ITS Toolkit

tools and options for reforming public transport intelligent transport systems

COMPANION GUIDE

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TOOLKIT CREDITS
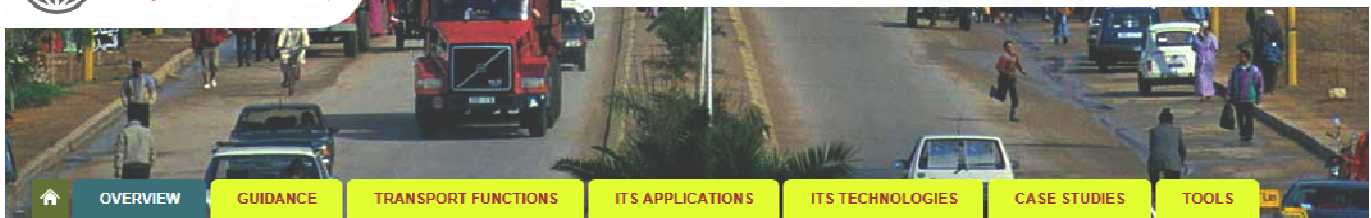
FOREWORD

Welcome to the **Passenger Transport ITS Toolkit**!

The **Passenger Transport ITS Toolkit** is part of a comprehensive library of reference and capacity building resources that have been prepared by the World Bank for policymakers and senior technical managers in urban transport. The **Passenger Transport ITS Toolkit** is part of a public transport Toolkit suite that includes the **Urban Bus Toolkit** and the **Public Transport Fares Toolkit**.

The objective of the Toolkit is to provide a basic understanding of all aspects of Intelligent Transport Systems (ITS) for urban passenger transport. The Toolkit is a step-by-step guide that helps urban transport managers and leaders plan, design, and implement ITS that can improve the efficiency and attractiveness of the passenger transport systems in their cities.

The Toolkit provides key information that will help leaders and managers understand:

- The basic characteristics of ITS
- How to:
  - Assess the need for potential ITS applications through careful evaluation of public transport planning, management, and operations functions
  - Identify ITS system inputs, outputs, information processing, communications, and system architecture requirements
  - Estimate initial ITS implementation and ongoing operating and maintenance costs, and
  - Estimate potential ITS benefits

The target users for the Toolkit are policy and investment decision makers in cities considering whether to introduce or enhance ITS applications for urban passenger transport.

The focus of the Toolkit is on public transport. It does not address the full domain of ITS applications for other transport modes such as the private car or freight transport.

The applications covered in the Toolkit are based on an initial needs assessment of the functions that are applicable to the planning, delivery and use of public transport systems. Issues related to fare collection systems are covered in greater depth in **Public Transport Fares Toolkit**.

The Toolkit is based on field research conducted in 2011 and represents general international practice at that time. However, ITS is a constantly developing sector, both in its applications and its technologies. The interested reader should examine the latest developments through links to live sites that are provided in the website part of this Toolkit.

There is also a wide range of suppliers of the applications and technologies. Each has their own website where more information can be found.

The **Passenger Transport ITS** Toolkit consists of two parts:

1. This short **Companion Guide** which provides a brief introduction to the Toolkit, the materials it contains (Main Content), and instructions for the use of the website (Using the Toolkit); and
2. A **website** which provides detailed information for the policy maker and the system operator. There are two versions of the website: 1) On-line that is accessible from anywhere with an Internet connection; and 2) CD ROM that comes with the Toolkit and can be used when no Internet connection is available.

What is ITS?

Intelligent Transport Systems (ITS) are a suite of public transport planning, operations management and customer service applications that use advanced information and communications technologies to improve the efficiency and effectiveness of specific functions. They enhance the effectiveness, efficiency, and usability of public transport services and benefit passengers, operators, and public transport authorities.

ITS involve customized, situation-specific applications that address specific functions. The applications use multiple data sources, mostly in real time, to make improvements. The main application areas in conventional fixed route, fixed schedule urban passenger transport are:

- Operations management
- Driver aids fare collection
- Traveller information
- Traffic management
- Security

ITS can be used to support other public transport planning and business process functions for conventional public transport. They can also be used to support the unique needs of operators and users of demand-responsive public transport.

ITS are comprised of a number of sub-systems and technologies, many of which support more than one application. For example, Area Traffic Control (ATC) "smart" traffic signal systems can provide support to both public transport priority and automatic vehicle location applications.
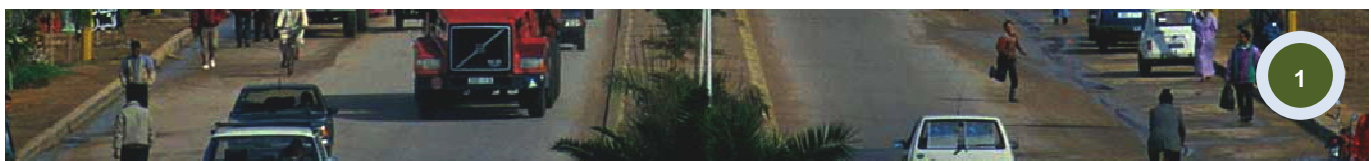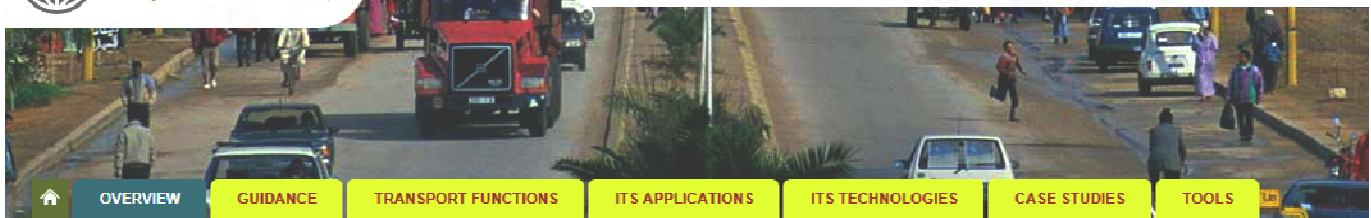
MAIN CONTENT

You are here: Overview »

- Technical requirements
- How to use the Toolkit
- Layout of the Toolkit
- Credits and acknowledgements
- Site map

Layout of the Toolkit

The Toolkit website is comprised of four progressive layers that are accessed through tabs on the website screen:

OVERVIEW | GUIDANCE | TRANSPORT FUNCTIONS | ITS APPLICATIONS | ITS TECHNOLOGIES | CASE STUDIES | TOOLS

- **Guidance**. The step-by-step process that should be followed for the planning, design, implementation, and evaluation of the proposed ITS system.
- **Transport Functions**. The public transport planning, operations management and customer service activities that can be supported by ITS systems. They are considered at the strategic, tactical, operational, support, and statistical levels.
- **ITS Applications**. The use of ITS for public transport functions. These functions are grouped into the following categories: operations management; driver aids; fare collection; traveler information; traffic management; security; demand responsive transport; and ITS-facilitated Functions.
- **ITS Technologies**. The technical systems and hardware required by the ITS applications. These applications are grouped in to the categories: automatic vehicle location; driver's console; operations control center; driver monitoring; vehicle monitoring; in-vehicle data hub and processor; electronic fare collection; travel information displays; surveillance equipment; vehicle identification; and communications.

This summary provides a basic understanding of each of the four subject layers. It provides an overview of the activities that need to be considered, and the principal options that have been identified in international practice.

The organization of public transport and terms used to describe the organization varies throughout the world. For the purposes of this Toolkit, the following definitions are used:

- An **authority** is defined as the public entity involved in the strategic planning, investment decision-making and

regulatory oversight of public transport in the respective metropolitan area or city.
- The **operator** is defined as the entity, public or privately held, that actually delivers the public transport services.

Toolkit Suggestions for Different Users

The Toolkit can be entered in a number of ways, depending on user needs and the purpose of the visit. The following suggestions are made for decision makers, transport managers, and technical task managers.

Policy and decision makers

Policy and investment decision makers in local governments or transport authorities, transport executives, transport regulators, and transport operators should enter the Toolkit at the **Planning** level of the **Guidance** section. At the planning level, they then can go to the relevant areas of **Transport Functions, ITS Applications,** and **ITS Technologies** that relate to the problems that they want to solve in their cities. They may also go to specific **Case Studies** in which the applications have been implemented. This approach will give them the necessary information that will help them prepare good functional specifications.

Transport managers

Managers of the relevant transport bodies charged with designing and developing the selected ITS application(s) should enter the Toolkit at the **Design** level of the **Guidance** section. They then can go to the areas of **ITS Applications**, **ITS Technologies**, and **Case Studies** that relate to these specific applications. This approach will give them the necessary information that will help them direct the preparation of good technical specifications and procurement documentation.

They should also review the **Evaluation** portion of the **Guidance** section. This will help them prepare an evaluation plan for ITS implementation.

