Chapter 49

Intelligent Transportation System - II

49.1   Standards

Standards provide some norms and regulations to be followed. Just as the standards are provided by IRC for the signs to be used similar standards are there for ITS. They bring oneness in the system. They help in generalizing any system. Also they bring homogeneity in the design. The standards help the non-transportation designers to adhere to some guidelines so that the system is sound technically.

49.1.1   Need of ITS standards

The need of ITS standards can be explained by five aspects:

- Product behavior.

- Interface.

- Performance.

- Co-ordination and interaction.

- Benefits to vendors, manufacturers and government.

Product behavior

The standards prescribe ways the product should behave. The behavior everywhere should be uniform. It should not happen that the product behaves differently in some different scenarios. It ensures uniform product responses. It also helps in easy understanding of a device. It provides consistency in the output. Confusion to the users is also avoided. Just as a STOP or GO sign is used it everywhere and every time means the same. Standards do the same thing in ITS.

Interface

Many devices are to be connected with each other. Connection of components to system must be universal. More 'plug and play' type devices should be used. By having a standard the device will get connected using a standard interface. For ex, many traffic signals should be connectable to same controller. If universal interface is not there, then many devices will not work everywhere, which is not desirable.

Performance

Check on performance of a device is essential. Standards should be set to have at-least minimum performances. The standards will help the manufacturers to develop quality and less expensive products. It will set the minimum quality threshold accepted for the product. Detection of under-performance of a device is essential to keep an overall check on the system.

Co-ordination and interaction

Data transfer is an important aspect in the ITS and the data flows from one agency to other. Thus the co-ordination and interaction between various agencies must take place effectively. The data must be in stored or transferred in standard format. Data sharing must be possible. Standard data dictionary and message sets are required for this purpose. The data for each organization should mean the same. Thus the data dictionary is essential.

Benefits to vendors, manufacturers and government

It helps the government in enforcing some rules which are otherwise difficult to implement. It also helps the vendors to choose the manufacturer best from the lot which will also be best for the users. It provides manufacturer with a guide to produce efficient device. If some standards are made by the government then the manufacturer has to follow the rules. So the uniformity is achieved in the product and its output. As all the devices are made by following same standards it provides same platform for vendors to judge a product. Thus a best product is selected by the vendor which will also be good for the user.

49.1.2 Case study

In US there are many types of toll collection systems implemented to collect the toll. Each system requires its own tags and receiver devices. This gives rise to many types of tags and receiver devices. Such variance in devices is undesirable and difficult to handle. Thus some standard platform was thought to be required to generalize the system. Standardization of

ETC was thus started with this issue in mind. Standardization will provide uniform platform. Still the process of standardization is ongoing and a single standard is in the making. It is expected to reduce the problems of toll collection in US. Thus from this case study it can be seen that the standards are helping the engineers to simplify the system and help in reducing complexities.

49.2 Classification of standards

Just like ITS services are classified into user services the standard are to be classified in some five groups depending upon the interface it is made for. These classifications are termed as application areas. The various application area in ITS standards are:

- Center - roadside interface

- Center - center interface

- Center - vehicle interface

- Roadside - vehicle interface

- Roadside - roadside interface

Each of the class has some sub classes or sub-groups. For each sub-group some set of standards are to be used. Each sub-group may have more than one standard to follow. This takes care for the standard to be effective in all aspects.

49.2.1 Center - roadside interface

Standards are made for the interface that exists between a center device and a roadside device. These are standards for communications between transportation management center and roadway equipment. Majority of the ITS services can be grouped under this. Various fields included are:

- Data collection and monitoring

- Dynamic message system

- Ramp metering

- Traffic signal

- Vehicle sensors

Data collection and monitoring

This application area includes the interface between a traffic management center or a data archive and roadside equipment. Primarily the interface is between traffic management sub-system and roadway sub-system. By this standard we can effectively control, monitor and collect data from the equipment on or at the roadside. The roadside equipment collects and processes signals from the sensors as vehicles are detected to generate information. The roadside equipment sends the information to the center. The standards included are:

- Object definitions for video switches.

