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Needs Assessment and Technology Assessment: Crucial Steps in Technology Transfer to Developing Countries

Kassahun Yimer Kebede[1], Karel F. Mulder[2]

(1) Mekelle University,Faculty of Science & Technology, Department of Industrial Engineering, P.O.Box 231, Mekelle, Ethiopia
(2) Delft University of Technology, Faculty of Technology, Policy and Management, Technology Dynamics and Sustainable Development Section, Jaffalaan 5, NL2628 BX Delft, The Netherlands

Abstract

Technology transfer has been a common practice of most developing countries and countries in economic transition as they usually don't have their own R&D and industries for producing the required technology. In transferring a technology there are a lot of factors to be considered. Most failures of technology transfer occur because of the failure to consider those factors. This paper focuses on the initial (though often forgotten) and crucial steps of technology transfer, Needs Assessment and Technology Assessment, and identifies factors involved in those steps. The study is based on a literature survey and case study analysis of technical, institutional, economic and environmental factors that should be considered in the needs- and technology assessment processes. The model that is developed serves as a guideline for technology transfer processes for developing countries. To validate the model, case studies from literature are used and discussed.

Keywords: Needs Assessment, Developing Country, Technology Assessment, Technology Transfer

1 Introduction

It is often claimed that technology transfer, mainly to developing countries, is often unsuccessful. Sometimes, lack of technology transfer has a clear economic reason, like for example in the case of lacking HIV/AIDS medication transfer to Africa (Rothenberg, 2006). However, more often failure occurs after the technology transfer has taken place. Well known, although still debated in its impact, is the Green Revolution, i.e. the transfer of Western agricultural methods to various developing nations to increase food production (Cf. Wright, 1992). Also in the transfer of management tools, like Enterprise Resource Planning or the Japanese Kaizen concept, failure frequently occurs (Recht/Wilderom, 1998).

In technology transfer to developing nations, failure is often tragic: the financial resources of these countries are very scarce and the failure of technology transfer might prevent that basic needs are fulfilled. Moreover, failures sometimes create the idea of an inevitable fate: 'nothing works, all aid is bound to fail'.

Main reasons for the failure of technology transfer are a lack of *Needs Assessment* and a lack of *technology assessment*. In this paper the importance of these two aspects of the successful technology transfer will be shown and the way to handle them will be elaborated.

In making the decision to transfer a technology from a developed country to a developing country much more should be considered than just the costs and benefits that arise by purchasing and transferring the hardware. Beyond 'hard' technological characteristics, a lot of factors must be considered which include the total system in which a technology is intended to function, skills to handle the equipment, spare parts of the technology, along with maintenance know-how, organizational and managerial procedures (IETC, 2003).

Although technology transfer involves various stakeholders, in this paper the focus will be on the purchaser and the user of the transferred technology. Purchaser and user might be different: governments might order technologies for the benefit of specific users such as farmers. The purchasers' needs might differ from the users' needs: governments might aim for example at purchasing 'high tech' that contributes to national prestige or to growth of national exports, targets that are often not supported by users. Purchasers' ideas of users' needs might also be influenced by prejudice or wishful thinking. At the other hand, purchasers might also aim at raising the users' development by introducing technologies that go one step beyond the needs that are expressed by users. In doing so, it might be easy to overestimate the flexibility of the user in adapting to the new technology.

Needs Assessment, aiming at assessing the actual needs of technology users, has to be the first step in the technology transfer process. It should clearly identify the bandwidth of the performance characteristics of the technology.

This paper mainly addresses the technology transfer to, between and within developing countries focusing at the company level and encompassing the broad range of technologies supporting the community and the regional, national and international policies for development. It identifies

factors to be taken into account during the Needs Assessment and the technology assessment process and a general model has been proposed in the last part of the paper. Additionally, some cases are included to show how the identified factors are affecting the technology transfer process.

2 Theories on Technology Transfer

There are a lot of factors to be considered in transferring a technology and different theories and models have been addressing some of those factors. The failure to take these factors into account resulted in many unsatisfactory outcomes and failures of technology transfer. There have been different models of technology transfer proposed at different times with different approaches:

- The general model for international technology transfer by Samli (1985) which encompasses five components; ***the sender, the technology, the receiver, the aftermath, and the assessment***. The model focuses on factors related to geography, culture, economy, people, business and government (Luper et al., 1991).
- Fried and Molnar (1978) proposed a trans-disciplinary model that considers man-artifact, task, and setting components of technology along with communication, domain, and legitimacy of the social organization.
- Madu (1988) developed a model that helps making a decision to transfer technology. He included defining needs and objectives as a second step in the model (Madu, 1988).
- Linstone (1989) suggested a multiple perspective approach that considers technical, organizational, and personal factors (Luper et al., 1991).
- In another model proposed by the Technology Atlas Team, each technology transfer process encompasses the four technology components - ***technoware, humanware, inforware and orgaware*** (Putranto et al., 2003; Luper et al., 1991)

The model developed in this paper has some similarities with the models of Madu (1988) and Linstone (1989). In our model it has been tried to identify the main factors involved in the technology assessment process and the model considers the technology transfer process as a sequence of steps of which the crucial and primary steps, Needs Assessment and Technology Assessment, are elaborated more. As these are the main and primary steps to determine the success of the technology transfer process, focus has been directed to these two steps.