Technical task managers

Technical managers charged with the procurement, installation, and implementation of the specified ITS application(s) should enter the Toolkit at the **Implementation** level of the **Guidance** section. They should also go to the portions of the **ITS Applications**, **ITS Technologies**, and **Case Studies** that are relevant to their specified applications. They often are working with external consultants and contractors with detailed knowledge of the subject. They need their own independent resource to inform themselves and, thereby, become good task managers.
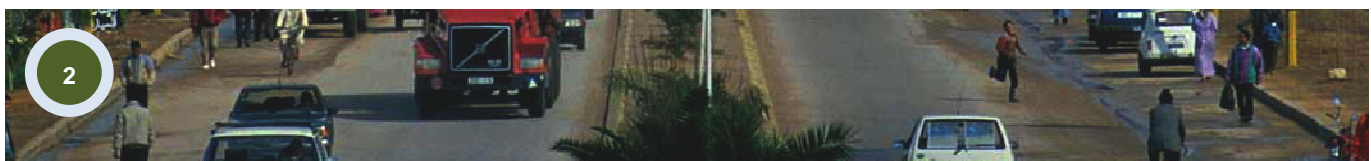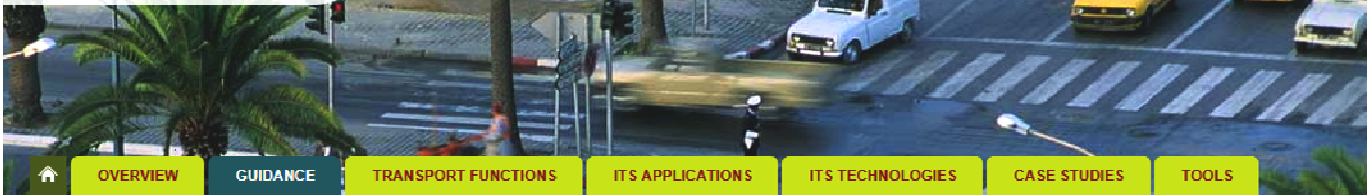
Guidance

You are here: Guidance »

- ▸ Planning
- ▸ Design
- ▸ Implementation
- ▸ Evaluation

A wide range of international experience has shown that there is far more to ITS than just purchasing and installing equipment. In almost all cases, ITS involves significant change in the business processes of transport operators, and the services offered to the customers.

The design of any ITS systems should respond to clearly-stated needs of the transport authority and/or operator. All of the key policy-makers and senior managers of the organisation should be involved, especially in project formulation.

The guidance provides a step-by-step guide to an ITS project, from initial goal-setting and planning, through detail design and procurement, to implementation and getting best use from the investment. It details the actions to take, and provides both advice and caution based on a wide range of international experience.

This guidance is structured according to the three main phases of an ITS deployment project, plus the often-forgotten fourth phase (Evaluation):

1. Planning
2. Design
3. Implementation
4. Evaluation

A total of 19 key issues are addressed in these four phases. A separate webpage is devoted to each issue.

The **Guidance** section of the Toolkit does not discuss the technical aspects of ITS. The technical information is presented in the **Transport Applications** and the **ITS Technologies** sections of the Toolkit. Many practical aspects are presented in the **Case Studies**.

If you are relatively new to the ITS domain, it is recommended that you read the four "high-level" pages devoted to planning, design, implementation, and evaluation. This will provide you with a good overview of the four phases, the 19 key issues, and the "end-to-end" process from planning to evaluation.

Once you are familiar with the subject, you can proceed to the individual issue pages. These provide extensive guidance on each of the 19 key issues.

Planning

The planning phase is a structured process to determine what the ITS is required to do, and how this fits within the broader corporate service, operations and management strategy. The following five planning issues are addressed in the Toolkit:

- What's your goal for ITS?
- What approach to take?
- Is ITS the right route?
- What must the system do?
- What type of ITS applications?

Design

The design phase covers all aspects of the detailed technical design and how ITS will be integrated into the organization. At the end of the design phase, all technical issues should be fully determined. The following seven design issues are considered in the Toolkit:

- What technology will it need?
- What platform will it need?
- What data will it need?
- What other resources will it need?
- What else can technology, data, and resources be used for?
- How will the business processes need to change to take full advantage?
- What will be the total cost?

Implementation

The implementation phase covers all aspects of delivering a fully-functioning system. This includes procurement, testing, installation, configuration, commissioning, training, and commencing operations. The following four implementation issues are discussed in the Toolkit:

- Supply the needed system
- Install the system in the respective working environment
- Deploy the system
- Make good use of the system
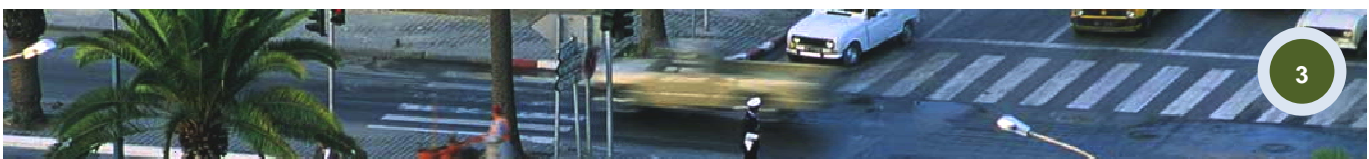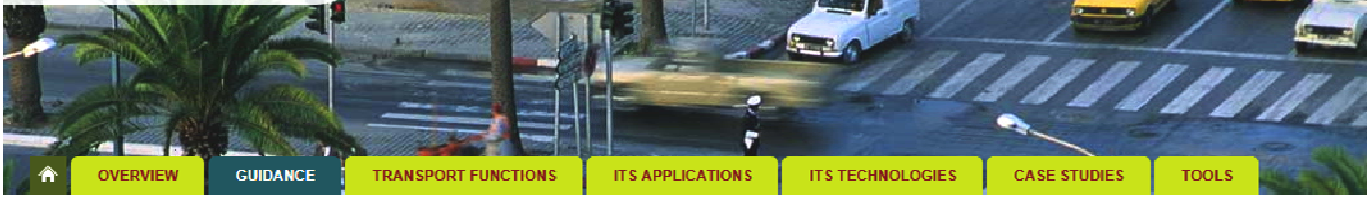
Evaluation

The post-implementation evaluation phase can help the transport authority and/or operator to determine what value has been received from their investment, whether it meets or exceeds the original expectations, and whether more can or should be achieved. Evaluation can help stakeholders: 1) identify aspects that are underperforming compared to expectations, and 2) target measures for improvement. It also may provide valuable feedback for future investments and their design.

The following three evaluation issues are reviewed in the Toolkit:

- Pre-implementation criteria
- Post-implementation and monitoring
- Evaluation
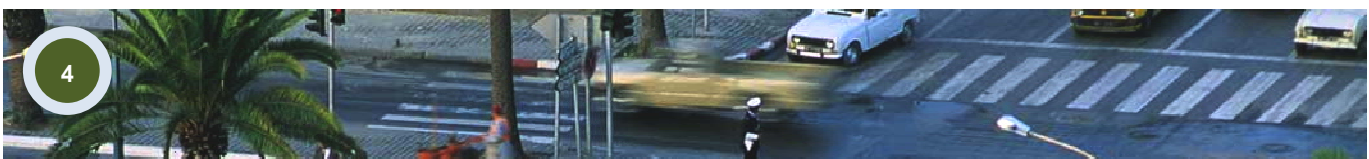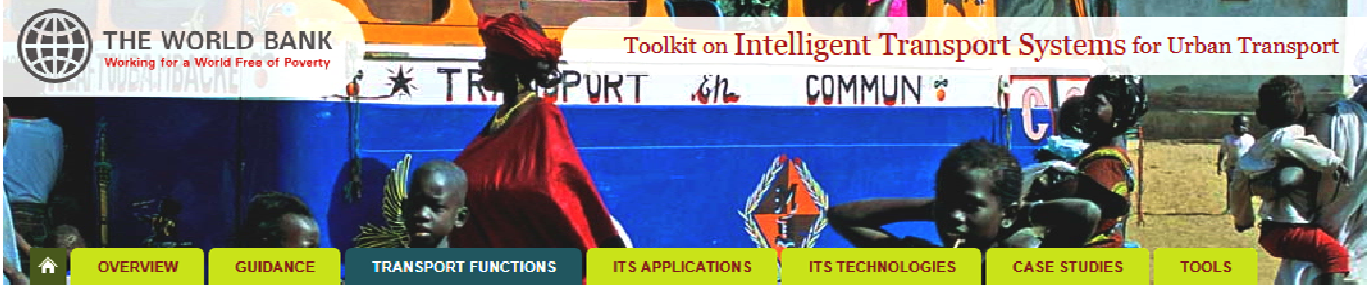
Public Transport Functions

You are here: Transport Functions »

- ▸ Strategic Context Level
- ▸ Tactical Planning Level
- ▸ Service Delivery Level
- ▸ General Support Level
- ▸ Statistical Analysis Level

The planning of any ITS program should respond to clearly-stated needs of the transport authority and/or operator. All of the key policy-makers and senior managers of the transport organisation should be involved at every stage of ITS development, but especially at the project formulation stage.

