PLE can be downloaded from www.vensim.com/freedownload.htm. The file Model.mdl is available on the Spider website.

http://www.xjtek.com/anylogic/
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Pirjo Elovara, Final report for the Project “Women’s Digital Baskets in Rwanda”, March 2011
Blog: keagu.wordpress.com (retrieved September 2011)
Appendices

APPENDIX 1: FULL LIST OF THE VARIABLES AND UNITS

(01) ALLOCATED TIME = 0.18, Units: 1/Day
(02) "ARTICLES/RESULTS RATIO" = 1/0.65, Units: article/result
(03) Budget = INTEG (-development spending-research spending, 650000), Units: SEK
(04) BUDGET CONSTANT = 3, Units: Dmnl
(05) Budget spent on development = INTEG (development spending, 0), Units: SEK
(06) Budget spent on research = INTEG (research spending, 0), Units: SEK
(07) COST PER ARTICLE = 5000, Units: SEK/article
(08) Development awareness = IF THEN ELSE("NORTH/SOUTH", 0.25 , 0.75 ), Units: Dmnl
(09) development spending = ((Total budget-Budget spent on development-Budget spent on research)/FINAL TIME)*Development awareness*BUDGET CONSTANT, Units: SEK/Day
(10) ENTHUSIASM CONSTANT = 0.006, Units: 1/human
(11) Enthusiasm for research = Planned research activities*ENTHUSIASM CONSTANT, Units: activity/human
(12) FINAL TIME = 740, Units: Day
(13) HUMAN RESOURCES IN RESEARCH = 5, Units: human
(14) ICT consciousness = Development awareness*Local ICT readiness/Total budget, Units: level/SEK
(15) ICT READINESS CONSTANT = 1.8, Units: Dmnl
(16) Increase in local ICT readiness=development spending*ICT consciousness/ICT READINESS CONSTANT, Units: level/Day
(17) Initial research activities=30, Units: activity
(18) INITIAL TIME = 0, Units: Day
(19) Local champions = IF THEN ELSE("NORTH/SOUTH", 2 , 5 ), Units: human
(20) Local ICT readiness = INTEG (increase in local ICT readiness, 2.8), Units: level
(21) Local ownership counterpart=IF THEN ELSE("NORTH/SOUTH", 1 , 5 ), Units: organization
(22) "NORTH/SOUTH" = 1, Units: Dmnl
(23) Performed research activities= INTEG (research activities, 0), Units: activity
(24) Planned research activities = INTEG (-research activities, Initial research activities), Units: activity
(25) POTENTIAL LOCAL CHAMPIONS = 5, Units: human
(26) POTENTIAL LOCAL OWNERSHIP COUNTERPART = 5, Units: organization
(27) Project fraction = Performed research activities/Initial research activities, Units: Dmnl
(28) Project is done = IF THEN ELSE (Project fraction<=1, 1 , 0 ), Units: Dmnl
(29) Prospects for sustainability = (Local ownership counterpart/POTENTIAL LOCAL OWNERSHIP COUNTERPART)*XIDZ (Research results for sustainable development, Research results, 0)*(Local champions/POTENTIAL LOCAL CHAMPIONS)*(Local ICT readiness/TARGET ICT READINESS), Units: Dmnl
(30) Published articles = Research results*"ARTICLES/RESULTS RATIO", Units: article
(31) Research results for sustainable development = Research results*Development awareness, Units: result
(32) research activities = IF THEN ELSE (Project is done, HUMAN RESOURCES IN RESEARCH*ALLOCATED TIME*Enthusiasm for research , 0 ), Units: activity/Day
(33) Research activity cost = Budget/(research activities*FINAL TIME), Units: SEK/activity
(34) Research results = Performed research activities*"RESULTS/ACTIVITIES RATIO", Units: result

(35) research spending = Research activity cost*research activities*(1-Development awareness)*BUDGET CONSTANT +(Published articles*COST PER ARTICLE)/FINAL TIME, Units: SEK/Day

