Technical Note 3

Innovative Approaches to the Application of ITS in Developing Countries

Toshiyuki Yokota
NRI

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Toshiyuki Yokota
Sr. Transport Specialist
Transport and Urban Development Department
World Bank
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Introduction

Deploying ITS in developing countries has many direct and indirect benefits for various stakeholders, including travelers, shippers, and transportation system operators. However, ITS is a new strategy for surface transportation with its own set of prerequisites. Decision makers must understand these prerequisites before setting directions for ITS introduction. Developing countries must meet the prerequisites before beginning serious deployment to maximize the probability that the introduction of ITS will be successful. These prerequisites, which are discussed in ITS Technical Note 1, are both institutional and technological in nature, and the new strategy represented by ITS goes beyond the normal boundaries of transport engineering. This has the potential to cause some confusion and additional difficulty when introducing and deploying ITS.

There are, however, some innovative approaches to help developing countries deal successfully with ITS. These approaches will make it easier to meet the necessary prerequisites and to “leapfrog” to an ITS-enabled transportation infrastructure. These innovations are not limited to technological improvement; they deal with the whole framework for planning and implementing ITS. The purpose of ITS Technical Note 3 is to describe these innovative approaches and illustrate their application in developing countries. Four approaches are identified: (1) Affordable ITS; (2) Step-by-Step approach; (3) ITS enhancing reliability and business efficiency; and (4) Public-Private Partnerships.

1. Advantages for Developing Countries in Introducing ITS

This section describes constraints and advantages for developing countries in introducing ITS.

1.1 Constraints in Developing Countries

Since the transportation system is a common element of economies the world over, many basic issues in road transportation are similar everywhere. Thus, typical transport policy goals will always include safety, efficiency, reliability, equity, and environmental friendliness. ITS can help societies achieve some of these goals.

In developing countries, these problems are further aggravated by additional constraints, including:

- An underdeveloped road network
- Severe budget restrictions
- Explosive urbanization and growth
- Lack of human and physical resources for complicated maintenance and operation
- High unemployment, coupled with less demand for automation

These constraints need to be overcome in order to provide benefits to the society as a whole.

In addition, although developing countries have additional constraints, they also have some advantages relative to the developed countries that have introduced ITS first, which can help overcome the additional constraints they face.

1.2 Latecomer’s Advantage

Developed countries went through a significant period of trial and error to get things right in ITS. Being a pioneer is always difficult and expensive (although it often proves worthwhile, as well). The introduction of ITS can be significantly easier for countries that are starting to introduce ITS now because of the following factors:

- ITS equipment and systems are now cheaper and more refined than in the past. Partly this results from the general decrease in the cost of information technology (IT). It also results from a more developed market and more experience in building ITS products and services.
- Communications technologies like cellular phones and the Internet are spreading rapidly independent of ITS. Their existence allows many kinds of ITS applications to be introduced without the need for significant investment in separate communications infrastructure.
- Developing countries are able to install ITS infrastructure at the same time that physical infrastructure is being built. This allows for far cheaper deployment than introducing ITS separately afterwards.
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• Experiences in developed countries can serve as the basis for successful ITS deployment in developing countries. This makes it easier to assess expectations realistically, both in terms of benefits and costs.

• The early adopters’ experience also makes it easier to identify the ITS services that are particularly beneficial to developing economies.

1.3 The Effect of Innovative Approaches

Given the different constraints, decision makers in developing economies need different approaches to deploy ITS. Fortunately, the latecomers’ advantage makes it easier to find such approaches, some of which may be better than the traditional approaches.

One advantage is that many developing countries have well-developed communications infrastructures. This communications environment can make ITS introduction much easier in relation to a return on investment and minimizing the cost of introducing the necessary communication infrastructure for ITS.

Another issue is planning. In the USA, Japan, and Europe, ITS deployment was considered to require an extensive planning process, guided by a whole range of services thought out in advance in the form of a comprehensive and detailed architecture system. The general consensus, however, is gradually moving away from such large-scale approaches. The whole process can be expedited by using the “Step-by-Step” planning method described in ITS Technical Note 5.

The overall effects of these innovative approaches are summarized in Figure 2. The left side of the figure represents the traditional approach, where the scope of ITS was narrower and everything had to be managed within ITS itself. The introduction process took longer (represented by the vertical height). With the innovative approaches (depicted on the right side), the scope has widened, but faster deployment is also possible (represented by the shorter vertical height), even with the additional burdens of staff training, for instance.

Although the necessary resources required for staff training will increase with the introduction of the cross-functional approaches like ITS, total lead time for the introduction process will be shortened.

Figure 1 Paths of Road Infrastructure Development

Figure 2 Expanded Choice Range of ITS Applications and Simplified ITS Introduction Process

2 Innovative Approaches

This section describes four innovative approaches for deploying ITS in developing countries, namely:

• Affordable ITS,
• Step by Step approach,
• ITS enhancing reliability and business efficiency, and
• Public Private Partnerships.