The transport functions section in the Toolkit is designed to help stakeholders: 1) identify the priority areas for the development of their urban passenger transport system, and 2) determine if there are ITS applications that address these areas.

You need to read this section of the Toolkit if you wish to analyze the performance of your passenger transport system, and identify which ITS applications could be implemented to improve it. If you already know which ITS applications are of interest to you, you should go directly to the **Applications** section of the Toolkit.

The transport functions have been organized into five levels:

- Strategic context
- Tactical planning
- Service delivery
- General support; and
- Statistical analysis

The potential role and appropriate applications of ITS are identified for each level. In addition, the advantages and cautions related to implementing and using the ITS applications are presented.

The functional model represents every aspect of the planning and operation of an urban passenger transport system. However, not all aspects are applicable to each city since they depend on the institutional framework and the role of the public and private sectors. Also, when para-transit services are operated, many of the functions are not formalized, but are carried out in an ad hoc manner not amenable to an ITS program.

Strategic context

The strategic context concerns policy decisions made about the nature of public transport provision within an urban area – its goals, targets, and constraints. Generally policy decisions are made over extended time intervals and often reflect changes in the political administration of a city.

The following seven strategic functions and potential ITS applications for the functions are described in the Toolkit:

- Planning context
- General service characteristics
- Public transport funding and cost recovery
- Economic regulation
- Role of public and private sectors
- Institutional framework
- Privatization of public transport

Tactical planning

Tactical planning addresses decisions about the specification of the transport service network and its user interface. It covers issues such as network definition; routes; interchanges; service timetables; vehicle types; fare collection systems; and external communications. The transport service networks for both the general public and for special-needs individuals (demand responsive services) are addressed in tactical planning.

Tactical decisions are made within the context of the strategic goals that have been set. Generally policy decisions are made over extended time intervals, but are subject to regular review and amendment as a city grows.

The following five tactical planning functions and their related potential ITS applications are described and assessed in the Toolkit:

- Network and modal planning
- Service planning and specification
- Service contracting and management
- Fares policy and practice
- External communications

Service delivery

This functional category covers the operational and user interface aspects of service delivery. These functions range from the rostering of buses and crews to the management of service delivery, fare collection, and the provision of traveler information. Most functions are performed daily.

Service delivery functions are undertaken by all public transport operators, whether in the formal or para-transit sectors. The systems used vary from the sophisticated to the ad hoc depending on the sector (formal or informal), operator size, and structure.

The following eight service delivery functions and their related potential ITS applications are reviewed in the Toolkit:

- Vehicle and crew scheduling
- Preparation of vehicles for duty
- Performance of service delivery
- Control of service delivery
- Management of incidents
- Fares collection
- Traveler information
- Security and customer services

There are a large number of service delivery functions. The following 13 service delivery functions and their related potential ITS applications are presented in the Toolkit:
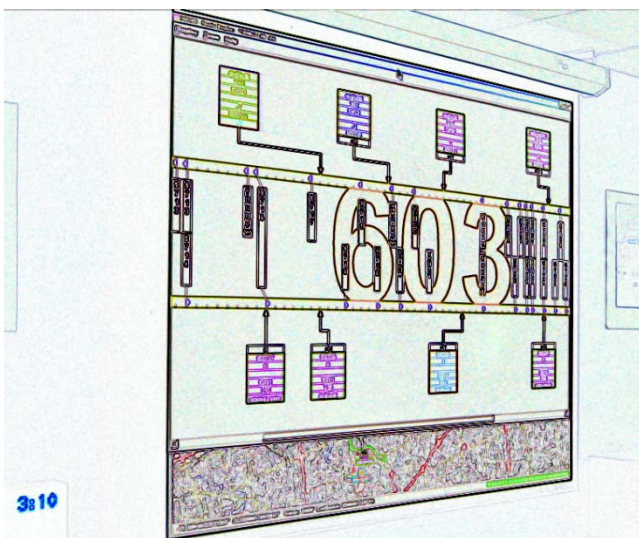
- Traffic and demand management
- Public transport priorities
- Operations control center
- Systems payment management
- Vehicle maintenance
- Inventory management
- Fleet renewal
- Environmental program
- Infrastructure maintenance
- Operator enterprise management
- Operator collective management
- Human resource and development
- ICT and ITS system support

Statistical analysis

This functional area involves the use of the data generated by the various transport functions to support management information systems and business process improvements. The challenge is integrate a wide range of systems and technologies so that they can work together effectively.

The Toolkit describes the following four statistical analysis functions and their related potential ITS applications:

- Legal and service compliance
- Financial accounting and reporting
- Consumption monitoring
- Incident analysis

General support

A range of functions are needed to support the delivery of public transport services. These include traffic and operations control; management of payment systems; fleet (and facility) asset management and environmental programs; infrastructure maintenance; and the management of operating entities and systems. These functions are performed on a regular schedule, sometimes daily.

Many of these functions are performed by an integrated public transport enterprise, while others are done by a passenger transport authority. Some might not be provided at all when there is no transport authority or equivalent city institution in place. However, virtually all of the functions are sub-contracted within a para-transit operated system.
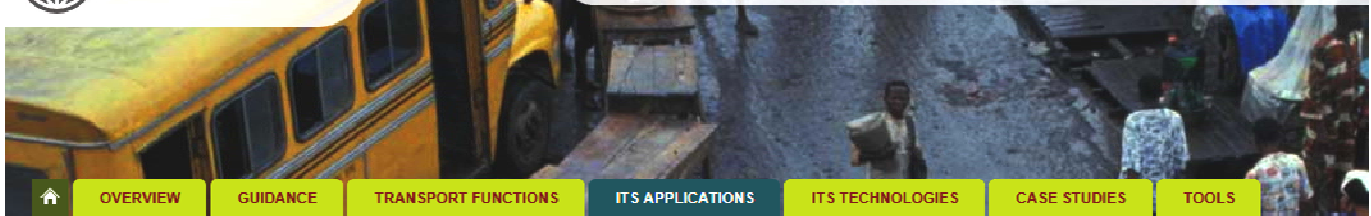
ITS Applications

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- ▸ Operations Management
- ▸ Driver Aids
- ▸ Fare Collection
- ▸ Traveller Information
- ▸ Traffic Management
- ▸ Security
- ▸ Demand Responsive Transport
- ▸ ITS-facilitated Functions

The Toolkit considers ITS from two related perspectives:

- **ITS Applications**. These are the functional aspects of the ITS systems.
- **ITS Technologies**. These are the specific devices, software, and platform tools used to deliver the ITS application.

The **ITS Applications** section describes **what** the ITS does and **how** it does it. From this perspective, technologies are simply a means of achieving the Application. As far as the application is concerned, specific technologies are interchangeable, and could be replaced over the application's lifetime.

ITS applications have far more in common from one location to another than the ITS technologies do. Although a low-technology approach may not support all of the functionality of its higher-technology counterpart, the principles, broad functions, mode of use, and data may be quite comparable.

Further, the supporting technologies may evolve over time and increase the functionality of an ITS application. ITS applications have a much greater degree of permanence over time than do ITS technologies, which are in a state of continual change.

The **ITS Applications** section presents the main ITS applications that are currently in use in urban public transport. The focus is on ITS used for bus, although many of the applications are also used by tram and urban rail systems. Many of the ITS applications are readily usable by the para-transit sector, however, the use of ITS in this sector is virtually non-existent.

A total of 41 ITS applications are presented in the Toolkit. They are organized into seven clusters:

- Operations management
- Driver aids
- Fare collection
- Traveler information
- Traffic management
- Security
- Demand responsive transport

An additional cluster covers ITS-related applications. These are applications which are not usually categorized as ITS, but which can receive much of their input data from the ITS systems and, in some cases, provide data which the ITS systems need. These applications cover resource planning and management, service performance, and administration, MIS and audit.

Each of the 41 applications is presented on its own page and is described from three perspectives:

- Objectives and functionality
- Technologies, data, and resource required to deliver the Application
- Benefits and cautions related to the Application

The material draws mostly on current practice within the urban passenger transport sector. The description of each application also indicates the **Case Studies** where the application is active. For some, additional relevant cities are identified. Where available, web-links are provided to relevant reports and other resources.

Operations management

Operations management applications help operators identify where their vehicles are positioned at any given time, both in terms of actual location and relative to their scheduled location. Dispatchers can use this information to monitor the service performance. They can intervene to ensure that the planned service is performed, and to respond to disruptions or incidents.

The data generated by the operations management applications are used extensively for post-event analysis. The operator uses the information to fine-tune the planned service, and to monitor driver performance. The authority uses the information to monitor service performance and service contract compliance.