- Data dictionary for closed circuit television

- Object definitions for environmental sensor station and roadside weather information system.

- Transportation system sensor objects.

- Data collection and monitoring devices.

The $1^{st}, 2^{nd}$ and 4th standards are used for video data collection. The 3rd is used when some environmental data collection is to be done. The last is the common standard to be followed while data collection is done.

Dynamic message signing

It is an interface between traffic management and roadway system. It gives real time information such as traffic conditions, weather conditions or any other advisory to user. It has one primary and several secondary standards. The primary standard is listed below. The standard included is

- Object definitions for dynamic message signs.

The standard is discussed below in detail.

Ramp metering

This application area provides an interface between traffic management and roadway system. The roadway sub-system includes a ramp meter which controls traffic in freeway lanes. One primary standard is included for this application. The standard included is

- Ramp meter controller objects.

Traffic signal

It is an interface that is used for local signal controllers. It is also used for master controller. The roadway sub-system includes a local-signal controller or on-street master controller. Based on the traffic data appropriate signal timing is decided and then interface provides information to controller about the signal timings. 2 major standards for this are:
The standards used are:

- Objects for signal system master.

- Object definitions for actuated traffic signal controller.

Vehicle sensors

This application area includes the interface between a traffic management and roadway system and a roadway and archived data management subsystem. The roadway subsystem includes roadway sensors that identify different characteristics and communicates it to main center. There are 4 primary standards for this application. The standards are:

- Object definitions for video switches.

- Data dictionary for CCTV.

- Transportation system sensor objects.

- Data collection and monitoring devices.

49.2.2   Center - center interface

It is an interface that is used to make standards for communication between management centers. This interface is important from planning point of view. The standards help in tackling the diversities. Effective communication takes place between various centers because of these group of standards. The archived data transfer is efficient and also the real time data transfer is possible. Various fields in center - center interface are:

- Data archival

- Traffic management

- Traveller information

Data archival

This application area includes an interface between the archived data management subsystem and the sources and the users of archived data. The data archive collects data for off-line analysis purposes such as planning and research. Data sources for the archive include traffic management centers, emergency management centers and commercial vehicle administration system. Effectively it is the data transfer between centers for planning and research. There are two primary standards for this. Standards used are:

- Archival data management system(ADMS) guidelines

- ADMS data dictionary specifications

Traffic management

It provides an interface between a traffic management center and other centers like transit management center, emergency management, toll operation, event promoter, media and other management centers. It enables transfer of real time traffic data and control over emergency-maintenance operations. Three standards are used for this. Standards used are:

- Message set for external TMC communications.

- Standard for functional level traffic management data dictionary.

- Message set for weather reports.

Traveller information

This application area includes the interface between information service provider and traveler information collector/disseminator. These interfaces support the roles of an ISP that may include information collection, integration of collected data and dissemination of aggregated data. Four standards are included in this. Standards used are:

- Data dictionary for advanced traveler information system (ATIS).

- Message system for ATIS.

- Messages for handling strings and look-up tables in ATIS standards

- Message set for weather reports

49.2.3   Center - vehicle interfaces

It provides standards for communication between management center and vehicle. The number of application area in this interface may be less but they assume high importance in ITS services. There effective implementation helps in overall effective use of ITS. Fields included are:

- Mayday

- Transit vehicle communications

MAYDAY

This application area includes interface between driver and emergency management center. The interface enables the driver or traveler to either request emergency assistance or have such a request automatically sent after a crash. One standard is included for this type of application. Standards used is

- On-board land vehicle Mayday reporting interface

Transit vehicle communications

This application area includes interface between transit vehicle and transit management center. Transit vehicles send information on location, passenger count, maintenance and so on to the transit management center. Similarly the transit management center provides information regarding dispatch, routing and other information. Standards used are:

- TCIP-control center business area standard.

