
**Smart community infrastructures —
Best practice guidelines for
transportation**

*Infrastructures territoriales intelligentes — Lignes directrices
relatives aux pratiques optimales pour le transport*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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Introduction

A well-functioning community infrastructure, of which energy (power), water and wastewater, solid waste disposal, information and communications technology and transportation are essential elements, is critical to the quality of life and economic productivity of any city or human settlement. Transportation plays a highly visible role in the lives of residents, ensuring people can get to work, engage in social activities, take part in commerce and access cultural institutions and any other amenity the city offers. In addition, transportation networks are needed for the distribution of goods throughout a city or region. Inadequate or poorly designed transportation systems can create significant economic costs from lost productivity, environmental impacts and health problems.

The features and services provided by such infrastructures are intended to assist people in communities with their businesses and lives, and to help stimulate activities to promote their businesses and enhance their lives by providing opportunities to come to, stay in and move within/outside communities. People do not want to spend all their time at home or in an office, even though improved information and communication technologies would bring them possibilities to do business or take action anywhere they like and anytime without moving. There is more to life than just business supported by electronic communication. People want to be able to move around independently and see, hear, touch, taste and smell directly what they have an interest in.

Transportation networks can be very complex, interweaving many different modes: by air, ship, ferry, train, truck and passenger vehicle, and by human-powered modes, like walking or biking. In particular, transportation serviced for intra-/inter-city communication by commuter rail, inter-city rail, high-speed rail, metro, trams, monorail, light rail transit, automated guideway transit systems, buses, trucks, ferries and air vehicles is popular and convenient for people, including the disabled, the elderly and those whose physical performance is declining, working or living in communities and coming to or out from there. This is because such means of transportation successfully convey passengers, delivery items and freight in large lots, punctually and at low cost, supported by established basic technologies that have developed over a long period and that are still being steadily improved even now. Cities need to have transportation systems that meet the needs of a diverse group of users, including commuters both within and outside the city, persons with disabilities and the elderly, and those shipping freight or other goods and parcels.

This document describes how transportation is planned, designed, implemented, operated, maintained and upgraded to take into account the points of view of different stakeholders, including the residents and governing authorities of communities, as well as the needs of the environment. This document also outlines minimum conditions to be respected in the performance of transportation systems, even after they have been installed, in order to realize the objectives of a smart transportation infrastructure, i.e. economically efficient transportation systems that meet or exceed user needs while minimizing environmental impact.

Decisions ranging from large-scale planning and investments to individual choices can shape the impact of transportation systems on a city. Decision makers need to think critically about transportation modes, as well as the features and services of those modes, to ensure the positive impacts of transportation infrastructure outweigh the potential negative impacts. In addition, given that populations and technologies change, decision makers need to monitor transportation systems to ensure that they continue to meet transportation goals. This document describes the smart transportation objectives and offers support for the development of integrated urban mobility plans, including the selection and application of transportation services.

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Smart community infrastructures — Best practice guidelines for transportation

1 Scope

This document provides general guidance on the planning, design, development, organization, monitoring, maintenance and improvement process of smart transportation systems and infrastructures, which can help promote solutions for intra- and inter-city issues, i.e. for issues both within and outside the city that impact quality of life, the environment or any other areas of city performance. This document applies to transportation infrastructures used for the movement of people, freight or other goods, including items transported for delivery.

This document is intended for use by city planners and other community decision makers, government officials, insurance providers, investment and financing organizations, transportation operators and service providers and manufacturers of transportation equipment. In particular, this document is intended to be used by those involved in making decisions about transportation modes to meet the objectives related to affordability, convenience, low environmental impact and reliability, while satisfying the needs of a diverse group of stakeholders, including city residents, visitors, government authorities, transportation operators.

This document addresses smart transportation by considering the factors that shape communities, such as population, demographics, locations, local culture and history. It addresses the scope of services, features and objectives to be met through smart transportation solutions. This document does not contain technical specifications for the construction of transportation assets or facilities.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <http://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1 city issue

problem or challenge that negatively impacts the quality of life for residents, visitors and workers in cities, the environment or any other aspects of city performance

3.2 transportation mode

specific means by which passengers, freight or goods, including delivery items, move throughout a city or area

3.3 transportation feature

feature of transportation technologies

EXAMPLE A feature of a light rail transit (LRT) system is that it can transport a specified number of passengers each hour.