In the model, Needs Assessment is taken as the first crucial step. Once the Needs Assessment is complete, a decision can be made on the necessity of a technology transfer. The Technology Assessment is the next step. The model is mainly constructed to give a guideline for the assessment of the technology to be transferred. Even though technology transfer involves both the transferor and the transferee, as mentioned above, more focus is given to the purchaser and user of the technology. As there will not always be ‘win-win’ outcomes of the technology

transfer process, the seller of the technology should also consider the factors that determine the success of the technology transfer. A satisfactory technology transfer process might bring the seller more customers and contribute to the long term success of both parties.

3 Towards an improved Process of Technology Transfer

Technology transfer is not as simple as its definition: taking technology from an area and implementing it in another area. The problems are caused by 'culture ladenness' of technologies: Studies of the process of technological change have focused on the propelling forces behind these changes. This body of knowledge clearly points to forces internal to the world of the technologist, like the dynamics of technological systems (Hughes, 1994) or technological paradigms (Dosi, 1982), as well as to social and economic forces relating to the creation of new technology, like evolutionary theories (Dosi et al., 1988), social-constructivism (Bijker et al., 1987), feedback mechanisms (Arthur, 1990). These social and economic forces could also be influenced in order to steer technology, for example to contribute to Sustainable Development (Weaver et al., 2000, Mulder, 2006).

For this paper, these forces do not need to be outlined in detail. It is clear that various forces that are 'local' in character contribute to the process of shaping new technologies. Technologies are therefore not universal answers to universal needs: they are shaped by highly localized forces.

However, once the investments in the development of new technologies have been made locally, the technologies escape their local character and spread to places with different social and economic conditions. The logic behind this development is that production costs of modern technology are often low as compared to the cost of their design; hence, replicating technologies is often more attractive than developing local technologies to serve local needs. Therefore, local and small scale production is often out competed by the economies of scale of global players that sell their technologies world wide. The consequence is that local or regional cultures continuously have to cope with the influx of new technologies that are alien to their social, economic and cultural conditions.

The transfer of technologies to other cultures sometimes creates controversy. An example is the resistance against McDonalds/fast food as being a threat to gastronomic cultures[1]. However, the social, cultural and economic conditions of most industrialized countries are rather similar, as being mainly Christian, market based parliamentary democracies. Problems of technology transfer between industrialized and developing nations become much worse. Technology transfer to developing nations is often a complicated process involving technical, economic, social, political and legal aspects (Putranto et al., 2001).

A technology that has proven to be appropriate and sound in a given area or under specific cultural conditions may not be appropriate under different conditions. The performance of a given technology is dependent on several factors determining the precise nature of the needs that has to be fulfilled by its service, and several factors that emerge from local culture, economic

and geographic circumstances. It is therefore necessary for a purchaser, company or other stakeholder, to choose an option that fulfils these specific requirements and needs (IETC, 2003).

There is a need to study the cultural roots of a technology before implementing the "western technology" into "eastern' culture" (Awny, 2005). The differences between the cultural roots of a technology, and the cultural environment of application, are frequently not recognized. Authorities in developing nations are often rushing to imitate the industrialized countries and transfer a technology without paying proper attention to this gap. This leads to inappropriate and unsatisfactory outcomes of many technology transfer projects (Luper et al., 1991). By the same reason, technology transfer was often more successful in colonial times than it is today: the process was coordinated by colonial authorities who ordered technologies in their home country. By their own experience of being transferred between cultures, they were better able to judge the factors that determined the success of technology transfer (Cf. Ravesteijn/Kop, 2008)

International Technology Transfer (ITT) has been a common practice and played a great role in the creation of worldwide manufacturing. *ITT includes the transfer of systematic knowledge for the manufacture of a product, for the application of a process or for the rendering of a service* (Zhang, 2003). Most ITT has been carried out by multinational companies for various reasons like:

- securing the supply of imported raw materials or components for its home market production (*vertical integration*),
- serving the host market with products, especially if import of these products would be expensive (*horizontal integration*),
- serving the world market by developing manufacturing capabilities in a foreign country that has the most profitable conditions in regard to costs of labor, capital, raw materials and transport (*globalization*) (Luper et al., 1991).

In making the decision to transfer a technology, the first and main step is

- the ***Needs Assessment*** –indicating the needs to be satisfied by the technology and its strategic importance
- the ***technology needs specification***-specifying the detailed requirements and constraints
- the specification and **assessment of direct and indirect effects** of the transfer of a technology (Awny, 2005; Madu, 1988).
- the ***technology selection***- considering the available technologies and

Since these major processes are the crucial steps in a technology transfer, we grouped them as Needs Assessment and Technology Assessment processes and both are discussed in the next part.