The following seven operations management applications are described in the Toolkit:

- Automatic vehicle location monitoring
- Route performance monitoring
- Schedule adherence support
- Service contract compliance
- Driving-standards compliance
- Emergency/incident management
- Dynamic rescheduling
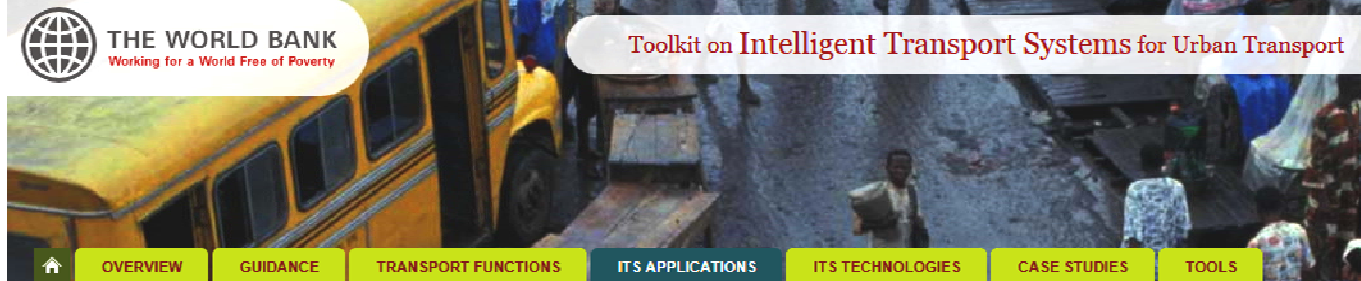
Driver aids

Driver aids applications support the bus driver in the performance of increasingly complex driving tasks. They cover three main roles for the driver:

- Performing the scheduled service
- Performing the driving task effectively and
- Safely managing the vehicles and the passengers

The following seven driver aids applications are described in the Toolkit:

- Schedule adherence support
- Collision warning and avoidance
- Precision docking
- Economic driving assistance
- Vehicle condition monitoring
- Passenger surveillance

Fare collection

Fare collection has a special significance in urban public transportation for four key reasons:

- The fare collection system must effectively manage a wide range of fare products that are tailored to different market segments.
- In cities with multiple transport providers, fare collection systems must manage the different products, handle tickets issued by different providers, charge the correct fare, and allocated funds across participating operators.
- The fare collection process impacts dwell times at bus stops and, hence, operational efficiency and costs.
- The high volume of transactions in an unprotected environment is highly vulnerable to fraud and evasion.

The following six fare collection applications are described in the Toolkit. The companion **Public Transport Fares Toolkit** deals with the issues and technologies in greater detail.

- Travel sales and payment
- Fare calculation and charging
- Travel authorisation and evidence
- Interchange/transfer authority
- Interchange/transfer rebate
- Revenue accounting and distribution

Traveller information

Operators have long provided a wide range of information such as timetables, signs information at bus stops and terminals, and information call centres. The core principle of ITS-supported traveler information is that information is provided "anytime, anywhere". ITS applications extend the provision of traditional information in three main ways:

- Electronic information channels, including internet and personal mobile devices
- Real-time information
- Computer-assisted information searches

The following nine traveler information applications are presented in the Toolkit.

- Traveler information on PC/Internet
- Traveler information on phones/PDAs
- Real-time information at stations/terminals
- Real-time information at bus-stops
- Real-time information in vehicles
- Vehicle-stop announcement
- Dynamic journey planners
- Alert services
- Emergency/incident advice

Traffic management

ITS can help bus services as they operate in difficult traffic conditions. The most common application is to provide priority for bus services at traffic signals and give the bus a green light at the earliest safe opportunity. This can improve both the journey time and the reliability of the bus services.

ITS can also be used to allow bus service selective access to restricted zones. It also can help enforce against violations of bus-only facilities by general traffic.

The following four traffic management applications are discussed in the Toolkit:

- Traffic signal priority
- Access control
- Interface with adaptive traffic control systems
- Public transport lane/facility violation monitoring

Security

Video cameras are the primary form of ITS security assistance to public transport operators. Cameras have improved significantly in recent years. They now provide higher resolution and are miniaturised while being offered
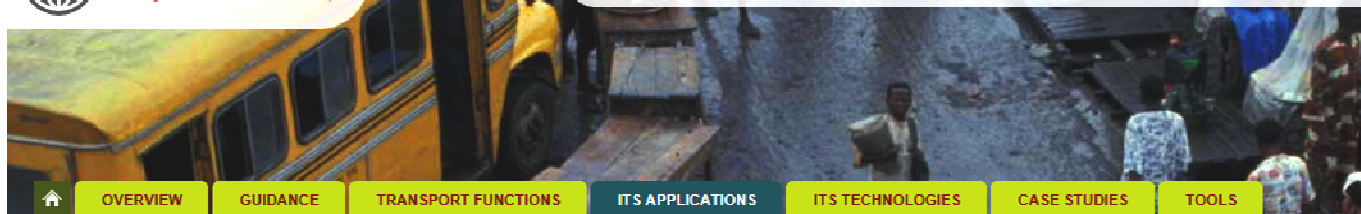
at lower prices. This has encouraged a higher level of deployment both in vehicles and in public transport facilities.

The Toolkit provides reviews of the following four security applications

- In-vehicle surveillance
- At-station surveillance
- Running-way surveillance
- Infrastructure/facility surveillance

Demand responsive transport

Demand Responsive Transport (DRT) adjusts the transport service to the needs of the customer. In current practice, two main forms of DRT are observed:

- DRT for special groups, such as the ADA para-transit in the USA. This is supplemental service for passengers whose physical limitations do not allow them to use the conventional transit services.
- DRT in areas of low-demand and rural areas. This is implemented in Europe and Australia, usually as an alternative to conventional services that have excessive subsidy requirements.

DRT services usually require pre-booking. The ITS applications handle the booking and reservation functions, the passenger assignment, the day-to-day operations, and the downstream administrative processes.

The DRT applications have high potential for use in para-transit services operated in the developing world. However, to date there are no known instances of such use.

The following five DRT applications are described and assessed in the Toolkit:

- Booking and reservations
- Traveler assignment
- Route optimization
- Customer pick-up/drop-off management
- Revenue recovery and administration management

ITS-related functions

Public urban transport companies carry out a wide range of non-ITS functions, many of which are computerized. These functions are not usually categorized as ITS. They are broadly in three groups:

- Resource planning and management
- Service performance
- Administration, management information systems (MIS), and audit

When ITS systems are implemented, these non-ITS functions often receive much of their input data from the ITS systems (e.g., trips/kms operated by vehicle, fares transaction records). In some cases, the non-ITS functions also provide baseline or assignment data to the ITS

systems (e.g. the scheduling system provides the timetable information to the automatic vehicle monitoring system).

The Toolkit presents the following ten non-ITS functions that are closely related to ITS and which are facilitated by the ITS systems:

- Network planning
- Service scheduling
- Service performance analysis
- Service contract management
- Systems payment management
- Payroll functions
- Vehicle maintenance scheduling
- Fuel consumption monitoring
- Management information
- Revenue protection
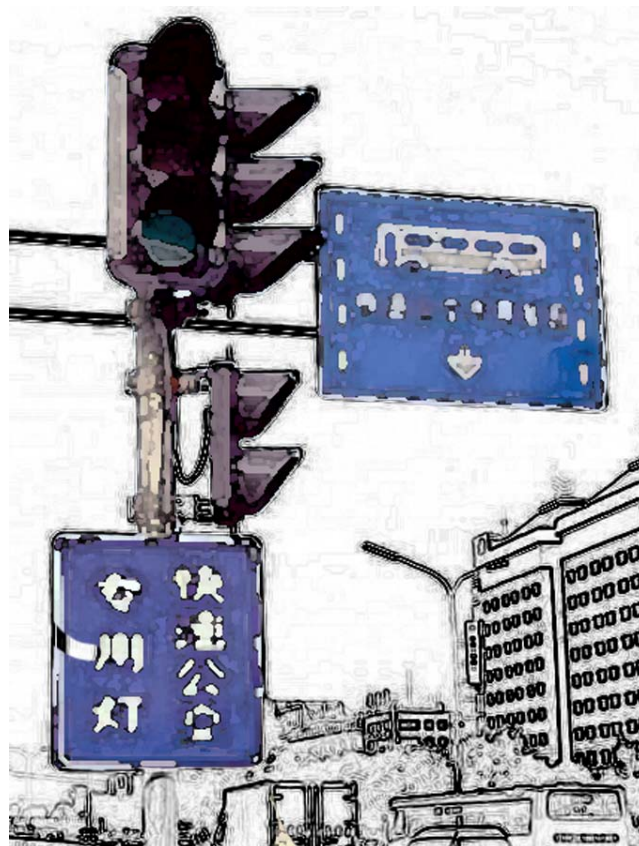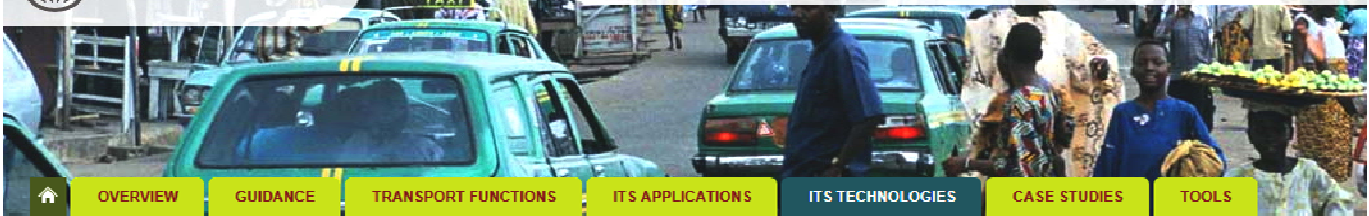
ITS Technologies

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- ▸ Automatic Vehicle Monitoring
- ▸ Driver Monitoring
- ▸ Vehicle Systems Monitoring
- ▸ In-Vehicle Data Hub and Processor
- ▸ Electronic Fare Collection
- ▸ Travel Information Displays
- ▸ Surveillance Equipment
- ▸ Vehicle Identification
- ▸ Communications

The Toolkit presents the main ITS technologies that are currently in use in urban public transport. The focus is on ITS used for bus, although many of the applications are also used by tram and urban rail systems.