**3.4
transportation service**

service provided by *transportation features* (3.3)

**3.5
transportation infrastructure**

infrastructure platforms that support *transportation services* (3.4)

**3.6
smart transportation solution**

solution to one or more *city issues* (3.1) provided by transportation systems that meets the needs of various city users

**3.7
smart transportation**

transportation that provides *smart transportation solutions* (3.6) given by *transportation services* (3.4)

**3.8
private transportation**

transportation that is personally owned

**3.9
public transportation**

transportation provided to the public

**3.10
transportation modality**

modality by single or multiple modes of public and/or private transportation for passengers, delivery items and freight

4 Fundamentals

4.1 Basic ideas and goals

The suitability or applicability of any particular technology or services to a smart transportation solution depends on the transportation mode and its technical and/or business case characteristics.

Smart transportation solutions support sustainable community development and align with the standards and existing framework that also support that goal. For example, ISO 37101:2016 identifies six areas critical for the development of smart and sustainable communities:

- attractiveness;
- preservation and improvement of the environment;
- resilience;
- responsible use of resources;
- social cohesion;
- well-being.

The objectives listed below, which demand smart transportation solutions, all support the overarching goals of ISO 37101:2016, Table A.1.

In addition, the 14 community needs identified in ISO/TS 37151:2015 that infrastructure performance should be measured against (availability, accessibility, affordability, safety and security, quality of services, operational efficiency, economic efficiency, performance information availability, maintainability, resilience, effective resource use, climate change mitigation, pollution prevention, and eco-system conservation) align with one or more of the objectives listed below (see [Table A.2](#)).

Objectives to be considered when evaluating the performance of transportation in the context of achieving smart transportation are as follows:

- to provide all persons, including children, the disabled, the elderly and those whose physical performance is declining, and economic actors with the means for convenient and productive lives and economic activity;
- to promote lifestyles that are not dependent on private automobiles;
- to promote transit-oriented development;
- to ensure convenient access to city markets, resources and amenities;
- to stimulate economic activity in downtowns or economically depressed areas of the city;
- to increase the city's competitiveness and status compared to other cities regionally, nationally or globally;
- to decrease the impact of human activities on the environment;
- to plan and develop transportation facilities and services based on well-sourced, stakeholder driven plans that consider budget resources and pay-back periods, safety and security, facility capacity versus projected need and environmental impacts;
- to preserve and enhance the scenic, aesthetic, historic, cultural and environmental resources of the community.

4.2 Location and objective for the development and installation of transportation infrastructures to provide smart transportation solutions

4.2.1 General

Transportation features and services should be selected and applied to achieve smart transportation solutions either within a single community or between communities within a larger region.

Transportation investments should be prioritized to achieve one or more of the objectives listed in 4.1, when the transportation is subsidized. To aid in the process of prioritizing the issues transportation infrastructures should address, community decision makers should develop an integrated urban mobility plan that identifies factors that shape transportation needs and choices and compares these factors to those that shape the smart community objectives.

EXAMPLE 1 Karlsruhe, Germany, is the first city to successfully organize through operation of LRT rolling stock between LRT lines in the city centre and heavy rail lines by Deutsche Bahn. By starting the passenger services in 1992, the LRT network was serviced in a wider area including the city centre and suburbs resulting in easy commutation for the people living and working in the area covered with the services.

EXAMPLE 2 Nagoya, Japan, installed a specific bus system or guided bus transportation. Basically, Nagoya City and the areas surrounding it have bus services as inside transportation for each city or area. However, the passengers' number increased, who commute between Nagoya and the surrounding areas. To provide a higher capacity for the commutation but not to change the transportation mode or bus that the citizens are already used to, Nagoya City installed a bus transportation system running vehicles inside Nagoya City and in the surrounding areas as a normal bus and between Nagoya City and the areas as a rapid bus running in an exclusive guideway.

4.2.2 Location where transportation infrastructures should be installed to achieve smart transportation solutions

Transportation infrastructures for smart transportation solutions may be installed in the following locations:

- within a region or a community;
- on routes connecting regions;

- on interfaces of transportation inside/outside communities;
- as improvements to existing transportation infrastructures.

An integrated urban mobility plan should, to the maximum extent practicable, identify for users the factors that shape the locational needs of transportation infrastructures, such as:

- size, location and demographics of residential population centres within and surrounding the city or community;
- location of low- and moderate- income households and the distance to affordable public transportation, as well as the potential impact improvements to transportation infrastructures could have on housing affordability;
- size and location of areas of commercial activity and employment within and outside the community;
- flow of freight and/or goods through a community;
- inventory of existing transportation facilities and assets;
- current transportation patterns, including mode use and traffic levels;
- current costs of the transportation system;
- environmental impacts of current transportation activity.