(36) “RESULTS/ACTIVITIES RATIO” = 1/10, Units: result/activity

(37) SAVEPER = TIME STEP Units: Day

(38) TARGET ICT READINESS = 4, Units: level

(39) TIME STEP = 1, Units: Day

(40) Total budget = Budget+Budget spent on development+Budget spent on research, Units: SEK

Evaluation of the SPIDER program “ICT Project Collaboration with Swedish Partner Universities 2007-2009”

A review made by Ulf Bråsjö
May - September 2010
Executive summary

The objective of this evaluation is to review the results and effects of the projects of the program “ICT Collaboration Projects with Swedish Partner Universities 2004-2009” (with focus on 2007 – 2009), supported and coordinated by SPIDER, the Swedish Program for ICT in Developing Regions, supporting developing countries to harness the benefits of information and communication technologies (ICT).

The evaluation has used a combination of desk research, stakeholder interviews, e-mail questions and follow-up calls to partner country and university representatives, concluded by a participatory workshop. Evaluation criteria have been Effectiveness, Impact, Relevance, Sustainability and Efficiency, but since most of the projects are not completely finished also Output and Outcome have been examined in the seven projects selected.

Projects

As a first general and important observation it should be stressed that the supported projects have a high relevance, addressing well recognized and wide-spread problems in the partner countries. Output and outcome indicate that the projects are on track achieving impact. Focus has been put on governing structures and mechanisms in order to achieve sustainable result. However, a few of the projects have had issues to keep local commitment or transferring the results to a long-term owner. Relations have been built within the Swedish and international researcher community.

Recommendations for a continuation

In the light of the promising results achieved so far by the University Collaboration projects, the overall recommendation is to continue securing additional funding to continue the program. On the other hand, if additional funding fails, it would be better to terminate/finish the program in its current form, but rather incorporate suitable research efforts in the projects initiated from the partner countries.

Project and program recommendations

- Encourage and finance Swedish and foreign master students to work in implementation projects, providing more cost-effective, flexible and “down-to-earth” resources
- Continue and improve the coordination and information exchange with Sida and UFORSK, especially as long as Sida is lacking an own function to support the "main-streaming" of ICT in their projects
- Finally, in order to best contribute to developing results using ICT in the partner countries it is strongly recommended that **SPIDER focuses on its role of network linking universities, civil society and private organizations** in order to "broker" ideas, partners, projects, methods and solutions both internationally and nationally.
### Introduction/Background

#### Background to program and evaluation
SPIDER, the Swedish Program for ICT in Developing Regions, started in 2004 to support developing countries harnessing the benefits of information and communication technologies (ICT). The University Collaboration Program (full name: ICT Project Collaboration with Swedish Partner Universities) started as i) incentives for the Swedish partner universities to get involved in the Network, ii) to raise the awareness and build knowledge of ICT4D among Swedish researchers and iii) to bring ICT4D into the Swedish research arena. SPIDER has also been very active in other programs, e.g. the partner country initiated projects, master education, a Ph.D. network etc. Olle Edqvist made an evaluation of the University Collaboration Program early 2007 and in April 2010 SPIDER commissioned this review.

#### Purpose of the evaluation
According to the Terms of Reference the evaluation should cover:

- A review of the results and effects of the projects of the program “ICT Collaboration Projects with Swedish Partner Universities 2004-2009” (with focus on 2007 – 2009, see below as agreed with the secretariat)
- A review of the administration and management of the program
- A review on the alignment to the former Sida/SAREC-support to researchers within ICT for development
- Recommendations for a continuation based on the assessments of the effectiveness of the program, and
- Suggestions on how the program can better support SPIDER overall objectives and better utilize existing budget allocations

It should be noted that both in Olle Edqvists and this evaluation most of the projects were not completely finalized. Nevertheless SPIDER wanted a judgement of the results as a basis for the continuation of the program. This evaluation focuses on the period 2007 – 2009, as agreed with the secretariat.
Evaluation criteria

