

Investigating Successful Implementation of  
Technologies in Developing Nations

By

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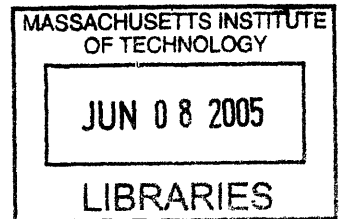
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# Investigating Successful Implementation of Technologies in Developing Nations

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## ABSTRACT

A study was performed to determine possible factors that contribute to successful implementation of new technologies in developing nations. Engineers and other inventors have devoted great effort to Appropriate Technology design over the last two decades, but few comprehensive case studies currently exist examining factors that lead to technology success. Existing studies of appropriate technology were summarized and a quantitative model was created to tabulate the data.

Factors of local maintenance, local production, and local need of a technology were found to be the most important to sustainable technology implementation. The model was then tested with a current Appropriate Technology project to examine the relevance of its results. Overall, the model proved applicable, though further studies are suggested to refine the model.

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# 1 Appropriate Technology Overview

## 1.1 Relevance

The term “Appropriate Technology” (AT), taken literally, would seem to apply to virtually any technology that has a suitable use in some arena. The commonly understood meaning, however, lies closer to the definition provided by the U.S. Congress’s Office of Technology Assessment: that AT is “usually associated with small-scale, decentralized industries that make extensive use of an abundant resource” in developing countries<sup>1</sup>.

Typically, Appropriate Technologies are implemented by organizations from industrialized nations such as the United States and attempt to cater the design and implementation to the specific characteristics of the target communities.

The need for AT design is fueled by the vast inequalities and debilitating poverty found throughout the world today. According to the World Bank<sup>2</sup>, living standards around the world rose over the last two decades; at the same time, however, 1.1 billion people still live in extreme economic poverty, earning less than \$1 per day. In Sub-Saharan Africa, an additional 150 million people joined this category since 1981. In terms of water supply alone, 2.2 million deaths occur every year from diarrheal illnesses because of a lack of access to clean drinking water in developing countries. In the area of public health and disease control, every year 8.5 million new cases of tuberculosis arise and 2 million people die from the disease, despite the fact that drugs exist that can cure the disease. Appropriate Technology design employs the goal of creating technologies that can lift people out of poverty, both by stimulating the local economies via job and

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<sup>1</sup> Office of Technology Assessment (1981). *An Assessment of Technology for Local Development*, (GPO Stock No. 052-003-00797-5). U.S. Government Printing Office, Washington, DC.

<sup>2</sup>“Understand Poverty.” *Poverty Net*. The World Bank Group: 28 April 2005.

<<http://web.worldbank.org/WBSITE/EXTERNAL>>

market creation, and by direct production benefits that can result from new technology. While millions of dollars have been spent developing new appropriate technologies, quantitative studies on the techniques for implementing AT are notably absent. This thesis looks to identify key success factors in delivering sustainable technology to developing countries.

## 1.2 History

The origins of the modern Appropriate Technology movement can mainly be attributed to E.F. Schumacher and his 1973 book *Small is Beautiful*<sup>3</sup>. Schumacher, a top economic planner for Britain, had worked as an economic consultant to Burma and India, where he gained the inspiration for writing his book. The main focus of his book was on job creation resulting from AT. Instead of using Western models for capital investment in a firm of the Third World, Schumacher argued that an “intermediate technology” model would have much more success in this environment. The intermediate technology should have improvements over the existing technologies in the developing country, but cost less and require less extensive training to operate than high-technology from Western countries.

Since Schumacher’s book was published, Appropriate Technology has gone through various incarnations and movements as Westerners adopted the idea. In 1975, around 500 organizations or institutions had an AT focus; by 1980, this number doubled to over 1000. In the 1970s, a second culture seemed to arise out of the original AT movement, one resulting from the counter-culture anti-industrial movement of the 60s and 70s. This environmentally-focused group supported AT, but in reality their emphasis

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<sup>3</sup> Schumacher, E. F. (1973). Small is Beautiful. Harper & Row, New York.

on the natural ran somewhat counter to the technological advances needed to really raise people in slums out of poverty<sup>4</sup>. The AT movement also went through a “better mousetrap” phase in the 1980s, during which many AT workshops around the world filled with technological gadgetry that never succeeded in the field as a result of a lack of dissemination efforts. This problem, the challenge of not just creating technologies, but of implementing sustainable technologies in the developing world, serves as the main driver for this thesis.