Unlike the ITS applications, only a limited number of the ITS technologies are relevant or readily usable by the para-transit sector (e.g. due to cost, complexity, technical support requirements). At present, the use of ITS in the para-transit sector other than certain "Smart Phone" applications is virtually non-existent.

A total of 31 ITS technologies are presented in the Toolkit. They are organized into nine clusters:

- Automatic vehicle monitoring
- Driver monitoring
- Vehicle systems monitoring
- In-vehicle data hub and processor
- Electronic fare collection
- Traveler information displays
- Surveillance equipment
- Vehicle identification
- Communications

Each of the 31 technologies is presented on its own page and is described from three perspectives:

- Objectives and functionality
- Technologies, data and resource required to deliver the application
- Benefits and cautions related to the application

The material draws mostly on current practice within the urban passenger transport sector. The description of each technology indicates the **Case Studies** where the technology is active. For some, additional relevant cities

are identified. Where available, web-links are provided to relevant reports and other resources.

The Toolkit also provides some guidance on the development and evolution of ITS technologies. New technologies continually emerge, usually with increased and faster processing power, increased memory and storage, increased functionality (or similar functionality in a smaller or cheaper unit), and enhanced software options.

This poses some interesting challenges for policy-makers, decision-takers and practitioners who are considering implementation of ITS, or who are faced with technology choices and/or investment decisions. One choice is to play safe and stick with "tried and trusted" technologies. Another is to embrace new technologies, to actively seek opportunities for new functions and services, to find lower cost options, and to use generic, non-proprietary solutions.

The Toolkit suggests four basic principles that should be considered when evaluating these choices. It discusses four fundamental concept options ranging minimal infrastructure to heavy infrastructure. This useful information should be considered in the planning phase of the **Guidance** section.

Automatic vehicle monitoring

The Toolkit discusses the following three technologies for automatic vehicle monitoring (AVM):

- Automatic vehicle location
- Driver's console
- Operations control center

There are also two related clusters that are fundamental to AVM systems. However, as these may be utilised by many other ITS applications and ITS technologies, they are shown separately in the technology clusters **In-vehicle data hub and processor** and **Communications.**

Driver monitoring

The primary reason for the monitoring of drivers is to control driver activity and, thereby, improve safety and reduce operating costs. The following two driver monitoring technologies are discussed in the Toolkit:

- Driving hours and rest periods
- Driver inputs and dynamic outputs

Vehicle systems monitoring

The objective of these technologies is to monitor vehicle performance. A major activity is monitoring the critical components of a vehicle such as the engine, driveshaft, and transmission. Early detection of failures may minimize the cost of repairs and protect the system from unforeseen service disruptions. Another activity is monitoring passenger usage which can help operators make better service planning decisions.
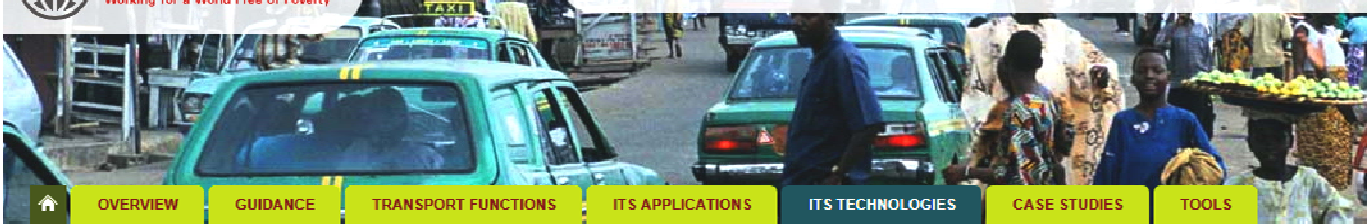
The following three vehicle systems monitoring technologies are presented in the Toolkit:

- Passenger boarding and loading
- Fuel-usage rate
- Technical status

In-vehicle data hub and processor

The on-board computer system on transport vehicles is the main data hub. It is the system which connects in-vehicle ITS devices and systems (e.g. automatic ticket machines, vehicle location devices, automatic passenger counters, information displays), as well as vehicle operations systems (e.g. engine control unit, automatic braking systems). The Toolkit provides an overview of the key elements of in-vehicle data hubs and processors

Electronic fare collection

There have been great advances in ITS technologies related to fare collection. These technologies have increased passenger convenience, improved revenue control, and supported the tailoring of fares to specific travel markets.

The following five electronic fare collection technologies are described in the Toolkit. The companion **Public Transport Fares Toolkit** deals with these technologies in greater detail.

- Electronic ticket-issuing machine
- Smart-card and card recharger
- Smart-card validator and display
- SMS or bar-code on smart-phone
- Bar-code reader

Traveller information displays

The core principle of ITS-supported traveler information is that information is provided "anytime, anywhere". The following five traveler information display technologies are described in the Toolkit and help make information more accessible:

- Public display on vehicles
- Voice announcement systems
- Infotainment systems
- Personal display on smart-phone or PDA
- Public display at terminals and stops

Surveillance equipment

Video cameras are the primary form of ITS security assistance to public transport operators. The Toolkit reviews the following four equipment technologies that can be integrated to form a surveillance system:

- Static video cameras
- Remote-controlled video cameras
- Digital video (loop) recorder
- Computerized image processing

Vehicle identification

These vehicle identification technologies support the monitoring of driver performance and the control and detection of unauthorized use of dedicated transport lanes and facilities. The following two vehicle identification technologies are examined in the Toolkit:

- Automatic number plate recognition
- Vehicle intelligent tag/transponder

Communications

Communication technologies are critical elements of any ITS application. Typically, data must be transported among different vehicles, facilities, and equipment. The following common communications technology types are described and assessed in the Toolkit:

- Between the vehicle systems
- Vehicle to and from control center
- Vehicle to and from stop shelter
- Vehicle to traffic signal or AWTCS
- Data download from vehicle
- Data communication between facilities
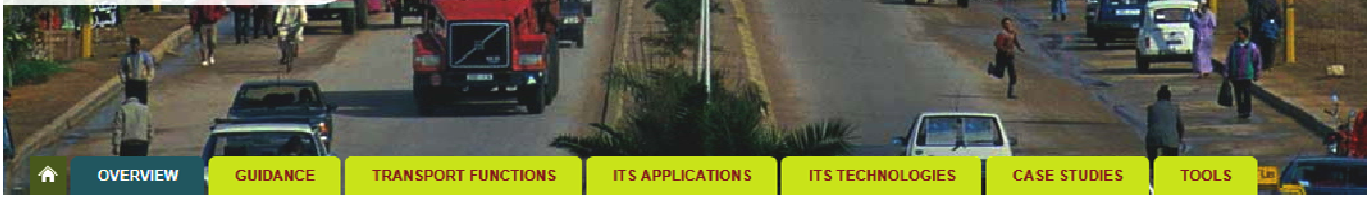
DECISION PROCESS AND KEY CONSIDERATIONS

The development of an ITS program that is cost-effective and addresses the unique needs of a particular city or region often seems difficult, confusing, and daunting to decision makers and transport managers. The Toolkit recognizes this need and provides a decision process and a listing of key considerations in the **Overview** section for evaluating cost-effective ITS opportunities.