4.2.3 Objectives for smart transportation infrastructures

When making decisions about transportation infrastructures, planners should identify the options:

- to transport people, freight and goods safely, reliably, conveniently, efficiently and economically;
- to provide transportation services that satisfy demand;
- to reduce environmental impact without reducing the quality of the transportation services;
- to improve the efficiency of connections between different modes of transportation;
- to reduce the total energy usage of the transportation infrastructure;
- to make transportation operation economically sustainable while ensuring it is affordable and accessible to all users;
- to improve communication to the public about all aspects of transportation services.

The above-mentioned objectives can be achieved by ensuring the transportation systems to be installed:

- to convey passengers, delivery items and freight safely;
- to convey passengers, delivery items and freight, especially when they are in a large lot;
- to convey passengers, delivery items and freight at a time;
- to convey passengers, delivery items and freight on time;
- to convey passengers, delivery items and freight as planned;
- to convey passengers, delivery items and freight at a low cost;
- to provide dense networks for transport;
- to provide frequent services for transport;

- to provide successful and easy connection for transport between different transportation systems or modes;
- to communicate where no public transportation is available;
- to communicate anytime, especially without being concerned about public transportation schedules;
- to communicate at convenience of passengers and senders/recipients of delivery items and freight;
- to communicate personally while securing privacy;
- to control total energy saving/consumption for transportation;
- to lower environmental load without degradation in service quality of transport operation.

With planning integrated urban transportation, the plan should enable:

- the transport of people and goods safely, reliably, efficiently and economically;
- the provision of networks appropriate for transportation needs, especially investing in and improving existing infrastructures;
- the creation of frequent services for transport;
- the provision of efficient connections for transport between different transportation systems or modes;
- the lowering of the total energy saving/consumption for transportation;
- the lowering of environmental impact without degradation in service quality of transport operation;
- the economically stable operation of transportation with fares that are reasonable or payable by local citizens.

4.3 Consideration of city planning

Selection of transportation features and services should fit together with city or regional planning and planning covering national boundary areas to provide smart transportation solutions in communities including national boundary areas. Such planning includes plans listed below:

- master plans for a city and a region (e.g. urban structures, use of land);
- general plans for transportation in a city and a region;
- master plans for a city and a region including national boundary areas (e.g. urban structures, use of land, sightseeing and exchange induction, welfare, local economy, housing and the residential environment, natural environment preservation, disaster prevention);
- general plans for an area having cities;
- developing plans using transportation services for a huge area fondly called a megalopolis;
- general plans for inter-city transportation networks;
- economy-developing plans for specific areas having cities connected by high-speed communication;
- co-operative developing plans for national boundaries.

5 Selection of transportation modes, features and services for smart transportation solutions in communities

5.1 General

This clause helps those with an interest in introducing transportation as solutions or smart transportation (e.g. governors, transportation operators) find the features of smart transportation to be set up by selecting transportation modes and features.

To solve specific city issues by introducing suitable transportation, transportation modes, features and services should be selected and installed to meet the needs of stakeholders and for the convenience for transportation users and to achieve smart transportation solutions. From the potential options identified in the integrated urban transportation plan, planners including stakeholders should determine which modes, features or services best advance smart transportation goals. Those goals should be designed and chosen to address city issues.

A planning phase is necessary to install transportation features and services that are deduced by transportation modes to be selected. This is because each transportation has its own transportation features that bring specific transportation services. The selection of transportation modes should carefully be determined by smart community governors, planners or developers to have public transportation carriers or private transportation holders/users successfully introduce smart transportation solutions aiming at solutions to the issues.

NOTE The selection of transportation mode is a critical step in introducing smart transportation into communities since the investment in transportation infrastructures can create path dependencies that will shape and effect the community far into the future. Care can help to emphasize modes that reduce the use of private vehicles and made the best possible use out of existing assets and facilities.

5.2 Selection criteria

5.2.1 General

The following criteria should be taken into consideration when selecting appropriate transportation modes, features and services.

5.2.2 Parameters to be considered in the selection of public transportation modes

In making decisions about public transportation investments, transport capacities between different potential modes (i.e. rail or bus) should be compared (see [Figure B.1](#)), as well as potential routes, the number of anticipated riders, transporting distances, the availability of land (for rail), carrying performance required (number of riders per hour), service speed (km/h), and budget scale. For good selection, some of such parameters should be combined for comparison.