- TCIP-common public business area standard.

- TCIP-fare collection business area standard.

- TCIP-on-board business area standard.

The TCIP stands for Transit Communications Interface Profiles. This is body forms under NTCIP. It is responsible to formation of standards regarding the transit management.

49.2.4   Roadside - vehicle interfaces

This interface provides standards for wireless communication between roadside and vehicles. These are implemented to increase the service of any system and their by increasing its quality. Communication takes place between a vehicle and roadside equipment by automatic means. Fields included are:

- Toll/fee collection

- Signal priority

Toll/Fee collection

This application area includes interface between toll or parking management facility and vehicles that would pay the toll or fee. This interface supports reading vehicle and processing electronic identification and associated account information. 5 primary standards are included in this. Standards used are:

- Standard specification for 5.9 GHZ data link layer.

- Standard specification for 5.9 GHZ physical layer.

- Standard for message set for vehicle /roadside communications.

- Specification for Dedicated Short Range Communication (DSRC) medium access and logical link control

- Specification for Dedicated Short Range Communication (DSRC) physical layer using microwave in 902-928 MHz.

Signal priority

This application area includes interface between traffic controllers and transit or emergency vehicles. The interface supports providing priority to the transit vehicles or preempting emergency vehicles, depending on the detection of the vehicle type or request from vehicle. This application area has 5 standards associated with it. Out of these 5 standards 4 are same as for toll collection. Standards used are:

- Standard specification for 5.9GHZ data link layer.

- Standard specification for 5.9GHZ physical layer.

- Objects for signal control priority.

- Specification for Dedicated Short Range Communication (DSRC) medium access and logical link control

- Specification for Dedicated Short Range Communication (DSRC) physical layer using microwave in 902-928 MHz.

49.2.5   Roadside - roadside interfaces

This area involves standards for communications between roadside and railroad wayside equipment. The most important of it is the interaction between the road and rail equipment.

Highway Rail Interface

This application area includes interface between railway and roadside equipment. The interface support co-ordinated operations of the railway and roadway-side equipment to improve the operations and safety for both rail transit and highway vehicles. This includes one standard between two systems. Standard used is:

- Standard for interface between railway subsystem and highway sub-system at intersection

49.2.6   Dynamic Message Sign Standard

Dynamic message sign standard is a standard employed to have certain set of rules and regulations for dynamic message signs. All the devices used should comply with the standard so that the device can be used on any platform. All the functioning of the device should be universal. It defines the data elements required for DMS. Data elements are like font, font size, the height of font, the spacing between characters, the type of message etc. It also defines the conformity-performance of a DMS device. That is it defines how the DMS system should work in any scenario. The performance of the system is thus checked. It contains mandatory, optional and conditional clauses which are needed to be followed.

There are many actions that are required to be done in a DMS system. All such actions can be done using some syntax. The standard provides these syntaxes that are to be used while working with the DMS devices. All devices should work with this syntax.

Sign configuration

All the parameters regarding the sign boards are included in this feature. Whenever a message has to be displayed some standard data of the sign board is required for proper display of message. To access this parameter some syntax is to be followed to get the information. 2 important parameters are:

- Height/Width of sign board- it gives the height and width of the board.

- Horizontal/vertical border parameter- it gives the border available on the board.

Font configuration

All data regarding the type of font, the size is described by the font configuration. It is a read-write parameter where we can access the data and also overwrite it if required. Height may be expressed in pixels. The important parameters are:

- Font name parameter - it gives the type of font to be used as default which can be changed.

- Font size parameter - gives the size of font.

Sign control objects

These provide some codes that are used for controlling any sign. The activity on a sign is governed by these parameters. Some important parameters are:

- Activate message parameter - provides a code - when to activate a certain parameter.

- Message display time remaining parameter - states the display time remaining for a particular message.