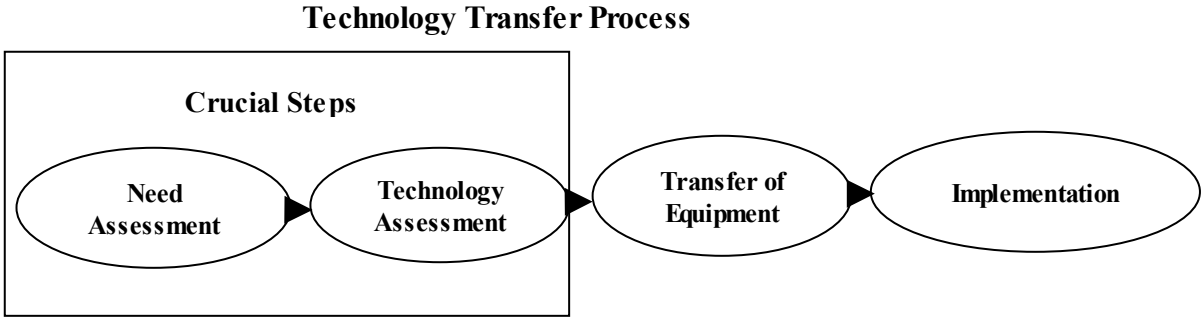

Figure 1. Crucial steps in the Technology Transfer Process

4 Crucial Steps and Factors in Technology Transfer Process

4.1 Needs Assessment

Often, developing countries transfer a technology which is unsuitable to their national interest; national prestige might play a strong role like in the creation of flag carrying airlines or the purchase of impressive military equipment. However, very often decisions lack proper Needs Assessment. Decision makers observe the success of a specific technology in its home country and decide to transfer it without proper assessment of the domestic needs for it.

The question what the needs are, that have to be satisfied, and what their priority are in regard to other needs is often not answered. This question is the key of Needs Assessment. Needs Assessment is defined as analyzing:

- the needs and their dynamics
- the 'owners' of these needs
- strategic policies and plans, for fulfilling these needs
- other stakeholders in regard to these needs (Cf. Strategic Problem Definition of Weaver et al., 2000).

Needs Assessment is a crucial step in a technology transfer decision. At the very beginning the needs of the country, the society in general, and the needs of the intended users have to be identified. These needs then lead to identifying technological options to satisfy them. Analysts should be aware that a 'need' is not equivalent to a 'demand': a 'demand' is influenced by the availability of technological options and their price levels. This includes a "rebound" effect as technology improvement leads to expansion of demand for its service (Green et al., 1992). A 'need' exists apart from price levels, while a 'demand' includes price elasticity.

The Needs Assessment should include policy objectives that are often integrated into a national

development plan. Technologies that fit specific strategic objectives could harm other strategic objectives. A capital intensive technology may not be advisable to transfer to a country with high unemployment rates, as the countries needs are not just to provide a specific good/service, but also to provide jobs. For a country focused on agricultural production, transferring technologies of high tech electronics industry may not be the right choice as the needs for the products will be very limited. Hence, Needs Assessment is necessary to indicate and identify the needs of the purchaser and the user. Analysis of the needs of all stakeholders that might be described in national strategic plans, might help to determine what is needed (Awny, 2005).

Once the problem is clearly formulated and the needs to fulfill are identified, the next step of the Needs Assessment aims at identifying the options to satisfy them. In the technology transfer decision making model of Madu (1988) identifying the needs and objectives is one of the crucial steps in the process. He states that in making the decision to transfer a technology, identifying the potentials and weaknesses of the existing technologies is carried out to decide whether the stated needs can be satisfied by the existing technology. Once the limitations of the existing technologies are known, he recommends evaluating and selecting the appropriate options for improvement (Madu, 1998).

4.2 Technology Assessment

In the industrialized world formal and informal Technology Assessment is carried out:

- The informal Technology Assessment is what many industries and government agencies do when they adopt new technologies: they analyze and discuss all costs and benefits of this adoption.
- The formal Technology Assessment mostly occurs when the stakes are high or decision makers expect conflicting views.

The aim of Technology Assessment is to inform decision makers, to provide an early warning signal for unintended consequences, to prepare stakeholders for possible technological changes, or to facilitate the participation of stakeholders in decision making (Smits/Leyten, 1988). More recently, stakeholder participation and feed back loops have been emphasized as important for the technological construction process (Constructive TA, Schot/Rip, 1997, Van den Ende et al., 1998).