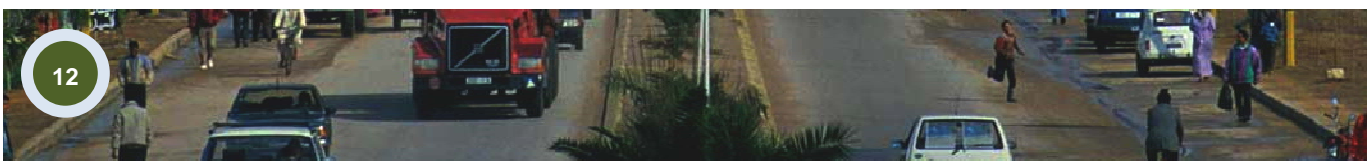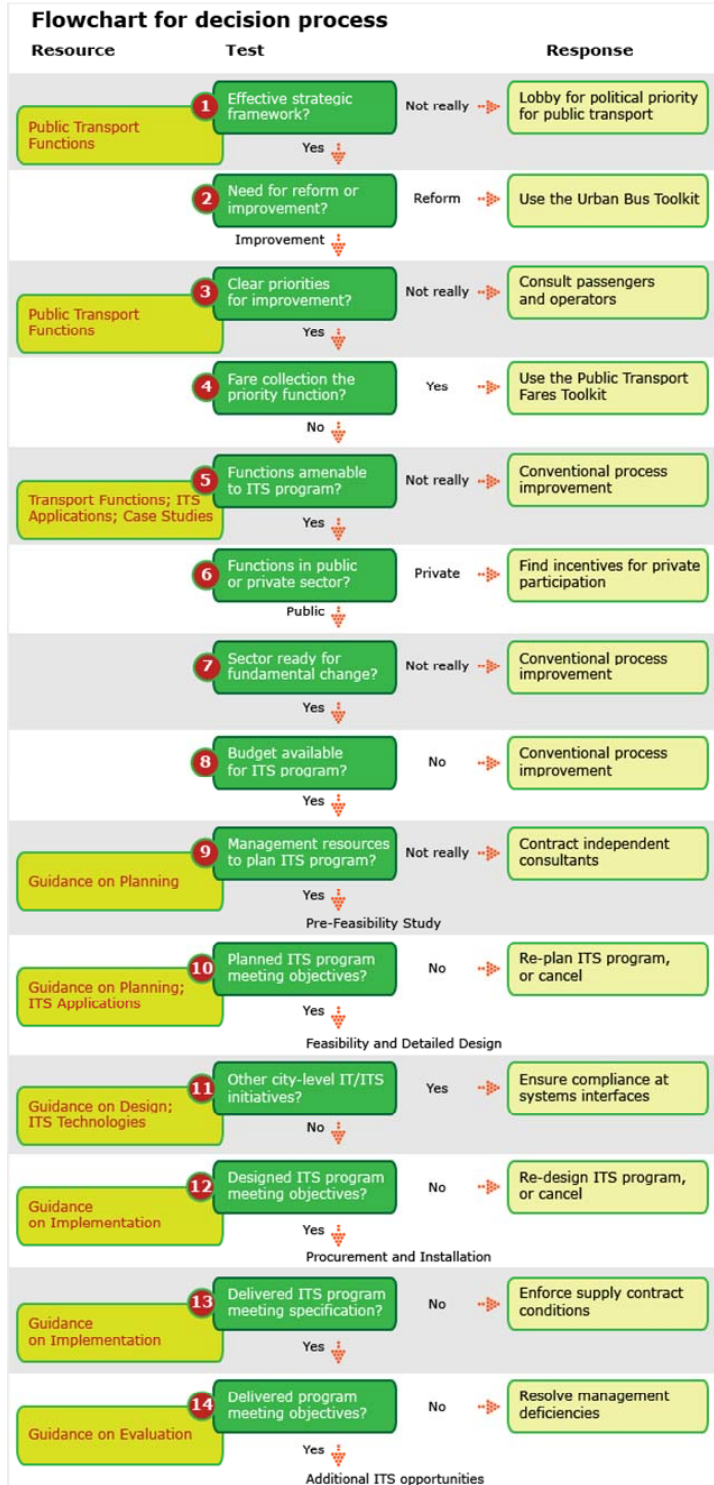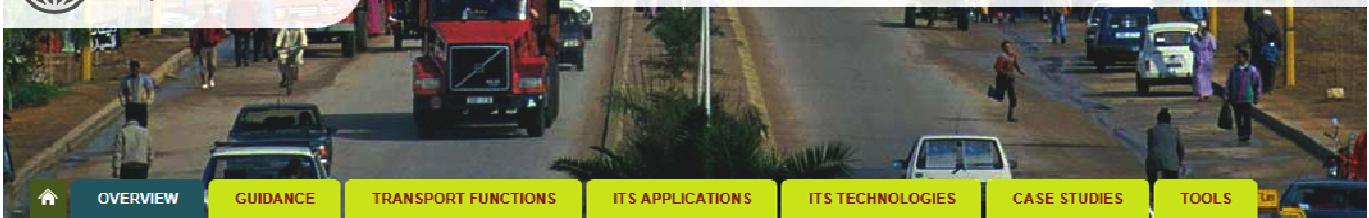## Decision Process When Considering an ITS Program

The sequential decision process consists of 14 questions that help decision makers and transport managers assess the ITS opportunities in their communities.

Flowchart for decision process

| Resource	Test		Response
Public Transport Functions	1 Effective strategic framework?	Not really →	Lobby for political priority for public transport
	Yes ↓		
	2 Need for reform or improvement?	Reform →	Use the Urban Bus Toolkit
	Improvement ↓		
Public Transport Functions	3 Clear priorities for improvement?	Not really →	Consult passengers and operators
	Yes ↓		
	4 Fare collection the priority function?	Yes →	Use the Public Transport Fares Toolkit
	No ↓		
Transport Functions; ITS Applications; Case Studies	5 Functions amenable to ITS program?	Not really →	Conventional process improvement
	Yes ↓		
	6 Functions in public or private sector?	Private →	Find incentives for private participation
	Public ↓		
	7 Sector ready for fundamental change?	Not really →	Conventional process improvement
	Yes ↓		
	8 Budget available for ITS program?	No →	Conventional process improvement
	Yes ↓		
Guidance on Planning	9 Management resources to plan ITS program?	Not really →	Contract independent consultants
	Yes ↓		
	Pre-Feasibility Study		
Guidance on Planning; ITS Applications	10 Planned ITS program meeting objectives?	No →	Re-plan ITS program, or cancel
	Yes ↓		
	Feasibility and Detailed Design		
Guidance on Design; ITS Technologies	11 Other city-level IT/ITS initiatives?	Yes →	Ensure compliance at systems interfaces
	No ↓		
Guidance on Implementation	12 Designed ITS program meeting objectives?	No →	Re-design ITS program, or cancel
	Yes ↓		
	Procurement and Installation		
Guidance on Implementation	13 Delivered ITS program meeting specification?	No →	Enforce supply contract conditions
	Yes ↓		
Guidance on Evaluation	14 Delivered program meeting objectives?	No →	Resolve management deficiencies
	Yes ↓		
	Additional ITS opportunities		

Key Considerations

There are a number of factors that decision makers and transport managers should consider in the design of ITS. These include:

- **Transport Systems are not an end in themselves.** It is important to identify the goal(s) for the transport improvement program before examining the appropriateness of an ITS-led approach.
- **Intelligent Transport Systems will not mend a broken or poorly organized urban passenger transport system.** ITS can only act to enhance one that is already reasonably effective. For guidance on possible reforms, refer to the **Urban Bus Toolkit**:
- **Intelligent Transport Systems are only truly effective where there is a willingness to change organizational and operational procedures to take advantage of the opportunities being created.** Using technology to do the same things as before will make little difference to the overall outcome.
- **Intelligent Transport Systems can be expensive, and may not have an obvious direct financial return.** However, ITS may enhance the usability of the system and the customer experience which may result in greater retention or even an increase of ridership.
- **All Intelligent Transport Systems have an ongoing management, operations and maintenance costs, which may be quite significant.** There must be an ability and commitment to meeting these expenditures as well as the human capacity to do these tasks effectively.

- **Intelligent Transport Systems are often easier to fund in the public sector, where returns may be evaluated against social welfare as well as financial criteria.** However their opportunity cost should be assessed against other local priorities, especially where resources are constrained.
- **Commitment to an Intelligent Transport Systems program may involve a significant risk of being dependent in the future on a single supplier's technology and support.** Internal management and technical capabilities should be developed to minimize this risk.
- **Private operators will not implement Intelligent Transport Systems with their own funding unless they see direct financial returns.**
- **ITS programs are not a substitute for the willingness of the public sector to enforce compliance by private operators.** However, ITS programs can be a power tool to assist enforcement.
- **Electronic fare collection is the ITS application with the most obvious financial return irrespective of public or private sector use.** Success in this domain can both serve as a technical platform for other applications and provide funding support for them. The **Public Transport Fares Toolkit** provides good guidance on this topic.
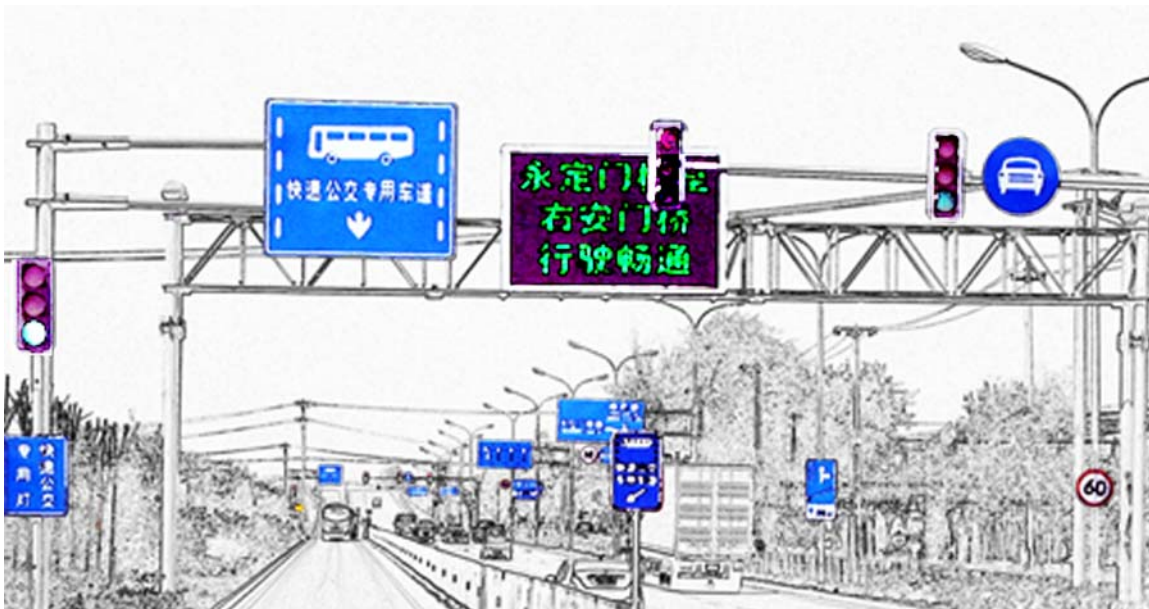
CASE STUDIES