The program has been evaluated based on the following criteria (prescribed in the Terms of Reference, here with definitions from Sida Evaluation Manual, Looking Back, Moving Forward, 2004):

- **Effectiveness**, the extent to which a development intervention has achieved its objectives, taking their relative importance into account.
- **Impact**, the totality of the effects of a development intervention, positive and negative, intended and unintended.
- **Relevance**, the extent to which a development intervention conforms to the needs and priorities of target groups and the policies of recipient countries and donors.
- **Sustainability**, the continuation or longevity of benefits from a development intervention after the cessation of development assistance.
- **Efficiency**, the extent to which the costs of a development intervention can be justified by its results, taking alternatives into account.

Of these criteria especially Impact and Sustainability are hard to evaluate until after considerable time has elapsed. The evaluator has for that reason used Output (product and services from the interventions) and Outcome (the likely or achieved short- or medium-term effects) as indicators for Impact. Even if it is early, absence of Impact or Sustainability may be observed in this evaluation.

Methodology

The methodology chosen in this evaluation needs to balance the partner country view (ultimate beneficiaries) with the view of involved Swedish university project members and the view of the developing agency (funder).

The University Collaboration Program has had a rather small budget of approximately 6.8 MSEK, supporting eight (8) projects during the period 2007-2010. Also the evaluation had to be low-budget and it was agreed with the SPIDER secretariat to use a methodology combining desk research, face-to-face interviews, e-mail questions, follow-up telephone discussions and a final participatory workshop, in line with Sida's advice on evaluations described in "Looking Back, Moving Forward".

It should be noted that the evaluation focuses primarily on the program as such, not the individual projects. When projects are mentioned in this report the purpose is to give the reader a better understanding of the program, its challenges and opportunities, not to comment on individual projects.

The evaluation has been carried out in the following phases:

- **Desk research (Preparatory phase):** study of relevant and accessible documentation in regards to the organization and program such as SPIDER Strategy and corresponding Action plans, current Sida application, Kerry McNamara's and Olle Edqvist's Evaluations, web-information etc. As a preparation before the project partner interviews, all relevant project documentation (applications, progress reports, final reports, conversation etc) was studied.

- **Evaluation phase/Data collection phase:**
  - **Stakeholder interviews** were held with representatives from the SPIDER Board, affiliated international representatives, the project assessment board as well as representatives from Sida including UFORSK (former SAREC). The purpose was to understand the organizational context of the evaluated program as well as to receive the respondents’ views on the program and its results. The questions and the respondents are listed in Appendix 1.
  - **E-mail questions** were sent to both the Swedish university and the partner country representatives for each chosen project. This methodology was chosen in order to balance the views of both the partner country and the Swedish university. Both representatives were approached with an introductory letter, subsequently receiving the set of e-mail questions listed in Appendix 2.
  - **Follow-up telephone calls** were made or face-to-face meetings undertaken to discuss the e-mail answers and any missing information.

- **Analysis phase:**
  - **A participatory workshop** was held where the evaluator met a selection of stakeholders and university representatives (listed in Appendix 3) during a half day session, presenting observations and conclusions as a base for an open discussion. This evaluation report reflects many of the opinions expressed during the workshop, nevertheless it is necessary to stress that
the evaluator is solely responsible for the final conclusions.

Projects selected:

It was agreed with the secretariat to choose seven projects (as two projects were run by institutions that were already covered through another project) from the period 2007 - 2009. Three of the projects were continuations of earlier projects. Note that the project run by Björn Pehrson is not part of the call for applications during 2007-2009, thus not part of the eight current projects (2007-2010). The following table lists the projects and the interactions with them during the evaluation:

<table>
<thead>
<tr>
<th>Institution</th>
<th>Project title</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lund University</td>
<td>Putting Knowledge to Better Use - Industry responsiveness to gender differences in ICT demand in Vietnam</td>
<td>Bo Göransson (E,T), LU Tran Ngoc Ca (E,T) National Center for Science and Technology Policy</td>
</tr>
<tr>
<td>Uppsala University</td>
<td>Expand INFORM in Africa</td>
<td>Martha Garrett (E,F), UU Anders Wändahl (F), KI</td>
</tr>
<tr>
<td>Örebro University</td>
<td>Agricultural market information for farmers</td>
<td>Åke Grönlund (E,T), ÖU Yousuf Islam (E,T), BRAC University, Bangladesh</td>
</tr>
<tr>
<td>Royal Institute of Technology/ Lund University/Karlstad University</td>
<td>Towards Sustainable Broadband Communication Markets in Rural Areas</td>
<td>Björn Pehrson, KTH Amos Nungu (E,F)</td>
</tr>
<tr>
<td>Royal Institute of Technology</td>
<td>Mobile ATMs for Developing Countries</td>
<td>Sead Muftic (E) Kasun deZoyea (E,T) University of Colombo, School of Computing</td>
</tr>
<tr>
<td>Blekinge Institute of Technology</td>
<td>Women’s Digital Baskets in Rwanda</td>
<td>Pirjo Elovaara (E,T) Eugène Ndagijimana (E)</td>
</tr>
<tr>
<td>Stockholm University/Royal Institute of Technology</td>
<td>Language Processing Resources for Under-Resourced Languages - continuation</td>
<td>Lars Asker (E,F), SU Björn Gambäck (F), SICS</td>
</tr>
</tbody>
</table>

E = e-mail answer received, T = telephone interview, F = face-to-face interview

It should be noted that none of these projects were completely finalized during the evaluation period, except the Mobile ATM project which delivered their final report during the period of evaluation.

Changing conditions during the program period

It has constantly been widely and vividly discussed how to best support development countries. All UN nations and many leading international development institutions agreed year 2000 on the eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – to form a blueprint for joint action. Also the Swedish government launched a Policy for Global Development 2003, which means increased emphasis on:

- Developing results (alleviating poverty) rather than pure research and public campaigns
- International development cooperation complementing the developing countries’ own efforts to achieve development (in line with the Paris-agenda)
- Cooperation and support through public organizations nationally, regionally and locally, through NGOs, trade unions and private enterprises

The Swedish support for ICT4D has also gradually changed from mainly implementing infrastructure, e.g. Internet access to partner country universities, to much more diverse projects supporting different sectors in society with knowledge, methods, software solutions and sometimes also infrastructure. The current evaluation has taken these changing conditions into consideration and the conclusions should hence reflect this.
Findings/Conclusions of the evaluation

Results and effects of the projects of the program

As a first general and important observation it should be stressed that the supported projects have a high relevance, addressing well recognized and wide-spread problems in the partner countries. E.g. lack of secure money transfer and limited access to banks for a rural population and guest workers are addressed in the Mobile ATM project. The aim of the AMIS project is to mitigate the power of intermediaries in regards to rural farmers in Bangladesh, assisting the farmers to receive more fair prices for their crops. The digital divide not only exists between North and South, but also between sexes. E.g. the Vietnamese project analyses the industry responsiveness to gender differences in ICT demand and will suggest areas where women will benefit from ICT. Women in Rwanda have got access to modern tools documenting and promoting their basket production.

At this early stage it is impossible to judge the projects’ impact, but e.g. the INFORM project demonstrates an impressive output (a large number of tailored workshops disseminating knowledge and experiences on how and where to find useful and free medical online information, source books also made available on www.inform-network.org) and outcome (awareness among medical staff from a large number of countries all over the world according to INFORM’s visitor map).

ICT is promoted as a tool for better living conditions and improving public and private work. E.g. the benchmarking project in Tanzania analyses success factors for affordable broadband services in rural areas. In the studied project a governing structure is in place for the operation and maintenance of the network and experiences have been synthesized into a model to assess if preconditions are met to successfully launch new broadband projects, everything in order to achieve sustainability.