Message parameters

All the data regarding the various types of messages their characteristics are controlled by these parameters. The changing of any message or the status of any message can be assessed by these parameters. Some important parameters are discussed below:

- Max. no. of changeable message parameter - it specifies the maximum number of changeable messages that can be stored or used at a time.

- Message run time priority parameter - it gives the run time priority of the message and thus is helps in decision making.

- Message status parameter - it gives the status of the message i.e. whether it has been displayed or not; whether it is edited; whether it is being edited, etc.

Illumination objects

This gives the parameters related to the illumination of the sign boards. The status of present illumination, the source of illumination can be assessed. Some important parameters of it are:

- Illumination control parameter - it gives the source of the illumination of the sign board. The source can be assessed and also can be changed. Thus it is a read-write parameter.

- Illumination brightness level parameter - it gives the brightness around the sign board. Some sensors are used to know the current brightness level.

Status objects

They help in finding the status as is specified initially. Some important parameters are:

- Current speed parameter - it gives the current speed of the vehicle. It is an read-only parameter.

- Current speed limit parameter - it denotes the current speed limit of the corridor. It is a read-write parameter.

Power status objects

It gives the power status of a vehicle. This type of DMS service is inside the vehicle. It gives information to the driver. Some important parameters of this field are discussed below:

- Low fuel parameter.

- Engine RPM parameter.

- Power source parameter.

49.2.7 Standards testing

Just as testing is required for any new thing which is made, the standards are also needed to be tested. It is like an evaluation of a system. It helps in judging whether the standard made is effective or not. Also the practicality of standard is needed to be judged. So testing is essential for any standard. It can be done in 3 ways.

Validation testing

Standards are continually tested during development process. It ensures that it satisfies all requirements. The standards are validated in this step.

Verification testing

This examines the practicality and economic viability to build system based on standards. This is mainly done by vendors and users. It can be performed by reviewing and analyzing the standards documents or developing software for the same.

Experienced based testing

This type of testing is done by experience. It includes real world experience with the system. As it is subjective mostly it is not followed.

49.3 Evaluation

Just like testing is done for standards the whole ITS system is also needed to be evaluated in stages. It helps in judging any project and its deployment. It minimizes the risk of project failure. It helps in identification of current performance of system.

49.3.1 Types of evaluation

The various types of evaluation stages are:

- Planning level evaluation

- Deployment tracking

- Impact assessment

- RP and SP survey

Planning level evaluation

Evaluation is done before the project is implemented. During the planning stage this type of evaluation can be done. Previous data can be used for doing this. Two methods of this are:

- Benefit cost analysis- the benefits of the project need to be evaluated. The cost of the project is also to be found out. Then depending upon the ratio the evaluation is done.

- Relative ranking- it is a weight based method. Weight given to criteria and the value of each alternative is calculated.

$$S = \Sigma K \times V \tag{49.1}$$

where, S is the value of alternative, V is the value of one criterion, and K is the weight of that criterion.

Here, S is the total value of the alternative. More the value of alternative, more prospects of that alternative to be selected. Each alternative can be evaluated by different criteria. The value of that criteria is denoted by V. Study is to be conducted to calculate the value of the

criteria. K denotes the importance of that criteria to the alternative. It is a global entity and does not change with the value of the criteria. For example, consider a case of providing the signal priority system on a certain link. For evaluating this system an important criteria is the travel time on a corridor. The value of the travel time will be the V value. Also the weightage to this parameter will be K.

Deployment tracking

This evaluation is done when the project is being implemented. It gives the idea regarding the difference in the goals and actual work undertaken. We can determine the current progress rate of the work. The future directions needed to to be taken can also be assessed. Effective way of knowing this is the amount of data transfer between various agencies.

Impact assessment

After an ITS system is deployed it is allowed to collect data over a period of time. The data collected is regarding the parameters from which assessment can be done. The criteria and the measure of effectiveness is mentioned in table. 49:1.