## 2 Procedure

First, background research was conducted on previous literature analyzing AT cases. Selected cases were taken from the literature and summarized in Section 3. The overall goal in selecting and analyzing the data was to find common themes among a large number of AT studies that could be used to create guidelines for future work. To improve relevance, articles describing higher-level management theories like multi-national corporation (MNC) strategies, marketing, or operational research were rejected. Additionally, articles written before 1980 were likewise rejected to improve relevance.

Shown in Figure 1, a chart with 10 possible success factors was then created to sort and analyze the results found in the research. Using this matrix, the effects of the factors were converted into mathematical values to compare the relative importance of the factors in technology sustainability.

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<sup>4</sup> Smillie, Ian. (2000). Mastering the Machine Revisited. ITDG Publishing, London.

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
<b>Factors</b>							
Familiar Technology	●	●	●	●		●	-
Local NGO							
Int'l NGO							
Gov't	○	○			-	-	-
Local Input							
Local Production							
Comm Training							
Local Maint							
Financial							
Local Need							
● Present, Positive Effect ○ Present, Negative Effect - Not Present, Negative Effect							
Blank means not addressed by author or unclear affect							

**Figure 1: Sample Factors Chart**

First, the cases were first separated into two groups: cases deemed successes were placed in the “successful” product group, *S*; cases that failed were placed in the “unsuccessful” group, *U*. The effects of the factors present in *S* were factored into a variable, *PE*. The *PE* of a factor was increased or decreased by 2 based on whether the factor had a positive or negative effect on the case. The *PE* was further modified by the number of times the factor had a “Not Present, Negative Effect” in *U*. This weighted value was termed the *Strong Positive*, or *SP*. For example, “Familiar Technology” received an *SP* of 6 and was modified by 1 to have an *SP* of 7, whereas “Government” received an *SP* of -2, was modified by 3, resulting in an *SP* of 1. The *SP* of a factor represents the maximum potential positive effect of a factor.

The *SP* was then further modified by to take into account negative effects of factors on unsuccessful cases. Each “Present, Negative Effect” case in the *U* group for a factor decreased the *SP* by 1. Thus each factor was assigned a final adjusted value, *P*. The resulting *P* values were then analyzed and interpreted in Section 5.

Using the results of the model created, an implementation plan was made in Section 6 for a current AT project under development. The project, involving solar water disinfection using polyethylene bags, shares characteristics similar to the other projects reviewed: it is a relatively simple, low-cost intermediate technology that has a very large potential market. The relevance of the information provided by the model was then interpreted and conclusions were drawn about the relevance of the model.

## 2.1 Appropriate Technology Definition

Since the term “Appropriate Technology” covers decades of work in fields ranging from mechanical devices to macroeconomic theories to software programs to public policies, the use of AT will be restricted for the remainder of this paper. Thus AT will refer only to physical technologies of a mainly mechanical nature implemented by individuals or small groups outside North America and Europe. This means that AT services such as the Grameen Phone or Grameen Bank will not be addressed in this paper. Additionally, this paper will not look at technology implementation or management for MNCs, but rather technologies that a single inventor or small non-governmental organization (NGO) could implement. The study of technology transfer management for MNCs comprises an entire field in and of itself, and includes very different implementation requirements than those related to small-scale organizations. Also, this paper will not look at technology transfer in Eastern European countries;



although these countries can be considered developing countries, the different economic conditions would again create a different set of requirements for this study.

### 3 Existing Research

The original intent of the literature review was to examine studies that analyzed multiple AT cases and that quantitatively analyzed the results. Although many books have been written on technology transfer for MNCs, and many more have been written concerning macroeconomic or public policy issues related to AT, very little literature could be found on the subject given the low-technology AT definition stated above. Instead of looking at previous multiple-case studies, then, individual case studies were chosen and analyzed.

#### 3.1 Cases

##### **Case 1: Nala Plugs in India**

Source: *By the People, For the People: Small and Sustainable Dams Help Revitalize Indian Communities and Groundwater*, by Patrick McCully<sup>5</sup>.

This study looks at small dams, called “nala plugs,” implemented in Saurashtra, India. These dams create surface water for feeding livestock and washing clothes, as well as vital groundwater for farmers in the arid plains. Before the nala plugs existed, women would have to walk miles away to fetch water and rely on monsoons for the supply. The nala plugs project was started in 1995 by the Kundla Country Villages Service Center, a Gandhian NGO. Since then more than 1,000 plugs have been built in 35 villages.