Both formal and informal Technology Assessment are almost absent in most developing nations. The dominant mode of thinking in most developing nations is that one should try to obtain the sophisticated technologies from industrialized countries, with very often a lack of understanding for the preconditions for these technologies to be successfully applied. So in general, not even an informal Technology Assessment takes place. However, a Technology Assessment, giving an integrated picture of the consequences of the introduction of a new technology is crucial for development. The introduction of the non-indigenous Nile perch into Lake Victoria, that created

a new fishing industry but also devastated local fish stocks, can be seen as a horrific example of where a lack of Technology Assessment might lead to (Masciarelli, 2005).

A technology transfer is said to be successful when the "three pillars" are fulfilled according to IETC's (International Environmental Technology Center) report:

- *environmentally sound*,
- *economically viable a*nd
- *socially acceptable* (IETC, 2003).

Hence, Technology Assessment is done to assure technical validity, economic viability, political feasibility and environmental and social acceptability (Chen, 1979) of a technology transfer.

A technology transfer can only be really long term successful if the technology is continuously maintained and improved afterwards. This requires a certain innovative infrastructure in the country: the technology should be controlled and maintained by properly trained operators. Above that, there should be experts that are able to adapt the technology to new demands, or the availability of new and improved components. This is an important element of the TA. If this is done properly, long term costs of technology transfer might be prevented by developing the ability to improve, adapt, replicate or even re-sell the technology (International Environmental Technology Center, IETC, 2003).

The factors that should be considered in assessing the technology from the developing countries perspective are discussed in the next part.

- **Technical Factors**

In a country where there is no appropriate infrastructure and supporting technologies, it is difficult to utilize technologies to their full capacities (IETC, 2003). Low technical and innovative capabilities are among the barriers of successful technology transfer that need to be taken into account (IEA, 2001). Under-utilization and inefficiency of a technology are common experiences of developing countries after a technology transfer (Sharif, 2003). It is not only due to lack of knowledge and craftsmanship, but also to a lack of innovative capacity to adapt technologies to demand.

- **Economic Factors**

Economic factors include the availability of human resources, capital, land, energy and other raw materials. The availability of these factors favors transfer of specific forms of technology (Madu, 1988). However it doesn't imply that a labor based nation should stick to labor augmenting technology. Rather it should consider its weaknesses and explore the improvement options.

Resources also include factors such as raw materials, foreign exchange, real estate, and so on (Luper et. al, 1991). Subsidies, macro-economic conditions and market conditions are important factors that should be given attention in the Technology Assessment (IEA, 2001). Patenting and licensing of intellectual property rights also need considerations in transferring a technology. As

a technology transfer to developing countries often has the target of replicating, even re-selling of the technology, (IETC, 2003) these issues need consideration and agreements before transferring a technology.

- **Institutional Factors**

Institutional factors in this study encompass

- organizational,
- social,
- cultural, and
- political factors.

Organizational:

The successful implementation of a technology often requires the various units of the purchaser organization to have a strong interactive attitude as their roles in the organization might be affected. However, in most developing countries the hierarchical form of organization is dominant, and it is difficult to apply network management systems that allow for more independence and interaction. (Ten Heuvelhof, 2006).

The way in which organizations are created affects their exploitation of technologies. The introduction of a new technology requires the ability of the organization to manage changes associated with this introduction into the organization (Madu, 1988; Cui et al, 2006). The introduction of a new technology mostly requires organizational flexibilities. Flexibility is often lacking in developing nations. Semi-autonomous units, like the business units in Western corporations are virtually absent in the larger organizations of the developing nations.

Social:

A technology should be *socially acceptable* i.e. it should contribute to the local community. Many new technologies provide local jobs and income. However, in some cases new technologies destroy jobs. A real life example: a city in Western Europe offered help to a city in the developing world. The city in the developing world would receive street sweeping cars as were used in Western Europe. Would this really be socially acceptable if it implied that dozens of local street sweepers became unemployed, with unemployment rates of over 50 %?

Cultural:

A technology should be *culturally acceptable*. Cultural factors include the attitude, way of life, religion. Taboos, language, the concept of time, the concept of honor and respect, and work ethics are also included in this category (Luper et al., 1991). Culture also implies the working habits of the nation. In developing countries like e.g. Ethiopia, working in a factory is (in some regions) regarded as a job of very low status. This has a strong cultural background. Cultural

preferences might hinder a successful technology transfer (IEA, 2001).

Very often the culture of (part of) the purchaser country of a technology needs to adapt for a successful technology transfer. Resistance might be strong. Training and education for awareness might sometimes reduce such resistance (Cui et al., 2006). Especially the production and consumption of various food products might be unacceptable. (Chen, 1979)

Political:

The political climate of an area is a factor that should be considered before a technology transfer. Political instability and corruption are mentioned as barriers for technology transfer (IEA, 2001). The safety and stability of a country is a determining factor for investors and foreign relations. For example, the Ethiopian government bought and transferred modern textile machineries to Adwa, near to the Massawa port area. It has been functioning below its full capacity and under a high cost of production. The textile technology needed a huge investment and the factory was assumed to import raw materials and export its products through the nearby Massawa port. This port unfortunately is blocked because of the Ethiopia-Eritrea war. The feasibility study for the decision making on this technology transfer didn't consider political stability. The textile plant has been facing huge additional costs for getting raw materials and exporting its products through a different port far from its site.