5.2.3 Subsidization to transportation operating business

Basically, transportation business is run with two aspects; one is as public work and the other as private business. The former is nowadays common, including private company-operating business partly subsidized, while the latter is not easy or successful due to difficulties in operating transportation business with good financial management. In case private business is partly or fully subsidized, it is not necessarily private business but sort of public work. Private business is run to seek profit while public work is organized for public welfare. Then, the direction of operation of transportation business depends on management with/without subsidized.

Transportation decision makers should analyse the business cases and the availability of funding to determine how different funding models will affect transportation services, maintenance and other aspects of transportation systems.

5.2.4 Transportation mode

Transportation modes for smart transportation solutions on surface to be selected to apply as a smart community infrastructure, which are included in this document, are:

- rail;
- commuter buses/bus rapid transit/inter-city buses;
- trucks;
- ferries;
- pipelines;
- air vehicles;
- walking;
- bicycles;
- motorbikes;
- automobiles;
- boats;
- transportation devices assisting passengers, delivery items and freight in moving in stations and terminals (e.g. elevators, escalators, moving walkways, conveyers);
- vehicles or systems and their additional instruments assisting mobility-impaired persons (e.g. scooters, Segways).

NOTE Rail includes commuter rail, high-speed rail, inter- and intra-city rail, rail serviced directly among key cities, metro, trams, light rail transit (LRT), monorail, automated guideway transit (AGT), high-speed surface transport (HSST), aerial tramways, magnetic levitation trains and linear induction motor trains.

5.2.5 Technical and business contents of transportation modes

5.2.5.1 General

Smart transportation solutions will be developed by using particular modes of transportation. The information below describes some of the technical or business contents of particular transportation modes to be selected to build up smart transportation. This information is helpful in deriving expected services from transportation features that individual transportation modes have.

5.2.5.2 Public transportation

Services to be provided by public transportation depend on what the transportation conveys.

Technical and business aspects in public transportation depend on public transportation modes, which support smart transportation solutions.

a) Rail mode:

- passenger, delivery items and freight services (e.g. customer services at stations and freight yards, refrigerators for delivery items/freight to be kept at low temperature);
- accommodation preparation and management (e.g. water supply, cleaning, air-conditioning, coach brightness adjustment);
- train operation (e.g. scheduling, dispatching, refueling, train crew);

- rolling stock (e.g. accommodations, maintenance, refrigerators for delivery items/freight to be kept at low temperature);
 - power/signalling;
 - communication for train operation;
 - facilities (e.g. stations, tracks, civil engineering structures);
 - safety (e.g. surveillance);
 - the environment (e.g. noise, vibration, pollutant and greenhouse gas emission, sunlight);
 - information availability (e.g. making real-time information available to passengers about service frequency, destinations and cost).
- a) Bus/truck mode
- passenger, delivery items and freight services (e.g. customer services at bus stations, refrigerators for delivery items/freight to be kept at low temperature);
 - bus and truck operation (e.g. scheduling, dispatching, drivers and conductors);
 - refueling/power charging;
 - signalling/bus or truck tracking systems;
 - communication for bus/truck operation;
 - vehicles (e.g. accommodations, maintenance, refrigerators for delivery items/freight to be kept at low temperature);
 - facilities (e.g. bus stations, freight yards, taxi stands, bus and truck lanes on public roads, bus tracks, civil engineering structures for bus/truck operation);
 - information availability (e.g. making real-time information available to passengers about service frequency, destinations and cost).
- c) Ferry mode
- passenger, delivery items and freight services (e.g. customer services at ports, refrigerators for delivery items/freight to be kept at low temperature);
 - ferry operation (e.g. scheduling, dispatching, crew);
 - refueling/power charging;
 - signalling;
 - communication for ferry operation;
 - vessels (e.g. accommodations, maintenance, refrigerators for delivery items/freight to be kept at low temperature);
 - facilities (e.g. ports, ferry terminals, civil engineering structures for ferry operation);
 - information availability (e.g. making real-time information available to passengers and senders/recipients about service frequency, destinations and cost).
- d) Air vehicle mode
- passengers, delivery items and freight services (e.g. customer services at airports, refrigerators for delivery items/freight to be kept at low temperature);

- refueling/power charging;
- air vehicle operation (e.g. scheduling, dispatching, crew);
- aircrafts;
- facilities (e.g. airports, civil engineering structures for aircraft operation).