You are here: Case Studies »

- Dublin, Ireland
- Florence, Italy
- Izmir, Turkey
- Prince William County, USA
- Zurich, Switzerland
- Johannesburg, South Africa
- Mysore, India
- Accra, Ghana
- Cebu, Philippines
- Sri Lanka

A set of case studies has been prepared to illustrate how ITS are used in practice. The sites have been selected to provide diversity in environment, operator type, scale, ITS implemented, and degree of experience with ITS.

The case studies are presented in three clusters:

1. Sites where ITS is well established:
    - Dublin, Ireland
    - Florence, Italy
    - Izmir, Turkey
    - Prince William County, USA
    - Zurich, Switzerland
2. Sites where ITS is currently in first deployment:
    - Johannesburg, South Africa
    - Mysore, India
3. Sites which are considering the use of ITS and/or are carrying out some initial testing:
   - Accra, Ghana
    - Cebu, Philippines
    - Sri Lanka

Each case study is presented in detail. The information includes:

- **Contextual information**: Regulatory environment; operator information; basis of service organization and procurement; basis of financial support.
- **ITS**: Overall ITS approach; individual ITS systems implemented; technical details; means of operations management.

- **Implementation experience**: Preparation; procurement; installation and implementation; post-implementation experience; lessons learned; benefits achieved.

It is strongly recommended that decision-takers and practitioners familiarize themselves with these case studies and with other sites that have implemented ITS. There is a vast array of experience which can be drawn on – not all of it pleasant, but all of it valuable. It is clear that the implementers are willing to share what they have learned with their counterparts in other cities and regions.
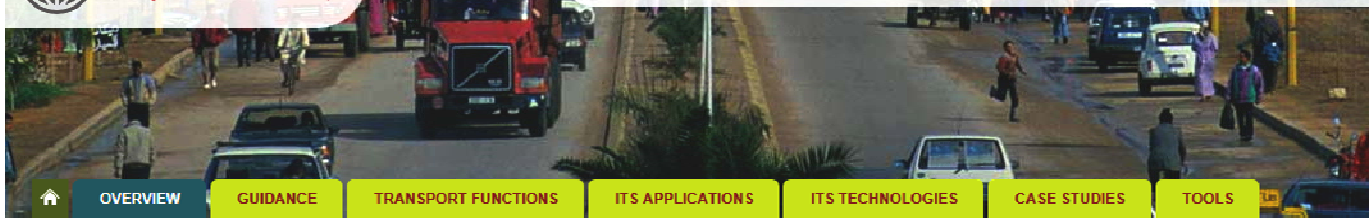
USING THE TOOLKIT

The Toolkit was designed to be straightforward and user-friendly. To make the best use of the Toolkit, it is important to understand:

1. Technical specification required to use the Toolkit; and
2. Toolkit features

Technical Specifications

The Toolkit was conceived as a website so that it could be universally compatible and accessible to all users. There are two versions of the Toolkit:

1. **On-line** that is accessible from anywhere with an Internet connection; and
2. **CD ROM** that comes with the Toolkit and can be used when no Internet connection is available.

The only difference between the two versions concerns the links to external sites and external content. On the CD ROM version, these links only work when used on a computer that is connected to the Internet.

The Toolkit can be used with slow Internet connections. However, it will perform better and faster when a stable high-speed connection is available.

Browser compatibility

Both versions only require a standard browser to be used. No additional software or installation is needed.

The following standard browsers can used to view the Toolkit:

- **Mozilla Firefox** version 6, and later - Microsoft Windows; Linux; Mac OS X; FreeBSD
- **Google Chrome** version 15, and later – Linux; Mac OS X (10.5 and later, Intel only); Microsoft Windows (XP SP2, and later)
- **Microsoft Internet Explorer** version 7, and later - Microsoft Windows XP, Vista, and 7
- **Apple Safari** version 5 - Mac OS X Snow Leopard and Lion; Windows XP, Vista, and 7; and iOS

To ensure optimum performance of any web application, it is always advisable to upgrade your browser to the latest available version. These are free and most allow automatic installation. Check periodically for updates and maintain your software up to date to ensure smooth operation.

The Toolkit employs JavaScript. This is a standard feature in the above browsers, and it is usually active by default. Should the option be switched off in your browser, you can simply switch it on in the setting or preferences of your browser.

Recommended operating system and hardware

Recommendations are made for following operating systems regarding the system versions, computer processors, hard disk capacity, and computer memory.

- **Windows**: XP Service Pack 2+/Vista/7 - Intel Pentium 4 or later; 100MB hard disk; 128MB memory
- **Mac OS X**: 10.5.6 or later - Intel Mac; 100MB hard disk; 128MB memory
- **Linux**: Ubuntu 8.04 or later/Debian 5/OpenSuse 11.1 - Intel Pentium 3/Athlon 64 or later; 100MB hard disk; 128MB memory

Usability on mobile devices

The Toolkit is usable on mobile devices such as Apple iPhone and iPad and Android handsets. These devices should have an Internet connection using the mobile versions of current browsers.

Toolkit Features

A consistent interface is used throughout the Toolkit. Once you familiarize yourself with its components you will find the Toolkit easy to use.

Main navigation bar

OVERVIEW | GUIDANCE | TRANSPORT FUNCTIONS | ITS APPLICATIONS | ITS TECHNOLOGIES | CASE STUDIES | TOOLS

At the top of the page a series of tabs correspond to the seven areas of the Toolkit. Placing the mouse or touchpad pointer over each of these reveals a pull-down menu listing the sections within that area. Clicking on any of these titles/headers displays the content of the relevant area/document in the main display area below.

Overview and **Program Guidance** are your entry points. They provide you with the essential information to find your way around the Toolkit.

Transport Functions, **ITS Applications**, **ITS Technologies** and **Case Studies** are the content areas.
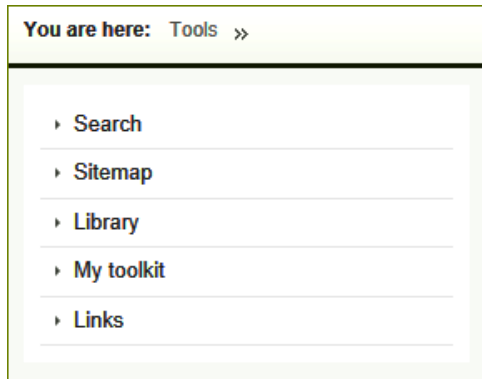
Tools is where you find additional aids and features to complement the content.

Wherever you are in the Toolkit these same options are available at the top of the page. You will be able to jump directly from any page in the Toolkit to any other area and will never find yourself in a dead-end.