##### *Implementation Factors*

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<sup>5</sup> McCully, Patrick. “By the People, For the People: Small and Sustainable Dams Help Revitalize Indian Communities and Groundwater.” *Multinational Monitor*. Washington: Apr 1999. Vol. 20, Iss. 4.

The nala plugs project succeeds where a previous government-built water system failed. A primary reason for this, according to McCully, is the project's intimate relation to the people. Village committees decide where the plugs should be built and then assign user groups to them. These groups then have the responsibility of maintaining the structures, which helps create a sustainable system. Additionally, the dams use technology based on older Indian practices, ensuring effectiveness and acceptability in the region.

### **Case 2: Boreholes in Mozambique**

Source: *Sustainable Water Supply for a Remote Rural Community in Mozambique: Oxfam Australia and the Chicomo Rural Development Project*, by Elizabeth Mann<sup>6</sup>.

Mann describes the effort by Oxfam Australia to improve water supply using maintainable boreholes in the Inhambane Province of Mozambique. Of an estimated 250,000 hand pumps in Africa, less than half are in working order. Oxfam Australia discovered in 1994 that many boreholes in Inhambane were destroyed by war, and has worked on building 27 boreholes serving over 12,000 people since then.

#### *Implementation Factors*

Similar to the case with nala plugs, village representatives used a consensus system to pick most borehole locations. In three cases, local leaders picked the area. Also, communities formed groups around the pumps and collected money for maintenance of the pump. Because of new Mozambique legislation, Oxfam was forced to ask communities to collect the equivalent of US\$50 before installing pumps. This was a difficult change for some communities, as water supplies were previously provided for

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<sup>6</sup> Mann, Elizabeth. "Sustainable Water Supply for a Remote Rural Community in Mozambique: Oxfam Australia and the Chicomo Rural Development Project." *Greener Management International*. Sheffield: Summer 2003., Iss. 42.

free. In retrospect, the new pay system could have transitioned better if Oxfam had explained the requirement to local leaders. Oxfam also employed three technicians to train the communities to ensure that each site had numerous people who could dismantle and reassemble the pumps.

### **Case 3: Upesi Stoves in Kenya**

Source: *Stoves for Rural Livelihoods*, by Smail Khennas<sup>7</sup>

This article looks critically at the problems in commercializing the Upesi wood-burning stove in rural Kenya. The Upesi stove improves upon the stoves being used in poor communities by reducing the amount of fuel required for use and improving overall safety. It was chosen out of five designs tested in five regions of Kenya in a project implemented in 1990 by the Intermediate Technology Development Group (ITDG) and the Kenya Energy and Environment Organization (KENGO). In five years, ITDG has trained more than 13 women's groups to make an Upesi stove.

#### *Implementation Factors*

Khennas's article emphasizes the differences between ITDG's implementation of the stove and the process taken by another group called GTZ. ITDG trained groups that had easy access to clay, the material needed to produce the stoves. In contrast, GTZ constructed kilns costing more than a thousand US dollars and gave them to entrepreneurs or women's groups. Additionally, ITDG trained the women's groups in how to price the Upesi, whereas GTZ subsidized the stoves and controlled the prices in order to improve dissemination.

### **Case 4: Mark II Handpumps in India**

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<sup>7</sup> Khennas, Smail. "Stoves for Rural Livelihoods." Technology for Sustainable Livelihoods. Intermediate Technology Development Group: 18 April 2005. < <http://livelihoodtechnology.org>>

Source: *High-Impact Appropriate Technology Case Studies*, by Thomas Fricke<sup>8</sup>

The Mark II Deepwell Handpump is a highly successful, publicly accessible water pump design implemented in India, Asia, and Africa. It includes an extremely durable design and can serve 200-250 people per installation on average. The Mark II was created by the U.N. Children's Fund (UNICEF) in cooperation with the Indian government in the 1970s. To date, more than 600,000 Mark II pumps have been installed in India, while another 20,000 have been exported to other countries.

#### *Implementation Factors*

The Mark II has achieved widespread success for many reasons. In terms of the design, the pump is very durable compared to previous designs; the materials used are of indigenous origin; maintenance issues do not require highly trained specialists; and the cost is low. The Mark II also encourages local participation in all steps of the pump life, including installation, operation, and maintenance. Furthermore, in 1976 a maintenance organization created a three-tiered system at the village, sub-district, and district level for ensuring sustained use of the pumps.

