Empowering Public Transportation Organizations in Developing Countries Through the Transfer of Appropriate Technologies

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ABSTRACT : Technology Transfer (T2) is the systematic application of research results. T2 remains to this day an untapped resource in both developed and developing countries. For the later particularly, the institutionalization of technology transfer is still in the stage of infancy. In spite of formidable hurdles, it is destined to yield bountiful harvest. The rewards that T2 institutionalization promises are unlimited. Generally, it will allow developing countries to do" more with less." It is a tool that public transport organizations can utilize to devise solutions to urban mobility problems, while leveraging scarce resources. It provides a window to the latest innovations and best practices. It grants an opportunity to these organizations to sift, adapt, modify, and transfer only technologies that are appropriate to the local needs.

This paper examines technology transfer practices in the transportation field. It discusses the benefits and challenges and outline a framework of operating a successful T2 organization in a developing country.

The paper provides practical tools to practitioners that can be used to establish goals, formulate T2 programs, and prioritize T2 projects according to organizational goals. T2 implementation remains an art, rather than a science. The objective of this paper is to guide the user to the implementation of T2 programs.

RESUME : Le transfert de technologie (T2) est l'application systématique de résultats de recherche. Il demeure à ce jour une ressource inexploitée dans les pays développés comme dans les pays en développement. Pour ces derniers, l'institutionnalisation du transfert de technologie en est encore à ses débuts. En dépit d'obstacles considérables, elle devrait pourtant porter largement ses fruits. Les avantages promis par l'institutionnalisation de T2 sont illimités. En général, cela doit permettre aux pays en développement de « faire plus avec moins ». C'est un outil que les organisations de transport public peuvent utiliser pour trouver des solutions aux problèmes de mobilité urbaine, peu consommatrices de ressources. Cela constitue en même temps une vitrine pour les innovations les plus récentes et les meilleures pratiques. Cela offre aux organisations une occasion d'examiner, d'adapter, de modifier et de transférer celles des technologies qui sont appropriées aux besoins locaux.

Cette contribution étudie les pratiques de transfert de technologie dans les transports. Elle dessine un cadre pour la mise en œuvre d'une organisation T2 réussie dans un pays en voie de développement.

Cette contribution fournit des outils pratiques pour les praticiens qui peuvent être utilisés pour fixer des objectifs, formuler des programmes T2 et fixer les priorités des projets T2 en fonction des objectifs organisationnels. La mise en œuvre de T2 demeure un art plutôt qu'une science. Le but de cet exposé est de guider l'utilisateur dans la mise en place de programmes T2.
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I. INTRODUCTION

While each country has its own unique culture, its specific demographic, historical, social, economic and political conditions, "developing countries" have long been lumped together because of their common plight. Developing countries share common characteristics. They share a dependency on the industrialized countries. There is rapid growth in population coupled with rapid urbanization trends (Dimitriou, 1990.) These two phenomena combine

together to create transport and urban problems of disastrous magnitude. The manifestation of these problems include rampant underemployment, lack of skilled manpower, high rates of inflation, high birth and death rates, low life expectancy, high illiteracy levels (World Bank, 1985.)

Furthermore, developing nations are characterized by a dual economy where modern and traditional modes of production, as well as extreme affluence and extreme poverty exist side by side. It has been argued, however, that while economic progress is one ingredient of development, it is by no means the only one. The development phenomenon is comprised of a series of stages that enable a country not only to progress economically, but politically and socially, eradicate inequities and poverty, and improve quality of life.

Given the unique characteristics, and historical background of developing nations, the question remains: Is rushing to force a development model mimiced from an industrialized nation a wise decision when this model was conceived and implemented to address problems in a drastically different setting? Amid their quest for development, developing nations have sought the adoption of technologies implemented elsewhere, in the hope that following the same path of development that industrialized countries traveled would energize the wheel of development and generate the same productive outcome.

These "quick fixes" encouraged primarily by international aid and loan policies have proven ineffective (Dimitriou, 1990.) During the last decade, developing countries have shifted their focus to the pursuit of appropriate development strategies that would generate sustainable development and break the cycle of dependency inequity and urban and population explosions.

The last decade witnessed the development and refinement of theory and practice of technology transfer in industrialized countries. Technology transfer is the systematic process by which a technology is applied and implemented within a setting other than that in which it originated. By its very premise, technology transfer holds the promise of resolving the dilemmas of developing nations. It rejects the blind adoption of technology but subject the technology to rigorous evaluation and adaptation to ensure it meets its intended goals. It is a process that seeks to mold and appropriate technologies to the specific needs and conditions of its host environment. Technology transfer in developing nations, however, remains largely untapped.

