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**QUALITY OF SERVICE CONCEPT**

Note by the secretariat

**1. Introduction**

Quality of service is a very complex and multifaceted concept. Transport users are entering the transport market where they find transport services produced by a variety of competing providers, both within the same mode of transport and often by competing modes. The choice made by the user/customer is based on many considerations. For passengers, for example, the priority in selection of a particular service may be given on the basis of travel time, comfort, accessibility, price or any combination of quality criteria. For freight transport users, the decision to engage a particular transport provider may also be based on a number of considerations, which may take into account different aspects of the quality of service (reliability, accessibility, transport time, safety, etc.)

In an attempt to systematize the current thinking about the concept of the quality of service and explore the possibility for developing a common approach to the concept, the secretariat presented at the fifteenth session of the Working Party an Informal paper listing a number of relevant considerations. Following the decision at the mentioned session, this Informal paper was circulated to member countries. Circulation of the secretariat's Informal paper No.1 (2002) had produced a number of replies (see documents TRANS/WP.5/2003/9 and Add.1-2). Most of the replies point to several important conclusions:

- it would be useful to use results of national and international analyses and their results in developing the concept of the quality of service;
- it is necessary to define the concept of the quality of transport service, especially in the international context, in order to allow the comparison of indicators of the quality;
- number of indicators should be limited to a manageable set;
- if it is not possible to develop quantitative indicators, they could be defined in qualitative terms;
- priority should be given to the development of indicators that reflect the user's point of view regarding the quality of service;
- ideally, separate criteria and indicators of the quality of service would need to be developed for passenger and freight transport and for different geographical coverage (national, regional, municipal, etc. level).
- time dimension is important for some quality indicators and for the discussion of the level of service (for example, traffic volumes and road conditions vary with time – peak and off-peak hours are important for flows on some roads while other roads operate close to their capacity throughout 12 hours of the day);
- the data on traffic flows and road capacity, as well as many other data originating from different national authorities, which are necessary for quantifying some of the indicators must be reliable.

One view is that the quality of service reflects the users' perception of transport performance and measures the availability of transport service, its comfort, convenience and other elements. The quality of service depends to a great extent on the operating decisions made by providers of transport services, especially decisions on where the transport service should be provided, how often and how long it should be provided, and what kind of service should be provided. Finally, the quality of service is also the result of the conditions in which the operator is working. These conditions are partly in the hands of public authorities in charge of transport, traffic management, etc.

## **2. Quality of service criteria**

The quality of service could be defined from various viewpoints - users, operators, ministry/agency, community or Government. Different viewpoints and the corresponding definition will also determine the criteria of the quality of service, and consequently indicators. Starting with the user or customer, the quality of service reflects users'/passengers' perception of the transport service and it could be defined as – the overall measured or perceived performance of transport service from the users'/passengers' point of view.

If the viewpoint of the operator is taken, the quality of service could then be defined in relation to economic or business indicators (effectiveness, efficiency, costs, etc.). This viewpoint may also include a comparison of the quality of competitive services offered in the same mode or between different modes (for example, high-speed train link between an airport and a city centre compared to public bus-transport on the same relation).

The ministry/agency's point of view on the quality of service must take into account the effectiveness and efficiency of providing the service and how individual departments, units and the agency as a whole perform their functions. From this point of view, the definition of the quality of service needs to take into account services that the agency delivers and organizational, managerial and other aspects of its functioning. From the community viewpoint, the quality of service concerns the effects of provision of transport services on the community it serves and role of transport in meeting community objectives, such as mobility needs, access to jobs and schools, reduction of pollution, etc.

Finally, from the Government point of view, the quality of service criteria may need to take into account aspects such as costs, safety, capacity constraints, coverage of networks, environmental aspects, etc.

The possibility that different points of view on the quality of service could be formulated implies that quite different criteria may become relevant depending on which point of view is considered. For example, the criteria of availability might be decisive for users' point of view and less relevant for Government or provider of service. Travel time on a particular relation and in comparison to another mode, or in comparison to an ideal value as an indicator of the quality of transport service is an important criterion for users and providers of the service, but might be less so for communities or Governments.