A new technology might also influence the political power balance. Therefore, Israel blocked Gaza from having its port facilities and airport. On a more local level, the introduction of new agricultural- and communication technologies in a village might strengthen the power of the farmers in regard to local rulers or merchants who might refuse to accept that.

- **Environmental Factor**

This factor includes geographical location, climate and sanitary conditions. It is often stated that the rich world cares for the pollution of life-supporting systems while the poor world cares for the pollution of poverty: pests, epidemics, unsanitary conditions, etc. (Chen, 1979). However, degradation of life supporting natural systems is becoming a day to day experience in developing countries (IETC, 2003). Very often, the populations are unaware of the harmful effects of pollution, until a disaster happens. The poisoning of about 1500 inhabitants of Abidjan, the capital of Ivory Coast, by illegal dumping of chemical waste from Europe, serves as a good example (Copnall, 2006). However, very often the effects of chemical pollutants are only observed after a prolonged period of time, which is often beyond the scope of decision makers in developing countries. Hence, a technology should be assessed for its environmental effects.

Resource depletion is an issue that a responsible government should take into regard. Very often, governments favor a strategy of cashing in on their resources in the short term, which might ruin the country in the long term.

Technology Assessment Factors			
Technical Factors	**Economic Factors**	**Institutional Factors**	**Environmental Factors**
Physical facilities (infrastructures and support technologies), Services and systems (operation, maintenance)	Human resources (both technical and non-technical expertise), Capital, land and other raw materials, Macro economic conditions, Market and property right (patents and licenses)	Organizational factors (structure, flexibility for change, decision making), Social factors (religion, taboos, language, concepts of time and honor, respect, work ethics), Cultural factors (taste, habit), Political factors (Political instability and corruption)	Geographical and climatic conditions, Ecological systems imbalance, human health effects, Effects of pollution, Resource depletion and environmental destruction

Table 1. Technology Assessment Factors

5 The Model and Its Elaboration

The proposed model that considers the crucial steps and factors in technology transfer is discussed and a simple example is included here to sketch the processes of the model. (See Figure 2.) The given example indicates how a need for transportation can be satisfied with alternative transportation types where the transportation technology cannot be produced at home and is transferred from an external supplier