This paper seeks to shed more light on the theory and practice of technology transfer. It offers a conceptual framework for operating an effective Technology transfer center in developing countries. It provides examples of case studies where technology transfer has been successfully utilized.

II. WHAT IS TECHNOLOGY TRANSFER?

Technology transfer is the process by which the products of successful research or practice are instituted within an organization. The transferred technology represents a solution to an existing or perceived problem faced by the user. Transfer encompasses exchange of information, adaptation of products to the user's needs, refinement, packaging and adoption.

The measure of whether transfer has effectively taken place is when the product being transferred replaces existing products. The tailoring of the product to its host environment and users is an intrinsic component of the technology transfer process. The pre-implementation assessment would have proved that the product to be transferred will be more effective than the outdated product.

An effective technology transfer program can generate numerous micro and macro-level benefits. Those benefits include maximizing return on investments, optimizing the allocation of limited resources, and "stretching budgets." In other words, technology transfer has the potential to empower developing nations to "do more with less."

III. FRAMEWORK FOR OPERATING AN EFFECTIVE TECHNOLOGY TRANSFER CENTER IN DEVELOPING COUNTRIES

1. Institutionalization and believing in the concept of technology transfer

For technology transfer to be effective and to generate expected transfer benefits, it must be institutionalized. To institutionalize technology transfer means to establish an organizational climate conducive to success and open to change and innovation. Such climate maintains flexibility, adaptability and responsiveness.

Technology transfer thrives in an organizational culture which restructures work process according to changing needs, adopts a leadership style that facilitates rather than dictates, emphasizes team building, and maintains open communication and collaborative cooperative working relationships.

In contrast, a climate that is most resilient to innovation and least likely to have an institutionalized technology transfer process is a climate which is resilient to change. It reacts rather than anticipates problems, focuses on rule compliance, and institutes repetitive routine jobs. It adopts a command and control leadership style,

erects fragmented rigid organizational boundaries, and centralizes information flow. It mistrusts change, and operates according to excessive bureaucratic layers. It is driven by the need to persevere the status quo, avert risk and minimize any remote chances of failure.

Organizations that are responsive to its customers' needs, perceive change as imperative to keeping pace with a dynamic world, commit themselves to pursuing and instituting vehicles of change, and allocate necessary financial and human resources to carry it out. Instituationalizing technology transfer would also entail institutionalizing collaboration.

A bureaucratic structure with excessive layers tend to restrict interaction, and in turn transfer, while a structure that vertically and horizontally integrate work functions, while allowing a degree of flexibility is conducive to successful transfer. An organizational culture maintains unwritten rules that governs employee interactions; it plays a crucial role in facilitating or obstructing transfer. Institutionalization of technology transfer demands an organizational culture that promotes the creation of an atmosphere where employees communicate formally and informally, so that a problem is communicated and resolved before it become a crisis. It is an open climate where information is free flowing and where rigid boundaries are dissolved.

2. Champion and dedicated staff

An integral component of technology transfer is the existence of dedicated staff who are committed to the mission of furthering development through technology transfer. Technology transfer process is a human process. It is developed, implemented and used by people. The human element is critical and can determine success or failure. It is an element that is often overlooked and neglected.

Successful transfer not only entails investing in the transfer effort, but the transfer agent as well. Technology transfer staff must have certain personal and professional characteristics and skills that would facilitate the transfer process. He/she must possess superior interpersonal skills that allow him/her to maintain an extensive communication network internally and externally across sectors and disciplines. He/she must have a clear sense of purpose and strong commitment and enthusiasm. They must have excellent listening skills that allow them to resolve conflicts and reach consensus. They must inspire confidence, possess an ability to integrate all stakeholders and bring them on board and solicit active participation and commitment.

A technology transfer provider must cultivate a close connection with the receiver and the host environment. He/She must establish strong familiarity with the receivers' needs and a clear realistic sense of what is implement able and what is not.

There are generally three modes of interaction between a technology provider and receiver. A passive provider delegates control over the process to the receiver. Collaboration is absent. Problems associated with this form of interaction are that there is limited two-way communication and interaction. The provider's opinion is usually ignored.