#### **Case 5: Photovoltaics in Zimbabwe**

Source: *Photovoltaics in Zimbabwe: Lessons from the GEF Solar Project*, by Yacob Mulugetta, Tinashe Nhete, and Tim Jackson<sup>9</sup>.

This paper critically assesses the large-scale implementation of photovoltaic (PV) systems as part of the GEF (Global Environment Facility) Solar project in Zimbabwe. The PV light industry has actually existed in Zimbabwe since the 1960s, but the dissemination of these systems has always been limited to urban workers who could

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<sup>8</sup> Fricke, Thomas. (1982) *High-Impact Appropriate Technology*. A.T. International, Washington D.C.

<sup>9</sup> Mulugetta, Yacob, Tinashe Nhete, and Tim Jackson. "Photovoltaics in Zimbabwe: Lessons from the GEF Solar Project." *Energy Policy*. Elsevier: 25 May 2000, Iss. 28.

afford to pay for the expensive systems. The GEF grants financing for projects solving environmental problems and has funded half a billion dollars for projects in the past decade. The GEF Solar project surpassed its goal of bringing light to 9000 households after four years of operation.

### *Implementation Factors*

The PV project was implemented by GEF and the Solar Electric Light Fund (SELF), with support from the UN Department of Technical Cooperation for Development. While this was an impressive coalition of international development organizations, there were no key partners from Zimbabwe. Because of the complexity of the PV system, GEF and other organizations had to provide subsidies and other financial assistance to manufacturers, installers, and end users. The finance scheme for the end users included a low interest revolving fund to make credit available to rural households.

### **Case 6: Photovoltaics in the Marshall Islands**

Source: *Appropriate Technology: Tools, Choices, and Implications*, by Barrett Hazeltine and Christopher Bull<sup>10</sup>.

*Appropriate Technology: Tools, Choices, and Implications* serves more as a resource for general AT design than a case study of previous work. However, it includes a discussion of a PV system implemented in the island of Utrek, part of the Marshall Islands, as part of a venture by Hughes Corporation and NASA. The system was offered to the island as part of a litigation settlement after U.S. nuclear tests caused thyroid cancer among Utrek islanders. The author contrasts the failure of the PV system to the design of traditional sailing craft used by islanders. He stresses the importance of finding a real community need and using local parts and labor.

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<sup>10</sup> Hazeltine, Barrett and Christopher Bull. (1999) Appropriate Technology: Tools, Choices, and Implications. Academic Press, Boston.

### *Implementation Factors*

The system was manufactured and purchased from a Hughes Corporation, who had designed the system for spacecraft use. It was installed by a local who had worked as a mechanic in the Navy. Fluorescent lights were divided evenly among homes and attached to solar cells. The battery system, designed for use in spacecraft, proved to fail easily in the hot and humid island environment.

## 4 Results

While all the articles discuss projects that were successful during implementation, three of them debate the sustainability of the projects analyzed. In case 3, although the Upezi stoves prove efficient and acceptable, they do not succeed in commercialization. In case 5, the GEF PV system reaches 10,000 households, but lacks a sustainable market system after GEF leaves. And in case 6, the PV system is implemented without taking into consideration many of the local needs.

Figure 2 shows a summary of 10 success or failure factors identified in the articles. A filled circle generally indicates that the factor was involved and had a positive effect on the project. An empty circle indicates that the factor was involved but was identified as having a negative effect on the case. A dash indicates that the factor was not present in the project but identified by the author as a factor that could have benefited the case. Blank boxes show factors that were not addressed by the author or had an unclear effect on the project. The “Local Input” category refers to if local participation in the product design occurred. “Financial” refers to if the NGO or government offered

financial assistance to the local users via subsidies, credit systems, or any other methods.

Case 3 has been split into the ITDG and the GTZ implementations of the product.