5.2.5.3 Private transportation

For private transportation, services listed below should be provided to the owners and the drivers or operators of the transportation by the responsible governmental, government-related organizations or manufacturers in charge.

a) General

- work by road administrators (e.g. traffic surveillance, road maintenance);
- work by channel administrators;
- work by air traffic authorities;
- work by police departments;
- work by fire departments;
- work by vehicle, boat and air vehicle manufacturers;
- work by driving or operating licensors;
- green spaces or complete streets for walking and bicycles;
- bicycles sharing services;
- dedicated bicycles lanes.

b) Public transportation for personal use

- rental bicycles;
- rental motorbikes;
- rental cars.

5.2.6 Services provided by transportation

5.2.6.1 General

Services to be provided for the users are as listed below when a transportation mode is selected for smart transportation solutions.

5.2.6.2 Public transportation

a) Passenger services

- train/bus/ferry/air vehicle operation;
- safety for driving;
- weather forecast and information;
- communication of emergencies;

- travel planning;
- easy access to stations, ferry terminals and airports (e.g. pathways with roofs, access formation to connect stations, bus stops, ferry terminals and airports, introduction of passengers);
- ticketing;
- ticket inspection (e.g. at stations, in coaches);
- fare collection;
- connection and change;
- inter-modal connection (e.g. rail and buses/trucks, rail and ferries, buses/trucks and ferries);
- direct through operation (e.g. between different rail carries, between sections with different-gauge tracks);
- information provision and indication (e.g. announcement in stations and coaches, languages, frequency, timing, indication of operation and connection conditions);
- control of passenger flows and goods delivery routes in stations, ferry terminals and airports;
- assistance to the disabled, the elderly and those whose physical performance is declining;
- food business (e.g. cafeterias, restaurants, dining cars, minibars on trains);
- shop operation;
- advertisements;
- internet connection;
- convenient location of stations, bus stops, ferry terminals and airports in a city;
- appropriate station and bus stop intervals in distance;
- business introduced into transportation facilities other than transportation services (e.g. nurseries, polling places);
- coach accommodations (e.g. formation, service equipment);
- clean vehicle bodies and accommodations (e.g. no graffiti, no trash, no odours);
- delay minimization;
- optimization of the passenger capacity of coaches or train sets/buses/ferries/air vehicles;
- electronic fare payment through banks;
- varieties of choices of travelling means;
- arrangements at emergency (e.g. providing detours by other carries or transportation modes);
- fare adjustment at accidents (e.g. ticket refund, free change of tickets, extension of ticket valid periods);
- fare selection depending on a variety of customers' demand and trends;
- flat-rate fare in a specific zone;
- freight (fare) pool systems;
- affordable fare.

b) Delivery items/freight services

- train/bus/truck/ferry/air vehicle operation;
- safety for driving;
- weather forecast and information;
- communication at emergency;
- shipping/receiving planning;
- pick-up/delivery services;
- storage services;
- delivery items/freight tracking (e.g. registering at picking-up, shipping and delivery);
- packing/unpacking services;
- safe-handling for fragile or flammable items (e.g. item packing with transparent materials for easy recognition of contents);
- time and date appointment for pick-up and delivery;
- electronic fare payment through banks;
- pick-up/delivery services in a building or an area;
- door-to-door pick-up/delivery services with containers in cities.

5.2.6.3 Private transportation

a) Common vehicles

- safety for driving;
- control of private transportation;
- comfortable road conditions (e.g. line shapes, visibility, pavement);
- traffic information (e.g. congestion, traffic control, road maintenance work);
- service information (e.g. energy station and shop location);
- information on connection to other transportation (e.g. train, bus and ferry timetables);
- weather forecast and information;
- information signs;
- emergency calls;
- energy stations (e.g. gas, LPG, electric power, hydrogen);
- parking lots;
- vehicle sharing;
- rental vehicles;
- green spaces or complete streets for walking and bicycles;
- bicycles sharing services;

- dedicated bicycles lanes.
- b) Pooling vehicles
 - rental bicycles;
 - rental motorbikes;
 - rental cars.

5.2.7 Feasibility of transportation business

When providing smart transportation solutions in communities, feasibility of transportation business technically and financially supporting such smart transportation solutions should be confirmed in advance from the viewpoints of:

- payability (e.g. forecast for demand, estimation of costs required, financing arrangements);
- business cases expected by installing transportation.

6 Application of selected transportation features and services

6.1 General

In order to enable transportation features and services to effectively work to solve specified city issues and to realize smart transportation solutions in communities, certain conditions should be respected when applying transportation features and services to transportation operation.