While these approaches are also applicable to ITS deployment in developed countries, the relative benefit is greater in developing countries, because of their starting point and limited resources. This section explains these four approaches together with a discussion on good practices.

2.1 Affordable ITS: Use of Existing Infrastructure

"Affordable ITS” refers to the ITS services and applications that can be adopted at low cost, by leveraging existing IT infrastructures such as the Internet and the cellular phone system. By stressing affordable ITS, decision makers in developing economies can focus on the ITS application that can (1) be deployed immediately or in the near future, and (2) provide the greatest return on investment, in terms of lives and money saved, and improved services.

General purpose IT environments, such as mobile phone networks and the Internet, have seen spectacular growth and a corresponding reduction in cost. In many cases, they have reached a level sufficient to substitute for the dedicated, wired communication networks that have been traditionally used for ITS deployment. Other general-purpose resources, such as Geographic Information Systems (GIS), Global Navigation Satellite Systems (GNSS), and Global Positioning Systems (GPS) can also be harnessed. The innovative use of these resources provides a promising and cost-effective way to deploy ITS both by the public and the private sectors.

For example, some automobile manufacturers have introduced automatic crash notification (ACN) systems in their vehicles to increase their attractiveness. When the airbags activate, an on-board cell phone automatically calls the emergency center and provides relevant authorities with the exact location of the crash, the name of the vehicle owner, and other registration information. The driver can also talk directly to the emergency center through an installed cell phone. Some manufacturers offer this capability as a standard feature, with free service for the first year.

End users also benefit from the use of existing communications capabilities. This kind of affordable ITS allows people to use existing and familiar devices to interact with ITS applications, and avoids cluttering the automobile interior with additional and unfamiliar gadgets.

Equally important, ITS can play an important role in increasing the efficiency and utilization of these communications infrastructures, thereby improving the long-term return on investment for these resources.

There are many good examples of the use of Affordable ITS as follows:

Innovative Development Practice 1: Road Conditions Monitoring System with GSM

Many parts of Eastern Europe have harsh climates, with hot summers and cold, snowy winters. Road managers require real-time information about road surface conditions so that action can be taken to ensure safe conditions when roads are snow-covered or icy. Detection systems have been deployed in some areas for use in road management.

The trunk road linking Bucharest and Brasov in Romania, for example, has sensors at several points to measure road surface temperature and nearby air temperature. The data is relayed to a control center through the GSM cellular network so that appropriate maintenance vehicles can be dispatched at the right time (figure 3). The system helps cut the cost of anti-icing agents and vehicle dispatch.

The use of the GSM network contributes to lower development cost. Although the functions are basic and simple, their ability to provide the necessary information is adequate for the problem at hand.

Innovative Development Practice 2: Use of Mobile Phones for Incident Response

The Brazilian Association of Highway Concessionaires (ABCR) has introduced an emergency system that sends information on the condition of injury victims, from digital cameras in the ambulance to the hospital, over the Internet. This allows the medical staff to instruct the ambulance paramedics on what to do, and it also gives the hospital more time to prepare appropriately for the incoming patient (figure 4).
Innovative Development Practice 3: Road Traffic Information

The recent spread of GSM cellular telephones in East Asia has led to the use of the Short Message Service (SMS) as a medium to provide road traffic information for cellular phone users (figure 5).

Innovative Development Practice 4: Information Collection and Delivery Systems That Rely on People

ITS is usually considered to be about automation. However, systems for the collection and dissemination of information are underdeveloped in developing countries. Basic data such as traffic conditions is often not available. In these cases, pedestrians and drivers equipped with mobile phones can become virtual "probe-persons" for the collection and dissemination of traffic information.

For example, in Bangkok (Thailand), a private radio station operates a traffic information service that compiles traffic information from 200,000 listener members. Information from listeners is collated and broadcast. Also in Bangkok, traffic managers use images from CCTV cameras installed on toll roads to evaluate the traffic situation and enter VMS messages manually.

This combination of human effort with widely available technologies, such as mobile phones, has made basic ITS applications possible in these areas.
than creating one’s own architecture from scratch. Picking the necessary services and modules from an existing comprehensive architecture can create an architecture that is suitable for the region or country. The second is to start by developing a simple architecture, reviewing it from time to time, and allowing it to evolve step by step. The base architecture should be chosen with the aim of future interoperability with surrounding regions/countries. This process is described in more detail in ITS Technical Note 5.