Left hand column

You are here: Tools »

> Search
> Sitemap
> Library
> My toolkit
> Links
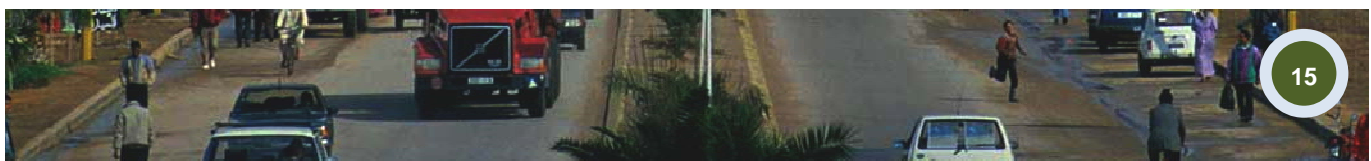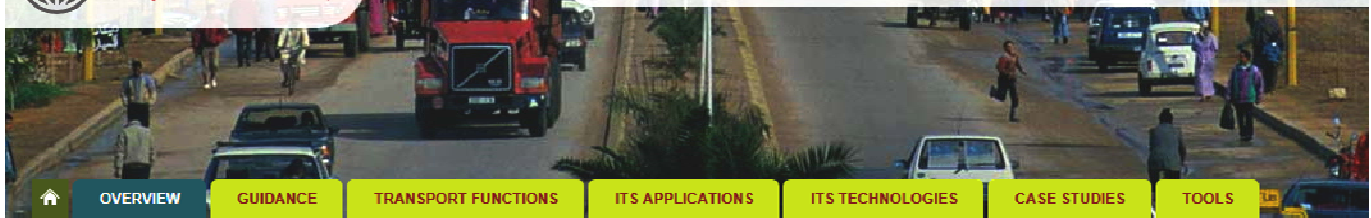
On the left hand side of the screen you see a list of the documents available in the area that you are visiting. Clicking on each of the titles/headers will display the content of the selected page.

Breadcrumb trail

You are here: Tools » Library » Glossary

Breadcrumbs are a secondary navigation scheme that reveals the user's location within a website. Wherever you are in your journey through the Toolkit you will see, just below the tabs at the top, the breadcrumbs telling you where you are and the path you have followed to get there. Clicking on any title/header in the list of breadcrumbs is the quickest way to retrace your steps.

You are here > Tools > Library > Glossary

A second breadcrumbs navigation bar is provided at the bottom of each page in the blue task bar. You can use this in the same way as the top breadcrumbs navigation bar.

Expanding the page view

In the top left hand corner of the display area there is an **Expand content** button. This allows you to expand the main display area to full width, which can be useful if you are viewing the Toolkit on a small screen. If you choose to print the page when expanded, it will print as you see on the screen.

When the page is expanded you can shrink it again and reveal the left column by clicking on **Collapse content**. This will be at the top left of your page at that point.

Searching, printing and bookmarking

🔍 SEARCH   + 📑 ADD TO MY TOOLKIT   🖨 PRINT
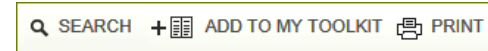
On the right hand side just above the main display area you find three options: **Search, Add to My Toolkit** and **Print**.

Clicking on **Search** lets you search key words in content titles through the Toolkit. The search function provides you with a listing of the content titles with the key words. The search function can also be found under **Tools**.

Clicking on **Add to My Toolkit** will let you save to your computer a copy of the page that you are currently viewing. This allows you to set aside documents you want to refer to later, or to create sequences of selected documents you intend to use separately from the Toolkit.

Selecting the option opens a small window where you can give a name to the document. The path to it will be saved automatically, and you can add your own notes to it. The document will be saved to the **My Toolkit** area, which is to be found under the **Tools** menu.

By selecting **My Toolkit**, you will go to a page where all the documents you selected are listed with the title you gave them. Using the **My Toolkit** features, you can reorder the sequence, edit the notes, and go directly to the page.

When your computer is connected to a printer, clicking on **Print** will print the currently displayed page. If it fails to print, please check your printer connection.

Text size

As in all browsers, you can enlarge or reduce the size of the text by pressing keyboard shortcuts in the following browsers:

- **Windows**: In Internet Explorer, Firefox, Chrome, Opera and Safari browsers:
  - To make the text bigger, press the **Ctrl** and **+** keys together.
  - To make the text smaller, press the **Ctrl** and **-** keys together.
  - To return to normal size text, press the **Ctrl** and **0** keys together.
- **Mac**: In Firefox, Chrome or Safari browsers:
  - To make the text bigger, press the **Command** and **+** keys together.
  - To make the text smaller, press the **Command** and **-** keys together.
  - To return to normal size text, press the **Command** and **0** keys together.
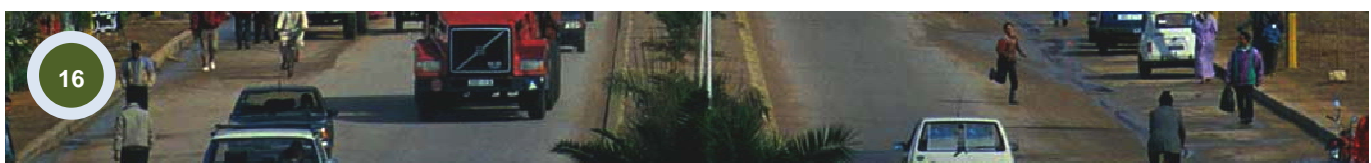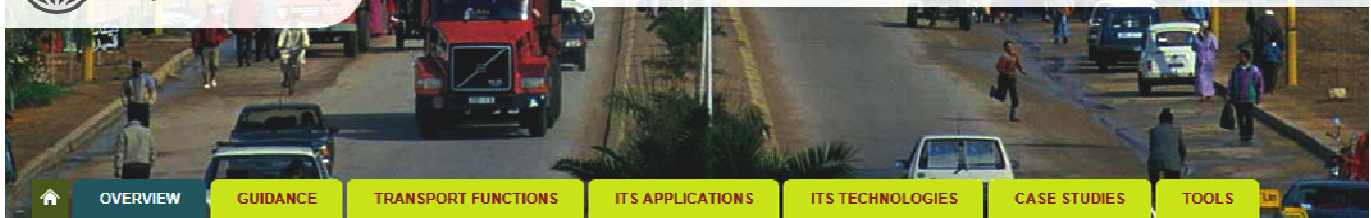
Sitemap

Under the **Overview** and **Tools** menus you will find a text-based map of the whole site — **Sitemap**.

It is organized by area — the one you get to by clicking on the main title/header on the tabs at the top of the page. Each element in the map is an active link taking you directly to the relevant page. The map will help you understand the hierarchy of the content and the relationship between each component.

Tools

This area provides the following aids and features:

- **Search** lets you search key words in content titles through the Toolkit. The search function provides you with a listing of the content titles with the key words.
- **Sitemap** is a text-based map of the whole site. Each element in the map is an active link taking you directly to the relevant page. The map will help you understand the hierarchy of the content and the relationship between each component.
- **Library** stores the **Glossary** and **Documents**. The **Glossary** provides definitions for the abbreviations and acronyms used throughout the Toolkit. **Documents** provide a listing of relevant publications on fare collection systems.

  It is not necessary to go to the glossary page each time you want to find the meaning of an abbreviation. Whenever these abbreviations and acronyms appear within the text of the pages, just place the pointer over it. A label will then appear with the definition.
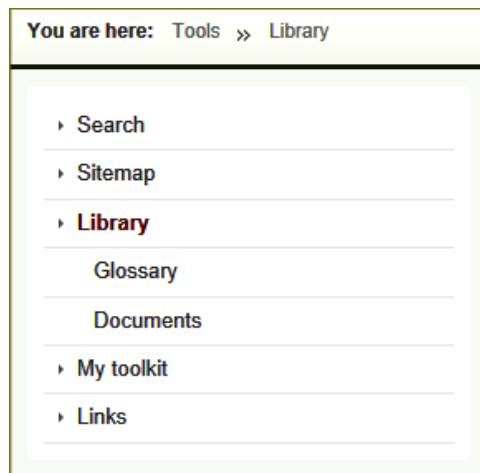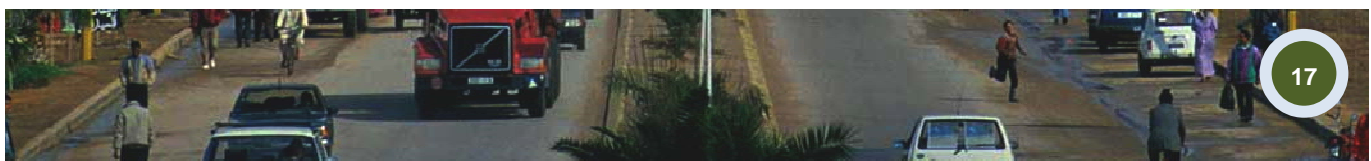

- **My Toolkit** contains the copies of the pages that are saved by clicking on **Add to My Toolkit**. This feature lets you save to your computer a copy of a page that you viewing in the Toolkit. This allows you to set aside documents you want to refer to later, or to create sequences of selected documents you intend to use separately from the Toolkit.

- **Links** provides relevant Internet links to references, World Bank documents, research centres, databases, International bodies, and standards bodies.

Tabbed browsing and multiple pages open at the same time

At times you may want to keep multiple pages open at the same time and be able to toggle between them. You can either have pages open in different browser windows or, more practically, use tabbed browsing. This will give you one titled tab for each open page at the top of your browser window. Just click on the tab to get to that page.

To open a link in a new tab in Internet Explorer 8, Mozilla Firefox, Apple Safari, and Google Chrome on a PC press the **Ctrl** key while clicking on the link, or right click on the link if you have a two-button mouse. You can then choose **open link in new tab** or **open link in new window** from the menu that displays. On a Mac use the **Command** key instead of **Ctrl**.