Commitment through local partners needs to exist from the very beginning in order to ensure sustainable results from the projects. E.g. the mobile ATM project has developed an interesting solution for safe mobile money transactions in developing countries. They have approached e.g. Grameen and Southamerican telecom operators, but without finding any permanent partner having a genuine interest in wide-spread deployment. OpenSource-distribution is now considered as an alternative, but this will rely on viral marketing rather than a partner having a vested interest in spreading the solution.

Also, the INFORM project seeking to saturate the need for online medical information had to change local ownership during the course of the projects and is still waiting to find the right partner to ensure roll-out and long-term ownership.

The fundamental idea behind the University Collaboration Program is to support ideas from Swedish researchers. This of course increases the risk that the results are not well received, addresses the wrong problem, or suggests unsuitable solutions from the partner country viewpoint. In order to minimize these risks, the researcher and SPIDER need to find a trustworthy local partner before the project is launched (see more under Recommendations).

Relations have been built within the Swedish and international researcher community. E.g. language research has been supported in Ethiopia on how to represent the widely used language Amharic in the digital world. Many other languages face similar problems and experiences have been shared in research papers and conferences in Africa connecting researchers. The University Collaboration Program has involved (on part time) students from partner countries, participating in the Ph.D. network and earning their exams in Sweden, and also to some extent Swedish master students working in the partner countries. This has created professional relations and and a valuable international network. However, with limited funding such projects risk to tie up scarce funds and may potentially cause “brain-drain” if the talents choose to stay in Sweden. In many of the projects there should exist possibilities to use “cheaper” resources, e.g. Master students, and offer MFS-like grants. That would give more flexibility and with more and shorter efforts more “mouth-to-mouth” experience sharing should take place!

The set-up of the University Collaboration Program, coupled with limited financial resources, prevent projects to pay salaries to local personnel, except for field workers. This means that the much needed local partner, and especially their leading person (being the counterpart to the Swedish university representative) must be financed from other sources. As one of the Swedish respondents phrased it: “This could be construed as a form of ‘research colonialism’ and not sound like the equal-basis ideal that SPIDER adheres to.”

Finally it could be concluded, by comparing the evaluated projects’ output with their very modest input (“low-budget” projects) that they demonstrate a high degree of efficiency in their execution. Also assessing their goals attainment (through examination of the outcomes achieved so far) leads to the conclusion that the ICT Collaboration Program provides a high level of effectiveness.
Administration and management of the program

The volume and scope of SPIDER's work has increased during a number of years. Initially “seed funding” was used to encourage Network members to initiate projects. Open calls were announced 2005 and 2006. A thematic call on “ICT, gender and development” was issued in 2008. The University Collaboration Program has had a quite modest budget, so with a quite open policy (with the exception of the gender-call) it is an obvious risk that SPIDER's limited resources are spread too thin. When the budget now is reduced due to Sida's constrained financial situation, another approach will be necessary. Consequently a necessary focusing has recently started on eHealth, eGov and entrepreneurship with eLearning as a cross-cutting subject.

The main characteristics for the University Collaboration Program has been that the initiatives have originated from the Swedish university Network. Partners have been sought for and have agreed to contribute, but the fact remains that the first initiative has been from Sweden. This is in contrast to SPIDER's main/core program, where projects are initiated from the partner countries, and also the new requirement for needs-driven projects expressed by the government and Sida. The immediate need for alleviating poverty in partner countries may seem to conflict with the academics view on research, but in the long run interests should align, since any positive development will need access to knowledge based on relevant research.

SPIDER's current financial dependency on Sida is obvious, but there is also a risk that SPIDER acts and behaves as a "mini-Sida" being more of a donor organization than an independent network linking competence between partner countries, the Swedish Network and donors.

However, SPIDER's staff are witnesses to be very responsive and flexible assisting and monitoring the projects. They have not just taken the passive role waiting for applications and reports, but have also been involved and visited the projects during their development/implementation, offering advice and contacts when needed.