RP and SP survey

Many times benefits cannot be expressed in terms of monetary units as is required for benefits cost analysis. In such cases RP and SP surveys are conducted. RP survey is the revealed preference survey. In this assessment of present system is done. In this survey the questionnaire is asked regarding the present facilities. The respondents grade the parameters set in the survey. Based on this grading the evaluation is done. SP survey is stated preference survey. This survey is done for future projects. In this type of survey the future project is explained to the respondents. They are given alternatives regarding this project. The respondents rate each alternative and thus total evaluation is done.

49.3.2 Evaluation tools

Some tools are used which help in evaluation of the ITS technologies. They are just the means of evaluation. The basic principle of evaluation remains the same. It can be done in 2 ways.

Traffic simulation models

This is a model based technique. In this method, models such as 'INTEGRATION', 'DYNAS-MART', 'DYNAMIT' are used for evaluation. It is a cost effective way of analysis. In these

Table 49:1: The criteria and measure of effectiveness

Performance Criteria	Measure of Effectiveness
Safety	Crashes
	Injuries
	Fatalities
Travel time	Travel time/delays for selected O-D survey
	Network travel time
Throughput	Vehicles / persons using the facility
Customer satisfaction	Ratings of travel experience
Air Quality	CO
	NO_2
	VOC
	HC
	Ozone
Fuel consumption	Reduction or not

models simulation is done considering the future ITS installment in the facility. The facility is reproduced in the software. The future changes to be made in the facility are added. Then it is simulated to show the desired results in terms of some traffic parameters. Also simulation is done without the introduction of the new facility. The parameters are again calculated. These two analysis gives the difference in the facility that may arise in the facility. This gives instant evaluation of the facility of ITS. Also it is cost effective as less personnel are required and the data collection is not a major issue. Evaluation can be done before the implementation of any facility. Thus cost savings in selection of alternative facilities is also observed. If the present technology used is not found satisfactory then some improved technology can be procured to fulfill our requirements.

ITS deployment analysis system

In this type of technique the traditional way of benefit-cost analysis is done. There are some software that directly compute cost and benefit. Some software use parameters like travel time, speed, delay to compute cost and benefit. But the basic idea remains the same. IDAS model of US DOT is an example of such software.

The basic principle in IDAS model is to calculate the benefit cost ratio. It helps in providing
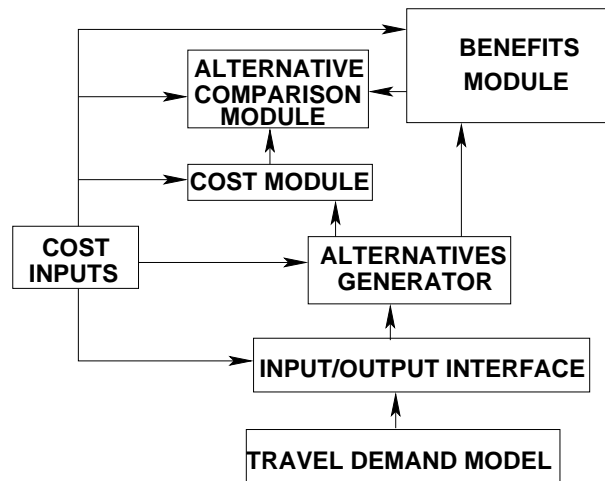
Figure 49:1: IDAS model

a step wise approach for calculate it. Initially input is to be given from a travel demand model. It will evaluate the input and output parameters from the system. Depending upon the parameters various parameters will be generated. Then the control goes to cost and benefit module where the benefits and cost of alternatives are calculated. Last step is comparison of these calculated cost and benefits. Depending upon the comparison is done. At all the steps cost input is given. This cost may not always be in monetary terms but can be expressed in some discomfort. The IDAS model is shown in Fig. 49:1.

Sample Question 1

Describe the Dynamic Message Sign Standard with 3 features?