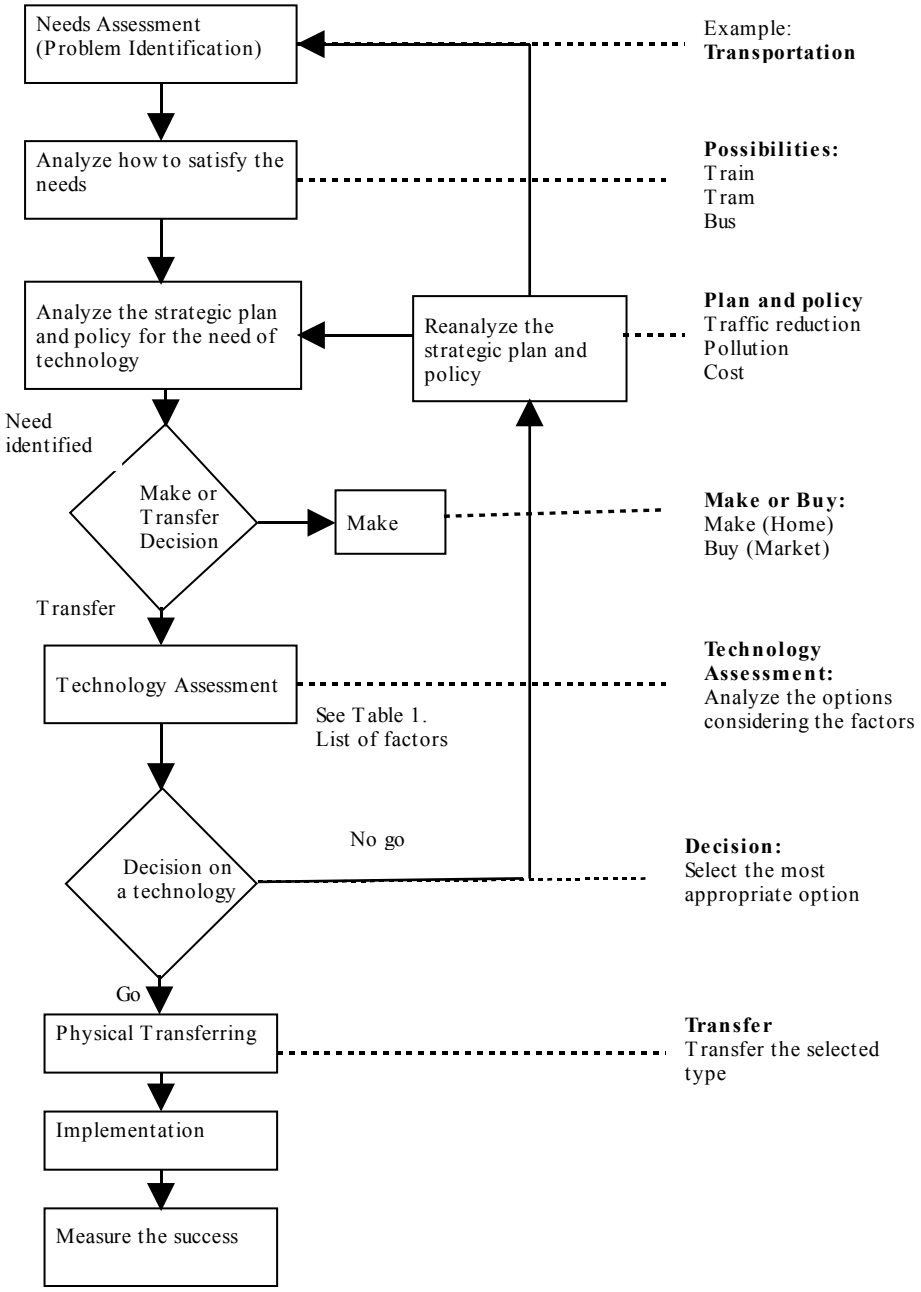

Figure 2. Technology Transfer Model

The model (in Figure 2.) consists of the following steps:

i. *Needs Assessment (problem identification):* This is the first step in the technology transfer process. Needs have to be identified, and the basic characteristics of the needs in

terms of quantity, price levels, and cultural preconditions. This involves identifying the needs of the receiving society. Basically the society is the center of analysis, not the available technologies.

ii. *Analyze how to satisfy the needs (options identification):* The needs identified require options to meet them. These options of how to satisfy the needs may not necessarily be technology related.

iii. *Analyze the (national) strategy and the policy plans for fulfilling the needs and for the options to satisfy that needs*: In general developing nations have set their priorities by strategic plans or development plans. These plans might determine the resources that governments are willing to commit to the options.

iv. *Make or Transfer decision*: Even though most of the technologies of developing countries are transferred from overseas, there are technologies that can be developed and used locally. The "make option" is attractive if the resources and skills needed to produce it are locally available, and the technology is of great economic or strategic interest to the country, but investing in the "make option" only for reasons of strategic interest can lead to disaster. For example, the Indonesian aircraft manufacturer IPTN, which was set up to supply the Indonesian archipelago with appropriate means of transport, was a sink for government subsidies, and could sell their ill-suited aircraft only by government enforcement (Towery, 1998). Since, the focus of this paper is in transferring technologies, we do not elaborate more on this point.

v. *Assess the technology considering social, cultural, economic and environmental factors*: Each of these factors has already been discussed in the Technology Assessment part of this paper.

vi. *Decision on a technology*: After assessing the possible alternative technologies, the most appropriate technology is selected. If no satisfactory technology is available, the strategic plans and policies should be reconsidered.

vii. *Physical Transferring process*: This is the actual and material transferring process of the selected technology. It includes all the procurement and transportation processes of the technology. But it must be remembered that technology transfer does not necessarily mean physical technology transfer, as services can also be included.

viii. *Implementation*: The final process of the technology transfer is implementing the technology. Additional recommendations for developing countries as stated by Awny (2005) are worth to be mentioned here; i.e. absorption and further modification of the technology should be taken into account. Proper consideration should be given to personnel training and maintenance.

ix. *Measuring the success*: Once the whole transfer process is done, measuring the success or failure of the transfer process helps to learn from mistakes and leads to improving the

next transfer processes.

5.1 Why a better model? Three cases of technology transfer.

Three cases of large scale technology transfer to developing countries and the learning experience from these cases are discussed to elaborate our model. The case studies are collected from other public sources. They are discussed with respect to the model that we proposed. We will focus on the Needs Assessment and Technology Assessment steps in these cases.