SPIDER has established itself as a well-known and competent organization. Several network conferences have been organized to encourage networking between the universities, e.g. the recent eHealth conference. However the network still appears to consist of individuals rather than universities so continued focus is needed on networking activities.

Finally it could be noted that none of the evaluated projects involve any Swedish private or public actor. This has however not been a requirement, but has more and more become Sida's desired way of collaboration in order to achieve knowledge transfer (in both directions). It should have been considered by SPIDER and the applicants, at least in the projects started during recent years.

Alignment to the former Sida/SAREC-support to researchers within ICT for development

When SPIDER was formed in 2004, Sida had through SAREC (later integrated into Sida) supported especially ICT infrastructure, mainly Internet and e-mail projects for universities within partner countries. Similar projects still exist within Sida's research support program (UFORSK), and are in a few cases handled by SPIDER staff. Sida supported the idea of creating SPIDER, since that made it easier to handle the interface towards the growing number of universities in Sweden.

The creation of SPIDER has certainly led to a bigger focus around ICT4D, especially in the academia, but may on the other hand somewhat lessened Sida's interest for and focus on ICT. As ICT is gradually being "main-streamed" within Sida (seen as a vehicle within interventions, rather than a goal in itself) it will still be necessary to continue coordination between UFORSK and SPIDER. The interfaces today between the organizations are quite weak, but are needed as long as Sida and SPIDER are working with ICT components in projects in the same countries.

Regarding the areas supported by the two organizations it could be noted that Sida (UFORSK) still supports big infrastructure projects, even since the technology has become drastically easier to plan, implement and operate. SPIDER's areas of interest lie much more on the end-user perspective, benefits, functionality and software development, which is better aligned with the trends in the whole ICT development arena.
Recommendations

Continuation of the program

In its current role SPIDER faces a changing situation as compared to the initial phase:

- Focus will increasingly be on development cooperation and support in collaboration with other organizations
- Developing tangible results (with the ultimate aim of alleviating poverty) will be even higher prioritized
- Funding has been reduced

In this financially crucial situation there are a few strategic options for SPIDER:

- Align scope of the projects to available resources
- Work differently to keep activity level, but change roles (e.g. going from own funding of projects to becoming a pure project organizer), intervention methods, ways of interaction, use of people etc
- Secure funding from new sources

The following chart puts the current budget in perspective. The University Collaboration Program is a small "player" as compared to other SPIDER programs and especially when comparing with Sida's resources through UFORSK.

In the light of the promising results achieved so far by the University Collaboration projects, the overall recommendation is to continue securing additional funding to ensure the continuation of the program. Examples of possible sources are EU (through the Seventh Framework Programme, CORDIS), UD, FORMAS, Vinnova, private companies, NGOs etc. This important work has already started, but has so far not given any tangible result.

Increased funding would secure the continuation of the University Collaboration Program and form a solid base for the implementation of the recommendations for improvement of the program that are described in the next section.

On the other hand, if additional funding fails, it would be better to terminate/finish the program in its current form, but rather incorporate suitable research efforts in the projects initiated from the partner countries. That would probably reduce the Swedish partner universities' possibilities to influence the project selection, but on the other hand give long-term benefits of working closer with and in pure demand-driven projects.

Project and program recommendations to better support SPIDER overall objectives and better utilize existing budget allocations

The following are recommendations based on the previous observations which should guide the "ICT Project Collaboration with Swedish Partner Universities" program towards a higher level of goal fulfilment:

Ensure that the projects are demand-driven, which means real needs and commitment exist in the partner country. Swedish researchers wanting to start a project needs to be very sensitive understanding local needs, identifying stakeholders, choosing project participants and understanding the full context the project will work within.

Later years research and experiences among developing agencies indicate that in order to create sustainable results, i.e. results that remain and survives local changes in e.g. environment and organization, every project must have a clearly identified counterpart taking local ownership. This means both an organization with sufficient impact, knowledge, personal and financial resources, but also a pin-pointed individual with the right leadership skills to fight for and guide the project locally.