On the other hand, an "all knowing provider" is on the opposite side of the spectrum. He/she assumes absolute control over decisions that affect the receiver. The receiver remains inactive and collaboration is also absent. Problems with this form are the potential of lack of commitment on the part of the receiver conceived out of a loss of sense of ownership of the process.

An ideal form of interaction occurs when there is equal participation in the decision-making process, balanced respect and trust, in other words, a true partnership. Both the provider and the receiver are equal partners who conduct joint planning, joint appraisal, and joint development and execution of the transfer plan. Joint ownership of the process, collaboration and interdependency between those two entities foster a climate conducive to success. This is a fertile ground for effective communication.

3. Setting up the framework and success factors for technology transfer centers

a. Need study

The success of the T2 program in the developed countries is mainly attributed to its diversity. Each T2 center designed its own programs and activities to meet the needs of its customers. These needs will absolutely vary. Learning about snow and ice removal techniques will serve areas frequently subjected to snow and ice, while this training will be deemed useless in other regions that hardly experience the fall of snow and ice.

It is therefore highly recommended that before a new T2 center is established, a need study should be conducted to find out the needs among local and other public agencies. A well designed, and concise questionnaire should be developed and distributed to potential customers asking their input about what programs and services are urgently needed. It is even more advantageous to list some potential programs, with brief description of each, to simplify the task of identifying needed services.

It is important to understand that a successful program at one center can be a total failure if duplicated at another center. For example, the Local Technical Assistance Programs (LTAP), a nationwide decentralized T2 program in the USA, adopted the "Roads Scholar Program" . It was met

with great success in the New England States. When this program was tried in the South Dakota LTAP, for three years, it was not successful. Some of the reasons might be the difference in culture between the Northern Midwest states and the east coast states. Completing certain number of training workshops and obtaining a non-academic certificate means a lot to the local government officials in the east coast community than it does to their counter part in the Northern Midwest.

The need study will shed some light on which program have high potential success and which one to avoid. This will pave the way to a good start, particularly when resources are limited and experimenting with several programs to see which one to implement can not only be costly but the new program might lose credibility.

b. Resources

For a new center, it is imperative to identify a secure source of funding. The country must be willing and committed to support and sustain the new T2 center. Having a champion in the government to see that this program properly serve its customer is a key to the success of the program. Combination of funding sources with specified amount of currency can be worked out successfully providing that each funding agency is committed for the long term. To minimize the cost of doing business the amount of indirect cost or overhead cost can be alleviated by the agency managing the program. Depending on where the new center will be housed, this indirect cost can be forgiven and in other cases it might not. In developing countries, every effort must be made to eliminate the indirect cost so full benefit from all the funding assigned to the program can be gained without losing any to the indirect cost.

c. Funding from and within international organizations

The success of any technology transfer (T2) venture depends on sustainable funding. The following funding sources have been identified by several T2 centers in the USA:

❑ Federal
❑ State
❑ Local Governments (cities, counties, townships, etc.)
❑ Insurance carriers
❑ Private sector
❑ Workshop fees
❑ Higher Education institutions housing the T2 center
❑ Grants

In developing countries, resources and funding can be an obstacle and therefore international assistance can be sought through the following organizations:
❑ World Bank
❑ United Nations
❑ Agency for International Development (AID)
❑ Grants

d. Twinning with an existing T2 center

Twinning is perhaps more commonly known as an international relationship between a T2 agent in an industrialized nation and an agency in a developing one. Twinning is defined as a technical and professional relationship between an organization in a developing country and a more mature and advanced partner organization in another part of the world for the purpose of technology transfer and institutional development. Twinning of institutions can be a cost-effective way to transfer technology and strengthen organizational and management systems in agencies responsible for road administration in developing countries.

Several nations established twinning relations with LTAP centers in the USA. The number of centers in the Baltic nations, South America, Europe, Russia, and Africa exceeds the number of centers in the United States.

e. Twining with an existing Local Technical Assistance Program (LTAP) center
What is LTAP?

The Local Technical Assistance Program (LTAP) program in the United States is considered a Transportation Technology Transfer (T2) model. After its inception in the early 1980's every state established an LTAP center. To serve the needs of the tribal governments of the Native Americans additional 7 centers were established. The current number of T2 centers in the USA is 58 including the one in Puerto Rico. After watching the success of the American LTAP centers, several nations established similar LTAP centers. The number of centers in the Baltic nations, South America, Europe, Russia, and Africa exceeds the number of centers in the United States.