Case 1: *Arsenic drinking water contamination and social mobilization in Bangladesh*

> Bangladesh is in many ways what we perceive as a typical developing country; it is predominantly agrarian, highly indebted, and has a huge disparity between its rich and poor population. Additionally, the country faces problems of over-population.
>
> Although it is in one of the wettest parts of the world, Bangladesh has always faced problems with the supply of clean drinking water. In the past decade a new disaster emerged. It turned out that two-thirds of the tube wells installed over the last thirty years – roughly 5 million in total – contain arsenic concentrations above the permissible levels set by the World Health Organization (WHO). These wells were installed to contribute to a secure and reliable drinking water supply. They would provide a good alternative to surface water supply with its associated bacteriologic diseases. In itself that goal has been reached. It is therefore a bitter observation that it is this very approach that has led to widespread arsenic poisoning of drinking water. Arsenic is chronically toxic after prolonged low level exposure and can lead to skin lesions, bronchitis, diabetes and eventually tumors and cancers. Roughly 42 million people (more than 30% of the population) have been exposed for many years to arsenic concentrations well above the WHO standard. Nowadays, several organizations are trying to implement technical solutions to supply the local population with safe drinking water. The success of these attempts differ as the focus is sometimes just on transferring equipment without any notice for the local needs for clean water, nor the local conditions under which the equipment have to be kept in operation. Some projects fail because people cannot be convinced not to use the local well and getting their water from a cleaning facility at further distance. Other projects fail to develop the proper organization to manage operation and maintenance of facilities.
>
> (Boes/Rammelt, 2006)

The Bangladesh drinking water case shows in fact two examples of technology transfer. The first is the transfer of tube-well technology; the second is the transfer of various technologies to solve the arsenic contamination problem. It shows that transfer and implementation of a technology is highly influenced by social and economic structures of a society.

- **The Case with respect to the Model proposed:**

i. Needs Assessment: Problem Identification

> Before having the tube-wells, people were often depending on microbiologically contaminated surface water for drinking. This created a severe public health problem.

ii. How to satisfy the needs: Options Identification

There were different technological options to supply drinking water to the Bangladesh society. The identification of these options for the Bangladesh society was absent during the period in which tube-wells were installed. At this moment various technological options are studied in order to prevent arsenic poisoning.

iii. Analyze the plan and policy for the needs of technology to satisfy the needs

The provision of clean drinking water technology was and is a priority in the rural development plans of the country.

iv. Make or Transfer decision

This decision depends on capacity of the country to make the technology at home or transfer it from outside suppliers. The technological options that can be produced locally are still not taken too seriously.

v. Technology Assessment

The Technology Assessment includes assessing the indirect and longer term effects of a technology. This was not carried out: the geological soil characteristics for the tube-wells were not studied at all. Had the level of the arsenic in the groundwater been known before, the tube-wells would never have been installed and an alternative technology would have been applied.

In solving the more recent arsenic problem, the local culture, organizational and cultural factors were often not considered. This resulted in a considerable number of failed projects.

All these factors are now being considered 'after the event' and studies are now being carried out to consider social and cultural acceptability of the mitigation of arsenic contamination technologies. The case clearly shows that both preventing and solving technology transfer problems require consideration of the technology assessment factors.

vi. Decision on a Technology

If the relevant factors had been clearly analyzed, the decision would probably not have been the same.

vii. Transferring process

The technology transfer process involved physical transportation and supplying of the available tools and experts to the implementation areas.

viii. Implementation

This step refers to the installation of the tube-wells in the assigned locations.

ix. Measure the success

In the case of tube-wells, evaluations were made only after the first arsenic related diseases occurred. This could have done much earlier, which had created better learning**.**

Case 2: *Animal drawn wheeled-tool carriers*

During several decades, research, development and promotion of animal-drawn wheeled tool carriers has been carried out. These implements have been universally hailed as "successful" but yet farmer adoption has been extremely disappointing. In more than thirty different countries around the world, improved animal drawn wheeled tool carriers have been introduced. The transfer and implementation of animal drawn wheeled –tool carriers, about 10.000, failed in all of the countries. Farmers did not pay a realistic price for these tool carriers. Almost all of them did not remain in use for more then 5 years. The main reasons for the failure were of a social and cultural nature. Attitudes and interests of the users, i.e. the farmers (the purchasers) in regard to the new wheel tool carrier, were not considered. All the development programs on animal-drawn wheeled tool carriers started at (agricultural) research stations. They were implemented in a top down way. In all the reviewed cases wheeled tool carriers worked well on the research stations, yet in none of the cases wheeled tool carriers work sufficiently well under normal farming conditions to continue using them.

The wheeled tool carrier programs illustrate the dangers of Needs Assessment and Technology Assessment limited to research stations and “top down” philosophies that were often guiding the work of these institutes. This example also highlights the problems of emphasizing technical efficiency rather than appropriateness, both to the needs of the farmers and to the realities of rural life. Farmers should be involved in all stages of planning, implementing and evaluation of programs that are aimed at their work.

Most individuals and institutions that are involved in technology transfer are afraid of adverse public reactions if they report “failures”. However, failures are often much more interesting for learning purposes as they often contain clear lessons. This requires a change of culture in order to allow for ‘failure’. If the national programs, the aid agencies and the international centers fail to accept this challenge, major opportunities for learning will be lost and more time and money will be wasted.

The wheeled tool carrier story is remarkable, for the implements have been universally seen as “successful” yet never been adopted by farmers. The main lesson from this case should be that crucial stakeholders should be involved.