Answer   Dynamic message sign standard is a standard employed to have certain set of rules and regulations for dynamic message signs. All the devices used should comply with the standard so that the device can be used on any platform. All the functioning of the device should be universal. It defines the data elements required for DMS. Data elements are like font, font size, the height of font, the spacings between characters, the type of message etc. It also defines the conformity-performance of a DMS device. That is it defines how the DMS system should work in any scenario. The performance of the system is thus checked. It contains mandatory, optional and conditional clauses which are needed to be followed.

There are many actions that are required to be done in a DMS system. All such actions can be done using some syntax. The standard provides these syntaxes that are to be used while working with the DMS devices. All devices should work with these syntax.

Features:

1. Sign configuration: All the parameters regarding the sign boards are included in this feature. Whenever a message has to be displayed some standard data of the sign board is required for proper display of message. To access this parameter some syntax is to be followed to get the information. Two important parameters are:

   - Height/Width of sign board- it gives the height and width of the board.
   - Horizontal/vertical border parameter- it gives the border available on the board.

2. Font configuration: All data regarding the type of font, the size is described by the font configuration. It is a read-write parameter where we can access the data and also overwrite it if required. Height may be expressed in pixels. The important parameters are:

   - Font name parameter which gives the type of font to be used as default which can be changed.
   - Font size parameter which gives the size of font.

3. Sign control objects: These provide some codes that are used for controlling any sign. The activity on a sign is governed by these parameters. Some important parameters are:

   - Activate message parameter which provides a code stating when to activate a certain parameter.
   - Message display time remaining parameter indicating states the display time remaining for a particular message.

Sample Question 2

Describe the methods of evaluation of ITS technologies.

Answer   ITS evaluation can be done in four different ways as given below:

(a) **Planning level evaluation:** evaluation is done before the the project is implemented. During the planning stage this type of evaluation can be done. Previous data can be used for doing this. Two methods of this are:

   - Benefit cost analysis- the benefits of the project need to be evaluated. The cost of the project is also to be found out. Then depending upon the ratio the evaluation is done.

Performance criteria	Parameters
Safety	Crashes
	Injuries
	Fatalities
Travel time	Travel time/delays for selected O-D or mode.
	Network travel time
Throughput	Vehicles / persons using the facility
Customer satisfaction	Ratings of travel experience

- Relative ranking- it is a weight based method. Weight given to criteria and the value of each alternative is calculated as $S = \Sigma K \times V$, where S is the value of alternative, V is the value of one criterion, and K is the weight of that criterion.

(b) **Deployment tracking:** this evaluation is done when the project is being implemented. It gives the idea regarding the difference in the goals and actual work undertaken. We can determine the current progress rate of the work. The future directions needed to to be taken can also be assessed. Effective way of knowing this is the amount of data transfer between various agencies.

(c) **Impact assessment:** after an ITS system is deployed it is allowed to collect data over a period of time. The data collected is regarding the parameters from which assessment can be done(Table. 3c).

(d) **RP and SP survey:** many times benefits cannot be expressed in terms of monetary units as is required for benefits cost analysis. In such cases RP and SP surveys are conducted. RP survey is the revealed preference survey. In this assessment of present system is done. SP survey is stated preference survey. This survey is done for future projects.

Sample Question 3

Describe how IDAS model can be used for ITS evaluation.

Answer   The basic principle in IDAS model is to calculate the benefit cost ratio. It helps in providing a step wise approach for calculate it. Initially input is to be given from a travel demand model. It will evaluate the input and output parameters from the

system. Depending upon the parameters various parameters will be generated. Then the control goes to cost and benefit module where the benefits and cost of alternatives are calculated. Last step is comparison of these calculated cost and benefits. Depending upon the comparison is done. At all the steps cost input is given. This cost may not always be in monetary terms but can be expressed in some discomfort.

49.4   Summary

This lecture give in detail ITS standards, its use and classification followed by various ways of evaluation ITS deployment. Some of the important ways of evaluation include: planning level evaluation, deployment tracking, impact assessment, and RP and SP survey.

49.5   References

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