SPIDER has been using the Logical Framework Analysis (LFA) model for the planning and development of partner country driven projects. The model guides the project to define the activities, outputs, purpose and goal. The method acts in a way as a check-list; while doing the analysis the participants are guided to raise the relevant questions. A project without a well-defined need and without local commitment and ownership will have difficulties to survive the analysis. It is suggested that the LFA work continues, but also that SPIDER utilizes the network (and the board members) in order to facilitate the
creation of synergies with new local partners in partner countries.

In line with this structured approach every project should at the start have an at least **tentative implementation plan** (if the projects are of a 'pilot' character) outlining how the suggested solution will be implemented, put in operation and scaled up, e.g. through building a start-up team, training of users, acquisition of devices/equipment (if needed), operating procedures etc.

In order to create sustainable results it is imperative that a **sustainability plan** exists. Many promising projects have failed when necessary management/administration/leadership capacity does not exist, when resources to continuously train new users, to operate and if necessary replace equipment does not exist. All this require that stakeholder interests align and together ensures sufficient personal and financial resources to continue use, continuously develop and benefit from the solution. Stakeholder involvement is also beneficial ensuring that proposed solutions adhere to local/national policies in the relevant thematic area. The sustainability plan needs to be discussed and drafted in the project planning/development phase.

Even if additional funding is retrieved it is recommended that the University Collaboration Program is **focused on the three areas Governance, Health and Entrepreneurship with eLearning as a cross-cutting activity**. Open calls should be avoided. In order to ensure "needs driven" projects it is suggested that the model where the partner country and SPIDER (secretariat or designated persons) together develop the project plan/application, including a LFA, a call for research resources is subsequently made to all partner universities in the Network. Planning grants (similar to Vinnova FP7 grants) could perhaps be offered to support the projects planning/development phase. This model would strengthen the focusing efforts, while still giving same opportunities to all participating universities. In any case the call process should be transparent to everybody in the network.

It is also suggested that the program continues to support a combination of basic and **applied research**. Innovative utilization and adaptation to local context of research results are important, and even more important in a developing context, as hurdles (e.g. usability issues, inappropriate choice of technical solutions etc) in the implementation and operation phases quite often have hampered sustainable results.

The Paris agenda encourages cooperation and coordination between developing/donor organizations. Within SPIDER's area especially IICD (The International Institute for Communication and Development) based in the Netherlands and IDRC (International Development Research centre) in Canada have achieved interesting results and it is suggested that SPIDER intensifies its collaboration with these organizations. This includes both the investigation of areas where partnering would be favourable (e.g. to reach new funders), but also agreeing on which areas SPIDER should not address in order to avoid duplicate efforts.

The value of the SPIDER network is significant, but the value could grow even more if further cooperation and knowledge sharing would be achieved to avoid isolation between partner universities. Examples (some of them already tried) are shared projects, conferences, electronic meetings/media. It is not only the responsibility of the secretariat to contribute, the network consists of its members and all good forces need to unite sharing knowledge, ideas and experiences. Project results should always be published online to improve transparency and to engage qualitative involvement.

Following the government's PGD (Policy for Global Development) involving **Swedish private and public actors incl NGOs in the projects** will also strengthen the network, opening up new opportunities of gaining broader competence, resources and funding.

Several Ph.D. students are involved in the program, but it is also recommended to open up a "new channel" by **encouraging and financing Swedish and foreign master students to work in implementation projects**, providing more cost-effective, flexible and "down-to-earth" resources. MFS (Minor Field Studies) are grants today offered by Sida through the International Programme Office to students for shorter projects in the partner countries. Despite that ~700 grants are given per year, only a small fraction goes to ICT projects (~15 projects found in the database). Also the Linnaeus-Palme exchange programme for teachers and students at undergraduate and master’s level should be possible to use. This is probably a matter of marketing, promoting and "networking" these opportunities to the students, since the possibilities already exist.

**Coordination and information exchange with Sida and UFORSK need to continue and improve**, especially as long as Sida is lacking an own function to support the “mainstreaming” of ICT in their projects.