(Starkey, 1987)

- **The case with respect to the major steps of Technology Transfer:**

i.*Needs Assessment*:

Though the needs for better tool carriers had been known, the needs of the users of the technology were not fully understood. Only the needs of society were identified, but not the

needs of individuals and the social and cultural preconditions to fulfill that needs.

ii.Technology Assessment

The technology proposed, the wheeled tool carrier, was not the appropriate technology for the needs of the farmers. Some of the factors which were not considered in the transfer and implementation process included:

- **Technical Factors**: the suitability of the carrier under normal conditions of farm work was not considered
- **Institutional Factors:** the social life, attitudes, culture and interest of the farmers were not taken into account during the design and development of the technology. It was a "top-down" approach where the designers didn't recognize the non-technological influencing factors.
- **Environmental Factors:** technical efficiency and use of technologies depended on the natural circumstances in rural areas. The requirements that originated from soil properties and landscape were ill perceived. The carrier proposed for flat soil was not efficient for most areas. Its impact on the environment varied considerably.

Case 3: *Green Revolution:*

*T*he term "Green Revolution" is used to describe the transformation of agriculture in many developing nations. It started after World War II, although the term "Green Revolution" was only used from the end of the 1960s. This Green Revolution led to dramatic increases in cereal production between the 1940s and 1995. Between 1970 and 1995 cereal production in Asia doubled, while population only increased by 20 %. Latin America also increased cereal production, but the gains in sub-Saharan Africa were more modest due to poor infrastructure, high transport costs, pricing mechanisms that penalized productive farmers, and lack of irrigation. This transformation occurred as the result of programs of agricultural research, extension, and infrastructural development largely funded by the Rockefeller Foundation, the Ford Foundation, and national governments. (IFPRI, 2002).

- **The case with respect to the major steps of Technology Transfer:**

Needs Assessment

There was a clear need for food throughout the developing world. However, the need for food in sub-Saharan Africa was inappropriately assessed: There was not so much a need to produce more food, but instead, there was a need for better distribution of food, and for security of food supply.

Technology Assessment of the Green Revolution

i. Technical Factors:

The Green Revolution required transfer of technologies from the industrialized world to the developing world. Technologies that required maintenance facilities, pesticides, machinery,

irrigation technology and fertilizers were scale-dependent.

ii. Economic Factors:

The Green Revolution increased the use of agricultural inputs. This led to the establishment of rural credit institutions. The wealthier farmers acquired more land through this credit system and disparities within rural societies and between regions increased. Many small farmers went into more and more debt and eventually lost their farm land. This caused migration to urban areas. The Green revolution resulted in higher agricultural yields but also in lower product prices and higher input prices. It thereby decreased the vitality of many rural areas in developing countries.

iii. Institutional Factors:

- ***Social***: interregional economic disparities which resulted from the easier adoption of the Green revolution in some areas than others.
- ***Political****: The* Green revolution was often related to a liberalization of agricultural markets. It weakened the rural socialist movements in developing nations.

iv. Environmental Factors:

The use of pesticides including DDT and other chemicals in the Green revolution brought environmental effects including poisoning of farm workers and villagers, water contamination, evolution of harmful pests and other ecological imbalances. The new crops that were bringing in larger yields were often more vulnerable to droughts and pests. Therefore, the Green revolution did produce more food, but did not prevent local famine.

One could say that one of the effects of the Green revolution was a world wide learning process. Research centers throughout the world studied the effectiveness of development aid and technology transfer. Interactive approaches that included the involvement of farmers in the development and transfer of technology have been developed and implemented on experimental scale. However, it is by no means certain that the mistakes of the Green Revolution will not be repeated.

6 Conclusion

Technology transfer has often been regarded as a rather simple process. Very often, it has just been executed without much consideration. This has created dramatic failures, as there is an urgent need to work on developing the underdeveloped nations.
Many factors in the process of technology transfer are often not recognized, and failure occurs rather frequently. In this paper, a general model was developed that gives a guideline and identifies factors for consideration in technology transfer processes to developing countries. The focus was especially on the primary and crucial steps; Needs Assessment and Technology Assessment, of a technology transfer process. The model proposed can serve as a checklist of factors that have to be taken into account in a technology transfer process.
The process that is sketched in this paper may look over-formalized and superficial. However, given the high failure rate and the recurrence of failures structural measures are required.
Since more emphasis has been put on the primary and crucial steps of the technology transfer process, more, and in depth, study is needed regarding the remaining phases of technology

transfer (the physical transferring and the implementation phases). However, it is believed that if all the factors related to the technology transfer including the probable and the possible impacts of the technology when implemented are considered during the assessment phases, the success of the technology transfer will be quite high. The cases included in this study for clarifying and validating the model show that such failures could have been minimized, if such assessments were done before the implementation of the technologies.

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1 Cf. for example discussions about McDonalds: Retrieved January 31, 2007, from http://en.wikipedia.org/wiki/McDonald's.