This clause will help those organizing smart transportation (i.e. the transportation carriers and operators) to solve specified city issues by using features and services provided by selected transportation modes.

6.2 Conditions for transportation features

Transportation features should allow transportation services to offer smart transportation solutions on a user-oriented basis. Transportation carriers should provide such services for their customers or users from the viewpoint of citizens.

6.3 Conditions for transportation services

6.3.1 General

Transportation services in communities should be established by preparing, combining, assembling or introducing appropriate transportation features to provide transportation services that directly offer smart transportation solutions to the users (e.g. see [Table C.1](#) for the service conditions to organize smart transportation for compact cities). The transportation services should satisfy the 14 needs identified in ISO/TS 37151:2015, Table 3 for the benefit of the users.

6.3.2 Services in the same transportation mode

In the same transportation mode, through-transportation transport should be offered as transportation services to the users as listed below:

- through train operation (performing availability, accessibility, operational efficiency and economic efficiency) (e.g. conventional rail and metro or LRT, electrified and non-electrified sections);
- operation with good connection in time and place between different carriers (performing availability, accessibility, quality of services, operational efficiency and economic efficiency) (e.g. connection between private and government-operated rail carriers);

- ticketing for travelling to other carriers (performing availability, accessibility, quality of services, operational efficiency and economic efficiency);
- arrangements for shipping to other carriers (performing availability, accessibility, quality of services, operational efficiency and economic efficiency);
- long distance and high-speed transportation (performing availability, accessibility, quality of services and economic efficiency) (e.g. inter-city high-speed trains, magnetic levitation trains);
- strategic commuter services (performing availability, accessibility, quality of services and operational efficiency) (e.g. direct connection of key stations downtown and in the suburbs)
- large network transportation systems (performing availability, accessibility, operational efficiency and economic efficiency) (e.g. multiple inter-rail carrier through train operation to bring people from a huge area to specific spots).

6.3.3 Inter-modal services

Among different transportation modes, inter-modal transport should be performed as transportation services for the users as listed below:

- inter-modal operation or operation with good connection in time and place between/among different transportation modes (performing availability, accessibility, quality of services, operational efficiency and economic efficiency) (e.g. connection of rail and buses, train operation to send/receive passengers, delivery items and freight to/from bus and ferry services);
- ticketing for travelling using inter-modal transport (performing availability, accessibility, quality of services and operational efficiency);
- ticketing for travelling to other carriers (performing availability, accessibility, quality of services and operational efficiency);
- communication with other carriers on the travel needs of the disabled, the elderly and those whose physical performance is declining (performing availability, accessibility and quality of services);
- arrangements for shipping to different-mode carriers (performing availability, accessibility and quality of services);
- reshipment of delivery items and freight at junctions (performing availability, accessibility, quality of services and economic efficiency).

6.3.4 Services on interfaces between public and private transportation

Between public and private transportation, easy changes from public to private transportation and vice versa should be organized as transportation services for users as listed below:

- temporary stops for private vehicles (performing availability, accessibility and quality of services);
- assistance to the disabled, the elderly and those whose physical performance is declining with changes between public and private transportation (performing availability, accessibility and quality of services);
- parking lots for private vehicles including bicycles, motorbikes and cars (performing availability, accessibility and quality of services);
- return delivery services for private vehicles including bicycles and motorbikes (performing availability, accessibility, quality of services and economic efficiency);
- on-board services for private vehicles including bicycles, motorbikes and cars (performing availability, accessibility and quality of services);

- private vehicle shipment (performing availability, accessibility, quality of services and economic efficiency);
- safe access for persons walking to/from transportation facilities (performing availability, accessibility, affordability, safety and security, quality of services and economic efficiency) (e.g. skywalks, pedways, sidewalks);
- easy access for persons walking to/from transportation facilities (performing availability, accessibility, affordability, safety and security and quality of services) (e.g. elevators, the escalators, moving walkways, sidewalks with a roof or protectors);
- convenient access for persons walking to/from transportation facilities (performing availability, accessibility, quality of services, operational efficiency, economic efficiency, effective use of resources) (e.g. kiosks, convenience shops, travel item shops, shoes and umbrella shops, first-aid stations, clinics, post offices, posts, stationary shops, internet access areas, fast food shops, restaurants, public phones, bank automated teller machines).