Finally, in order to best contribute to developing results using ICT in the partner countries it is strongly recommended that **SPIDER focuses on its role of network linking universities, civil society and private organizations in order to "broker" ideas, partners, projects, methods and solutions both internationally and nationally**.
Acknowledgements

All respondents approached in the evaluation have been very willing to contribute, sharing their information, experiences and opinions about the projects and the program as such. Also the SPIDER secretariat and my main contact Lotta Rydström have been very helpful giving access to information and helping me getting in contact with the right persons. However, as evaluator I take full responsibility of the conclusions presented in this report.

Appendix 1: Stakeholder interviews

Interview questions

- Have the application, appraisal and decision processes been, in your opinion, adequate to find and prioritize projects that support SPIDER’s strategy?

- Have the projects, in your opinion, had sufficient commitment in the partner countries (authority, resources, competence etc) and have they addressed genuine needs?

- Has SPIDER adequately, in your opinion, monitored, guided and supported the funded projects during the project cycle?

- To what extent have the supported projects, so far (most of them are not finalized), delivered added-value to i) partner universities ii) local partners iii) SPIDER iv) others?

- Have the projects results been disseminated in an adequate way in developing countries (mainly by local partners) and in Sweden and internationally by partner universities and/or SPIDER?

- Is the existing cooperation model (using Swedish partner universities as a channel) in your opinion a suitable and cost-efficient way to support SPIDER's overall objectives? If not, how could it be altered?

- What lessons have we learned so far from the partner university collaboration projects? Any best practices? Things to avoid?

- What are your recommendations about a possible continuation of the collaboration program? Would you propose i) to continue with open call for proposals, ii) to focus around thematic calls, or to support iii) research grants or iv) other means of collaboration?

Respondents

- Astrid Dufborg, SPIDER
- Ulf Pehrsson, Ericsson
- Bert Geers, T. U. Delft
- Tim Unwin, University of London
- Per-Einar Träffen, Sida
- Malin Åkerblom, UU
- Olle Edqvist
- Love Ekenberg, DSV
- Hannah Akuffo, Sida UFORSK
Appendix 2: Project interviews

Interview questions

1. How did the project objective/rationale/raison d’être originate? (How did the idea of the project come up? Who took the first initiatives? Who saw the needs and defined the suggested overall solution?)

2. How well were the objectives determined? (Did the application process guide you? How was the scope defined? Did the budgeting affect the set-up of the project?)

3. How supportive was the application process? (Supporting you or complicating things? Do you feel you were treated in a fair way? Was relevant information requested? Right type of factors/criteria assessed?)

4. How did you experience the collaboration with your counterpart? (Who was the main driver during the project? How did the communication work? Responsiveness?)

5. How do you experience SPIDER’s monitoring of the progress? (Has it been done in a relevant and an efficient way?)

6. To what extent do you believe the project has reached its objectives? (In the case the project is finished, otherwise do you believe that the results are on track? If objectives are not reached, what has happened? Would you run the project different if you had a chance?)

7. Is the project scalable and/or replicable? (If this is a pilot, do you see any obstacles running it in full scale? Will it be possible to implement in other regions/countries/markets?)

8. Has the project had secondary effects? (Added-value, perhaps not planned/expected? Other benefits? Negative effects not anticipated? Who has had the most benefit of the project, the Swedish University or the partner organization?)

9. Has the dissemination of project results been adequate? (In the case the project is finished, otherwise has the dissemination been sufficient so far? Have results been spread outside the executing institution/organization? By what means? Have you received any feedback?)

Appendix 3: Participatory workshop

Participants in the workshop September 7, 2010

Malin Åkerblom, UU
Lena Trojer, BTH
Björn Pehrson, DSV
Martha Garrett, UU
Amos Nungu, KTH
Pirjo Elovaara, BTH
Magnus Lundsten, SPIDER
Lotta Rydström, SPIDER
Ulf Bråsjö, Evaluator