There are several examples of the beneficial use of step-by-step approach:

Innovative Development Practice 5: Simultaneous Construction of ITS Systems

Introducing ITS in parallel with the construction of road infrastructure greatly helps to decrease the cost of ITS deployment. During the construction of the Lihna Amarela (Brazil, 22km in length), an automatic toll collection system, changeable signboards, systems for measuring traffic volume and vehicle types, and monitoring cameras were introduced (figure 7). The automatic collection system covers two of the 20 lanes.

Innovative Development Practice 6: Step-by-Step Architecture

In order to develop its own ITS architecture, South Africa is planning to use an existing architecture as its starting point, selecting the necessary parts and then allowing the architecture to evolve. The base architecture will be chosen so that there will be sufficient commonality with surrounding regions/countries to assure future interoperability.

2.3 ITS Enhancing Reliability and Business Efficiency

This type of ITS refers to selecting and introducing projects based on their ability to enhance the transportation system’s reliability and general value to users and operators (see ITS Technical Note 1). Such ITS enhanced reliability and business efficiency helps people to be more efficient and helps make travel more comfortable, more productive, and more reliable.

ITS can reduce travel uncertainty. One unfortunate aspect of most current transportation system is that travel time, both for people and freight, can vary widely from day to day, case by case. This uncertainty means that travelers and shippers must allow extra time for worst-case possibilities or risk being late at least some of the time. ITS can help eliminate the causes of uncertainty. But even if these causes remain, ITS can provide information to help people understand the situation better and plan accordingly. ITS can provide better real-time and/or predictive information that allows travelers and shippers and carriers to better plan trips.

ITS can increase security. ITS can improve the security of the transportation system and the security of cargo and people in transit. ITS can monitor the contents and locations of containers, as well as the cargo and routes taken by carriers. Likewise, ITS can track the location and status of public transport vehicles, and generally support, simplify, and increase the visibility of transport logistics. As the volume of cross-border cargo movement increases, enhanced security becomes even more important. In addition, increased security measures, if carefully created, can improve efficiency and productivity of shippers and carriers by standardizing and integrating the process for managing information about the transportation of people and cargo.

The public recognizes that more reliable travel planning and greater travel security have significant value. However, it may not always be easy for decision makers to justify the cost of introducing this type of ITS because: 1) the benefits of this type of ITS may be difficult to translate into traditional economic value; 2) in some cases this type of ITS has commercial appeal and should be introduced by private sector organizations.

![Figure 7 Simultaneous Implementation of ITS with Road Construction](image-url)
By its nature, this type of ITS may not necessarily produce nationally or internationally interoperable systems, since its deployment tends to be local and modest in scope. Nonetheless, the relative ease of introduction and modest cost makes it an important part of an overall ITS program. In addition, it helps provide the technical and economic foundation for providing ITS society-wide benefit (see ITS Technical Note 1). For example, if an individual traveler is attracted to wireless entertainment and information products, his/her purchases will contribute to the development of a communications infrastructure that can also support safety and traffic management applications.

There are several good examples of ITS enhancing reliability and business efficiency:

**Innovative Development Practice 7: Public Transport and Cargo Monitoring System**

Public transport is an important part of the transportation system in many developing countries. In some countries, the increase in privately-owned automobiles has lowered public transport ridership and revenues, which has led to a vicious cycle of poor service and lower usage. It is sometimes possible to break this cycle through the innovative use of ITS, increasing service levels and lowering maintenance costs.

For example, in Ploiesti (Romania), antennas and onboard units have been installed on buses on certain routes. Location information acquired by GPS is transmitted by GSM to the operating center. The data is processed by a standard PC, which sends arrival time forecasts to users. This system also helps promptly detect bus problems. Real-time information on vehicle location and status enables the operator to identify schedule deviations and to reschedule dynamically. The system monitors loading passengers, engine management systems, tire pressure, etc. The service also supports multimodal scheduling and planning systems.

This case illustrates two important points:

1) People find it valuable to be informed of expected arrival times through bus location systems. This system would not necessarily improve the average waiting time, but it improves the credibility and accountability of the public transport operations.

2) The system takes advantage of the existing IT infrastructure, such as GPS and GSM, to introduce ITS solutions economically.

Similar systems have been deployed for commercial fleet management. Fleet management requires tracking vehicles and cargo. Off-the-shelf products make it easy to develop such systems in developing countries. These services use Automatic Vehicle Location (AVL) and vehicle-to-control-center communications to provide vehicle location and other status information to fleet operators. These services also make good use of dynamic dispatching systems to improve the efficiency of the fleet management process. The system may also support logistics and freight management.

**2.4 Public-Private Partnerships**

Public-private partnership is another important innovative approach in the road sector. Many ITS projects have been carried out through public-private partnerships in both developed and developing countries. There are many good reasons for forming such partnerships:

1) Each sector does the part of the work it is best at. One example is cooperative vehicle-infrastructure systems, which are being explored in several developed countries. The public sector focuses on the infrastructure part of the work, and the private sector focuses on the vehicle part.