6.4 Monitoring of the performance of smart transportation

Transportation systems in a community should be regularly monitored to determine whether smart transportation solutions are still being provided and where improvements should be targeted. One possible monitoring system is ISO/TS 37151, which helps users establish performance metrics to measure how well infrastructure meets community needs.

7 Optimization of transportation services, features and modes along with generation and social trend changes

7.1 General

In general, technologies will be improved or discarded along with changes in demands, taste and culture while generations alternate or social trends change. Then, transportation services should be optimized to follow the latest states or situations taking place to communities currently existing and expected in the future. To optimize transportation service contents and quality for such a situation, transportation services, features and modes should be improved, changed or discarded to successfully provide smart transportation solutions even while such changes come up in communities.

7.2 Optimization of transportation services for current and future communities

To continually make smart transportation solutions advantageous to the users, transportation services supporting smart transportation solutions should be optimized for the situations of communities currently existing and expected in the future by choosing/discarding transportation features, improving them or introducing new features created with developed or innovated technologies.

7.3 Holding/discarding transportation features used for currently existing communities

To prepare suitable transportation services for smart transportation solutions, transportation features should be chosen/discarded, employed or changed, if necessary. Transportation features currently used should be checked at a certain time interval for their suitability and applicability to transportation services supporting smart transportation solutions offered/to be offered to the current and expected communities.

7.4 Reselection of transportation modes used for currently existing communities

To successfully organize smart transportation solutions by making its performance suitable to communities currently existing and expected in the future, transportation modes that have been used

should be reconsidered. The decision to hold or reselect transportation modes should be made by smart community governors, planners or developers.

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Annex A (informative)

Potential or expected smart transportation performance or features

[Table A.1](#) and [Table A.2](#) show the potential or expected smart transportation performance or features corresponding to the six purposes indicated in ISO 37101:2016.

Table A.1 — Potential or expected smart transportation performance or features for public transportation corresponding to the six purposes in ISO 37101:2016

Purposes	Public transportation				
	Rail	Bus	Ferry	Air vehicle	Others
Attractiveness	<ul style="list-style-type: none"> — Places (stations) to invite citizens to provide convenience and opportunities thereto — Steady transport- 	<ul style="list-style-type: none"> — Places (bus stations and stops) to invite citizens to provide convenience and opportunities thereto — Easy rides 		<ul style="list-style-type: none"> — Distant transport — Rapid delivery 	(Truck) <ul style="list-style-type: none"> — Easy shipping
Preservation and improvement of the environment	<ul style="list-style-type: none"> — Transport preserving nature by electric rail operation — Transport preserving nature by battery-powered rail operation — Low greenhouse gas emission operation 	<ul style="list-style-type: none"> — Transport preserving nature by battery-powered bus 	<ul style="list-style-type: none"> — Transport preserving nature 	<ul style="list-style-type: none"> — Rapid delivery 	
Resilience		<ul style="list-style-type: none"> — Capacity to take detour 		<ul style="list-style-type: none"> — Capacity to take detour 	(Truck) <ul style="list-style-type: none"> — Capacity to take detour

Table A.1 (continued)

Purposes	Public transportation				
	Rail	Bus	Ferry	Air vehicle	Others
Responsible resource use	<ul style="list-style-type: none"> — Large capacity transport — Recycled rolling stock — Adjustable voltage adjustable frequency train running 	<ul style="list-style-type: none"> — Recycled rolling stock 	<ul style="list-style-type: none"> — Large capacity transport 	<ul style="list-style-type: none"> — Large capacity transport 	
Social cohesion	<ul style="list-style-type: none"> — Easy accessibility to dense networks — Networks covering large areas — Mass transit — Low price transport — Service availability to all citizens — Mass transit 	<ul style="list-style-type: none"> — Easy accessibility to dense networks — Low price transport — Service availability to all citizens 	<ul style="list-style-type: none"> — Low price transport — Service availability to all citizens — Low price transport — Mass transit 	<ul style="list-style-type: none"> — Low price transport — Service availability to all citizens — Mass transit 	<ul style="list-style-type: none"> (Truck) — Easy accessibility — Networks covering large areas — Low price transport — Service availability to all citizens — Mass transit
Well-being	<ul style="list-style-type: none"> — Networks covering large areas — Rapid communication — Mass transit 	<ul style="list-style-type: none"> — Easy accessibility to dense networks 	<ul style="list-style-type: none"> — Mass transit 	<ul style="list-style-type: none"> — Mass transit — Rapid communication 	<ul style="list-style-type: none"> (Truck) — Networks covering large areas — Mass transit