	Case 1	Case 2	Case 3a	Case 3b	Case 4	Case 5	Case 6
Factors			(ITDG)	(GTZ)			
Familiar Technology	●	●	●	●		●	-
Local NGO	●		●	●		-	-
International NGO		●	●	●	●	○	○
Government	○	○			●	○	-
Local Input	●	●	●	●		-	-
Local Production	●		●	-	●	-	-
Community Training	●	●	●	-		-	●
Local Maintenance	●	●	●	-	●	-	
Financial		●	●	○	●	○	
Local Need	●	●	●	●	●	-	-
● Present, Positive Effect ○ Present, Negative Effect - Not Present, Negative Effect							
Blank means not addressed by author or unclear affect							

**Figure 2:** Factor Effects in AT Cases

The factors, from highest *P* value to lowest, were: local maintenance (10), local needs and local production (9), local input and community training (8), familiar technology (7), local NGO (6), international NGO and financial (4), and government (-2).

## 5 Analysis

### 5.1 Most Positive Factors

In considering this ranking with respect to the goal of sustainable technology implementation, the list is both confirmatory and revealing. At the top of the list are three factors emphasizing connections with the local community, which can be considered the Most Positive Factors. The ability of the community to maintain the product is at the top of the list; in every successful case, the NGO implementing the project provided extensive training to ensure that locals could continue using the product independently. At the same time, all the unsuccessful projects either lacked a maintenance program or had a very inefficient one. In case 5, the maintenance system GEF set up was so poor that 30 percent of the repair jobs had a response time of over 3 months.

Local needs and local production were seen as the next most important factors. While the local need may seem self-evident, it must be noted that in the two photovoltaic cases, a local need for the products was not established. In Zimbabwe, even the cheapest PV systems were too expensive for 80 percent of the rural population. This matches with the “better mousetrap” problem mentioned in Section 1, with people from an industrialized nation focusing too much on the technology alone. The ability to produce a technology locally is another key to sustainability. This was the one factor that all of the unsuccessful cases failed to implement. Organizations must carefully consider the benefits of donating expensive technology to developing countries; while this provides a short-term solution, in the long-term it can become useless waste.

### 5.2 Least Positive Factors



The factors at the bottom of the *P* ranking include “International NGO,” “Financial,” and “Government.” For the international NGO category, two notes must be made: 1) In some cases, particularly Oxfam in Case 2 and UNICEF in Case 4, international NGOs had a huge positive impact on the project; 2) In this analysis, domestic and international NGOs were differentiated as factors. However, one could conceivably consider all NGOs as a factor, in which case the *P* value would have been higher. International NGOs were distinguished from domestic NGOs in this study because the larger organizations have a much greater chance of overlooking local conditions and needs, whereas local NGOs by definition have members in the local community.

The financial support given in a project, like with the international NGO factor, can work to either help or hinder the success of the project. Like Oxfam in case 2, some NGOs set up a cost system where the local community pays for a partial cost of the product. The problem that can arise is that the community becomes dependent on the subsidy and abandons the project when the NGO program ends. The important goal of this approach is that the local community gains a sense of ownership and value of the product that will sustain it beyond this point. Another approach NGOs use is to simply donate the technology to the local community. The Mark II, GTZ and Utrek PV projects all chose to donate the products to the end users. However, in the Mark II project, the users were required to agree to upkeep, maintain, and provide future financing for the pump. While this would suggest that the Mark II project is proof that donating technology can work for sustainable technology transfer, further research is needed to draw more conclusive results.

Government support for AT projects had the lowest  $P$  score, at a value of -2.

While it would seem very important for the government of a developing country to support any AT effort, the data suggest some caveats for government involvement. The problem is similar to that of international NGOs. While governments can make indispensable financial, legal, and labor contribution to an AT project like in the Mark II case, it can also be too far removed from the target communities to be effective. In the Zimbabwe PV case, for example, the government was involved in the project but did not convey the needs of the rural community effectively to GEF. In the nala plugs and Mozambique borehole cases, the government had previously set up projects that failed in the same locations. The key for effective government participation goes back to the Most Positive Factors listed above; if the government or NGO ensures effective local maintenance, looks at local needs, and uses local production for the technology, it will have a much greater chance of sustainability.

## 6 Application

In order to test the effectiveness of the model developed above, it was applied to an AT project currently being developed. The resulting recommendations were then analyzed to discern if the model produced useful and pertinent information for the sustainability of the project.

### 6.1 Description of the SWDD Case

The Solar Water Disinfection Device (SWDD) project is an AT project currently being developed by undergraduates at MIT as part of a design course. Since the project is still in the prototyping phase, it will be pertinent to use the results above to analyze and

make recommendations for the implementation of the project. The project aims to use a proven technology, solar water disinfection, to address water purity problems in Zambia and other developing countries. The design includes a polyethylene bladder to hold water, a plastic screwcap spout, and a PVC handle attached with twine. The students have met with community partners in Zambia who have expressed interest in the project<sup>11</sup>.