2) Some of the risks involved in developing new systems can more easily be borne by the private sector (e.g., market risks) and some of the risks can more easily be handled by the public sector.

3) ITS is a field that requires continuous development of technologies. People from different disciplines can bring different ideas to the table, which helps produce innovation. Especially in the case of ITS, the system itself is a hybrid of information technology and various traffic technology. Breakthroughs may occur by putting together cross-functional teams to tackle old issues.

4) The main innovation in the new ITS approach lies in thinking about ITS as an open field, rather than a closed dedicated discipline. Promising hybrids include transport/computers, and transport/communications. In addition, the cooperation between government, industry and academia may provide an interesting breeding ground for innovative ideas.

One common model for public-private cooperation in infrastructure development and operation is called BOT (Build, Operate, Transfer). In this model, private companies bear the cost of building infrastructure. The public sector provides access to rights of way and other support. The companies own and operate the infrastructure, collecting tolls or usage fees. Once the investment has been recouped,
the facility is transferred to the public sector for continuing operation.

Other potential areas that have proven successful for public-private partnerships include:

- Road asset management and maintenance through public sector concessions to private companies
- Cooperative efforts to gather, assemble, and distribute traveler information
- Private sector participation in the administration and execution of wide-area road pricing
- Public encouragement of the freight hauling industry in countries where the industry is not well developed

There are several good examples of successful public-private partnership:

Innovative Development Practice 8: Road Design and Maintenance Management by Private Companies

Electronic toll collection (ETC) systems are among the most popular and common ITS applications in developing economies, since ETC systems generate revenue and help pay for themselves, often very quickly. In many developing countries, private firms build toll roads under a concession agreement with the public authorities based on BOT. In order to recover their investment as quickly as possible, private operators turn to ETC.

For example, in the Philippines, BOT operators have deployed an ETC system called “E-Pass” on the Skyway Road and South Luzon Road. ETC systems using an IC card and road-vehicle communications have been deployed in Thailand and Malaysia.

3 Summary

Traffic problems in developing economies are growing rapidly, especially in urban areas, becoming a serious obstacle to sustainable growth. However, a variety of innovative approaches can help yield rational solutions for policy makers.

Four concepts were presented in this Note:

- **Affordable ITS** is a strategy to deploy ITS inexpensively by leveraging the existing IT infrastructure.
- **Step-by-Step Approach** is a methodology to develop ITS in a systematic and incremental manner.
- **ITS Enhancing Reliability and Business Efficiency** is the process of identifying and introducing ITS projects based on the immediate benefits to users and operators of the transportation system.
- **Public-Private Partnerships** is the process of leveraging the strengths of both public and private sector interests through cooperative arrangements.

These innovative approaches have already proven successful in many cases in developing countries. And, as these cases indicate, policy makers can integrate these innovative approaches to yield much better results. Innovative approaches require extensive collaboration among various parties such as the public and private sectors, civil engineers and information specialists, domestic project teams, and multi-national institutions. Consequently, policy makers should play an important role not only as planners and decision makers, but also as coordinators for these cross-functional project teams.

The innovative application of ITS that we have described suggests several policy recommendations for developing countries that aim to introduce ITS, as well as developed economies that aim to achieve higher efficiency:

1) **Provide Incentives for Private Sector ITS Development**

It has been proven over and over that the main thrust of innovation comes from market-led competition. Therefore, the private sector is the natural place for many innovative ITS applications to be developed, deployed, and operated. However, a young industry like ITS may be perceived as too costly and risky.

Therefore, it is appropriate for governments to encourage participation of private businesses to enter the ITS industry, especially in areas where private sector ITS applications can help achieve social goals (e.g., reduced pollution and congestion). Some of the ways that government can do this include being an early adopter of ITS, and providing better information on the field.

2) **Promote Joint Efforts between Various Areas and Organizations**

People from different disciplines will often bring different ideas to the table, which is likely to lead to innovation, especially in the case of ITS since the system itself is a hybrid...
of information technology and various traffic technologies. Breakthroughs may occur by putting together different people to tackle an old issue. As mentioned before, primary innovation in the new ITS approach lies in thinking about ITS as a open, dynamic field, rather than a closed dedicated discipline. Promising hybrids may include transport and computers, and transport and communications. Also, the cooperation between the government, industry and academia may provide interesting breeding grounds for future innovative ideas. This can be enhanced by the formation of an ITS promotion organization to provide a focal point for various players in terms of information and coordination.

3) General Promotion of ITS

Also, it is important to promote ITS to ensure an expanding market to operate in. Social and organizational issues need to be addressed for this purpose. The need for constant system updates, maintenance and training needs to be stressed. Institutional arrangements that support the effective deployment of ITS are needed and decision makers have to identify promising approaches and the issues that accompany them.