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Table A.2 — Potential or expected smart transportation performance or features for private transportation corresponding to the six purposes in ISO 37101:2016

Purposes	Private transportation					
	Walking	Bicycle and motorbike	Automobile	Boat	Air vehicle	Others
Attractive-ness	<ul style="list-style-type: none"> — Transportation which can be scheduled at any time — Transportation which can be arranged for any route — Transportation which can adapt to capacity — Transportation which can connect with any other transportation 	<ul style="list-style-type: none"> — Transportation which can be scheduled at any time — Transportation which can be arranged for any route — Transportation which can adapt to capacity — Transportation which can connect with any other transportation 	<ul style="list-style-type: none"> — Transportation which can be scheduled at any time — Transportation which can be arranged for any route — Transportation which can adapt to capacity — Transportation which can connect with any other transportation 	<ul style="list-style-type: none"> — Transportation which can be scheduled at any time — Transportation which can be arranged for any route — Transportation which can adapt to capacity — Transportation which can connect with any other transportation 	<ul style="list-style-type: none"> — Transportation which can be scheduled at any time — Transportation which can be arranged for any route — Transportation which can adapt to capacity — Transportation which can connect with any other transportation 	
Preservation and improvement of the environment	<ul style="list-style-type: none"> — Transportation preserving nature — Environmental-friendly transportation 	<ul style="list-style-type: none"> — Transportation preserving nature — Environmental-friendly transportation 		<ul style="list-style-type: none"> — Transportation preserving nature — Environmental-friendly transportation 		(Hydrogen cell vehicle) — No environmental-load
Resilience	<ul style="list-style-type: none"> — Transportation which can be recovered at any time 	<ul style="list-style-type: none"> — Transportation which can be recovered at any time 				
Responsible resource use						
Social cohesion	<ul style="list-style-type: none"> — Contributions to human health 	<ul style="list-style-type: none"> — Contributions to human health 				
Well-being	<ul style="list-style-type: none"> — Contributions to human health — Owner-/ driver-/ operator-arranged travel 	<ul style="list-style-type: none"> — Contributions to human health — Owner-/ driver-/ operator-arranged travel 	<ul style="list-style-type: none"> — Owner-/ driver-/ operator-arranged travel 	<ul style="list-style-type: none"> — Owner-/ driver-/ operator-arranged travel 	<ul style="list-style-type: none"> — Owner-/ driver-/ operator-arranged travel 	

Table A.3 and Table A.4 show the potential or expected smart transportation performance or features corresponding to the 14 needs identified in ISO/TS 37151:2015, Table 3.

Table A.3 — Potential or expected smart transportation performance or features for public transportation corresponding to the 14 needs in ISO/TS 37151:2015

Needs	Public transportation				
	Rail	Bus	Ferry	Air vehicle	Others
Availability	<ul style="list-style-type: none"> — For compact cities — Dense networks — Through operation — Park and ride — Information services — Vertical transportation services in stations — Business in stations 	<ul style="list-style-type: none"> — For compact cities — Dense networks — Park and ride — Information services — Vertical transportation services in stations — Business in stations 	<ul style="list-style-type: none"> — Park and ride — Information services — Vertical transportation services in stations — Business in ferry terminals 	<ul style="list-style-type: none"> — Business in airports 	<ul style="list-style-type: none"> — Frequent pick-up/delivery — Scheduled transport — Door-to-door transport — Pick-up and delivery services at specific places — Delivery item transport for specific purposes
Accessibility	<ul style="list-style-type: none"> — For the disabled, the elderly and those whose physical performance is declining — Dense networks — Through operation — Station numbering — Park and ride — Information services — Vertical transportation services in stations 	<ul style="list-style-type: none"> — For the disabled, the elderly and those whose physical performance is declining — Dense networks — Station numbering — Park and ride — Information services — Vertical transportation services in stations 	<ul style="list-style-type: none"> — For the disabled, the elderly and those whose physical performance is declining — Station numbering — Park and ride — Information services — Vertical transportation services in stations 		
Affordability	<ul style="list-style-type: none"> — Tariff optimization — City planning 	<ul style="list-style-type: none"> — Tariff optimization — City planning 	<ul style="list-style-type: none"> — Tariff optimization — City planning 	<ul style="list-style-type: none"> — City planning 	
Safety and security	<ul style="list-style-type: none"> — Rolling stock arranged for disabled persons 	<ul style="list-style-type: none"> — Rolling stock arranged for disabled persons 			