Most of these centers consulted with the Federal/ T2 international program to seek their support and dwell on their expertise in that field. It was early recognized that twinning a new center in other nations with a well-established center in the United States was a novel idea. This concept yielded fruits for several new centers in developing countries. The twinning between the W. Virginia LTAP center and the Czech Republic; the Minnesota LTAP center and

Russia; and the Nevada LTAP center and Costa Rica provided mutual benefits to respective centers.

The concept of twinning is not limited to an LTAP center in the USA and another one outside the USA, it could be between any two centers, one of which is well established and the other is in the developmental stage within the same country or region.

It is very important to exercise the proper protocol before setting up any final agreement between the two centers. There should be some common interest and similarity between the two centers such as climate, topography, and population distribution, whether urban or rural, etc.

f. Program development

The new T2 center staff must take the results of the need study seriously and try to develop few programs that are deemed successful. The following programs have been successfully implemented at several T2 centers:

- Training (on-line, workshops, Manuals, interactive CD's, hands-on, etc.);
- Field assistance;
- Newsletters and Technical Bulletins;
- Library containing several volumes of printed material, Video, Software, etc;
- Road Show; and
- Road Scholar and applied research.

IV. CASE STUDIES TECHNOLOGY TRANSFER AND INDICATION OF MOBILITY ENHANCEMENT IN LDC

The LTAP centers in the states of Minnesota, Virginia, Nevada, and Ohio have been successfully involved in twinning activities with other centers outside the USA. Several successful lessons were learned as a result of cooperation between a new T2 centers in a developing/less developed country and a well-established center in the Unites States. Below are highlights of these case studies and lessons learned.

- **Minnesota LTAP and Siberia T2 center**
  - There must be a commitment from top-level management.
  - An exploratory visit to each country should be conducted before entering into twinning agreements.
  - Exchanging best practices between the two nations is a mutually beneficial arrangement. Sometimes the best practice is developed at

another country, which makes this endeavor of a global nature.
- Potential international market for both nations are opened by expanding test market base for new products.
- Training and developing new specialists in specific areas are warranted.
- Cooperative research is another area of mutual interest.
- **Virginia LTAP and the Czech Republic T2 Center**
- An agreement was signed between the Virginia LTAP and the Czech Republic. The Virginia DOT and the Virginia Transportation Research council became also involved in the transportation research and operation.
- The need for a champion in each country was a key to the success of this twinning and partnership activities.
- Interested parties must make financial commitments for exchange visits.
- The agreement must be tailored to meet the needs of the new center and provide some benefits to the LTAP center.
- Long term financial commitment is essential to the sustainability of the program.
- **Nevada LTAP and Costa Rica T2 Center**
- This agreement is very informal for the time being.
- Current funding is obtained from international grants. The funds were used to conduct training activities in Costa Rica.
- Graduate students from Costa Rica attend the University of Nevada-Reno where the LTAP center is housed and admission fees are waived. Students can work in labs or help with LTAP projects and get paid.
- **Ohio LTAP and Hungarian T2 Center**
- An agreement was signed recently.
- It was early recognized that the Governor's office must be involved in the process, as special protocols had to be accommodated.
- It is envisioned that this partnership will reap mutual benefits for both parties once it is formalized and once the potential hurdles are overcome. Some of these hurdles are:
- Language barriers.
- Cultural barriers about the way business is conducted.
- Uneven commitment by both sides.
- Lack of resources at the host center.
- Lack of long-term commitment.

❑ The central government concept in developing countries vs. home rule practiced by states in the US.

There are numerous twinning activities between LTAP centers in the USA and their counterparts in Africa, the Baltic State, Eastern Europe, and Russia. There are also several discussion and plans for establishing additional twinning activities, all of which attest to the effectiveness and success of this model.

V. CONCLUSION

Technology transfer is the systematic evaluation adaptation and application of appropriate technology. At the heart of T2 is the dual vision which constantly scans and assesses new comers on the stage of technology, while keeping a sharp focus on the immediate needs of its own environment. To be effective, technology transfer as a system must receive institutional, political and economic support. Players must be committed to the concept and to creating an open technology-friendly environment. A clear mission and well-formulated strategies to achieve it must be instituted. Twinning is an effective model that enabled some developing nations to establish mentoring and professional relationships with a successful T2 center. T2 opens a window to the world of innovations, and screens out unwarranted technologies.

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