## 6.2 Applying the Model

Using the 10 factors listed in Figure 1, the SWDD project was analyzed for sustainable features. Currently, the project features four of the factors: local input, local production, community training, and local need. According to the model developed in this thesis, the SWDD team lacks the following factors, listed from highest *P* value to lowest. Explanations are given for the missing feature if applicable.

*Local maintenance:* The SWDD project does not have a maintenance program planned because the products are extremely inexpensive and are not intended to be repairable. This might suggest that the proposed model is flawed because it does not apply to products that do not require repair. However, in the case of SWDD, the model raises a valid concern, as the products will become useless once the bags are broken. The model is supported by the SWDD team efforts, as the group's main concern is the durability of the product.

*Familiar Technology:* While the concept of solar disinfection has been introduced in many areas, it is not familiar in Zambia. The SWDD group plans to address this by providing training to users in Zambia. There is reason to believe that this will be successful, since it has worked with similar products in many other countries.

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<sup>11</sup> Anna Bershteyn, Eunmee Lee, Alfinio Flores, and Ed Hsieh. Personal Interview. 20 April 2005.

*Local/International NGO:* While the SWDD group has contacted local community partners, they are not working with an NGO currently. They are looking for a local NGO to work with, which is what the model would suggest they should do.

*Financial:* The group is not planning on providing financial assistance to the end users, since they are working to make the device affordable to the target market.

*Government:* The group does not have government assistance and is not planning on collaborating with the government on the project.

Applying the model to this project, the model succeeds in pointing out the main weaknesses of the project. Although the project could thrive without a plan for local maintenance, which would suggest a flaw in the model, the topic is a main concern for the SWDD team. Overall, while the model may not point out necessary changes for the implementation of the project, it does seem to point out the important features that are relevant to the project and that should be addressed.

## 7 Conclusion

### 7.1 Using the Model

The results of this paper suggest that the model developed in Section 3 succeeds in analyzing AT factors. Individuals or groups working on AT projects can use the model to find areas that might cause their projects to fail. The model can be applied by simply examining which factors are addressed in a project. The importance of the factors from highest  $S$  value to lowest are: local maintenance (10), local needs and local production (9), local input and community training (8), familiar technology (7), local NGO (6), international NGO and financial (4), and government (-2).

While this seems to provide a relevant ranking of success factors, the model should be used as a guideline rather than a checklist. As shown in Section 4, the factors may not apply to certain technologies. If a project lacks a certain factor, the team may not need to include the factor, but may only need to stay aware of the possible problems that the deficiency can create.

## 7.2 Future Steps

Although this thesis has produced useful results, the significance of several factors is still unclear. The influence of international NGOs has been very positive in some cases, and negative in others. A study should be conducted looking at the influence of international NGOs across a large number of AT cases, examining the specific contributions that the NGOs make in each case. Likewise, the influence of different financial assistance in AT programs should be studied to discern the effects of each method of financing. It is possible that donating technology will work in a project if the Most Positive Factors identified in this paper are present; however, further research needs to be done comparing the interactions of these factors.

The original intent of this thesis was to analyze the current AT literature to discern success factors for sustainable AT in developing countries. On this point, it has identified local maintenance, local needs, and local production as the most important drivers for success. While these factors and the model provided in this paper may not provide the ultimate key for sustainable AT implementation, they should provide a useful guide in finding the solution.

Appendix A: *Factor data*

<b>Factors</b>	<b>PE</b>	<b>NPN</b>	<b>SP</b>	<b>PNU</b>	<b>P</b>	<b>Rank</b>
Familiar Technology	3	1	7	0	7	6
Local NGO	2	2	6	0	6	7
Int'l NGO	3	0	6	2	4	8
Gov't	-1	1	-1	1	-2	10
Local Input	3	2	8	0	8	4
Local Production	3	3	9	0	9	2
Comm Training	3	2	8	0	8	4
Local Maint	4	2	10	0	10	1
Financial	3	0	6	2	4	8
Local Need	4	1	9	0	9	2

PE – Positive effect of factor when present in *S*

NPN – Factor when not present in *U*

SP – Strong positive effect, weighted for PE

PNU – Negative effect of factor when present in *U*

P – Final effect