This document offers two variants of the treatment of the quality of service based on two different viewpoints: that of the Government and that of the user of the transport services. If the viewpoint of the Government is taken, the corresponding indicators of the quality of service should then be determined in such a way that they best reflect the legitimate concerns of the Government in relation to the quality of service. However, if the viewpoint of the user is taken, then the set of indicators must be established in a way which best expresses users' perception of the quality of service (such as, for example, availability, accessibility, travel time, customer care, comfort, etc.).

Considering the quality of service from other viewpoints as mentioned earlier would imply the use of other criteria and indicators of the quality. Operators would probably assess the quality of service they provide and compare with other providers, by taking into account elements such as: capacity utilization, production costs, production costs components, financial and technical performance and appropriate indicators.

Governments, however, tend to consider aspects such as legal and operational framework, safety and security, environmental impacts and appropriate indicators allowing quantification and comparison of quality indicators for competing services within one mode and between different modes.

Informal document No. 1 (2002) offered a possible menu of options that could be used if other than Governments' point of view on quality of service is taken.

Therefore, bearing in mind that the point of view taken is that of the Government, possible criteria for the quality of service in transport sector could be:

- operational and legal framework
- safety and security
- environmental impacts

## 2.2. Quality of service indicators from Governments' point of view

Quality of service indicators are defined in relation to the quality of service criteria and should make possible and facilitate the quantification of criteria, measurement and comparison of various quality levels.

### 2.2.1. Operational and legal framework

The influence of the legal and operational framework set up by Government's regulatory and policy actions on the environment in which operators provide their services may be significant for the performance of operators and the quality of service they produce. This fact becomes especially important if benchmarking is on an international level, and the quality of services provided by operators from various transport systems is compared. The legal and operational framework may significantly vary nationally as well, and various Government policies could create more favourable operational and legal conditions for one transport mode than for another.

Table 1: Legal and operational indicators

<b>Name of the Indicator</b>	<b>Definition</b>
Degree of competition	Degree of competition between the various operators. Rate: monopoly=0, moderate competition=1, strict competition=2
Public transport passenger trips	Percentage of public-transport trips to total trips (pedestrian, bicycles, public transport, private-cars) in the operational area. [%]
Normal fare [Euro]	Normal fare (Euro) for a month of public transport use
Receipts from public sector for investments in infrastructure and rolling stock	Percentage of public receipts for investments in public transport infrastructure and rolling stock related to total investments [%]

### 2.2.2. Safety and security

Safety and security indicators cover three aspects. Safety on the one hand implies the actual traffic safety of users and operators from accidents, as well as the safety of the working environment from accidents. Security implies passengers' perception of security in vehicles and terminals.

Table 2: Safety and security indicators

<b>Name of the Indicator</b>	<b>Definition</b>
Traffic safety	Ratio of passenger injuries by 10 <sup>6</sup> passenger km [number/10 <sup>6</sup> pass. km]
Employee safety	Percentage of injuries by number of employees; percentage of criminal attacks on employees
Driver training	Number of in-service training hours per total number of drivers a year [training hours/total number of drivers]
Security at stops and stations/ freight terminals and transfer points	Measure of passengers'/users sense of security at the stops and stations/ freight terminals and transfer points. Rate 1=poor to 6=excellent
Security in vehicles	Measure of passengers'/users sense of security in passenger and freight vehicles. Rate 1=poor to 6=excellent

### 2.2.3. Environmental impact

Environmental impacts by various transport services could also be used as criteria for evaluating their quality. Services having less negative environmental impact could be viewed as having a higher overall quality rating and vice-versa. Environmental impacts could be expressed by a number of indicators, but for this purpose the following two are proposed:

Table 3: Environmental impacts

<b>Name of the Indicator</b>	<b>Definition</b>
Quality of vehicles	Number of vehicles failed in emission test per 100 tested vehicles
Emissions	Emissions of CO <sub>2</sub> , non-methane volatile organic compound (NMVOC) and nitrogen oxide (NO <sub>x</sub> ) per 10 <sup>6</sup> vehicle km
Noise levels	Percentage of population exposed to road traffic noise levels above 55 Ldn dB; and percentage of population exposed to rail noise above 55 LAeq dB.
Land take	Land take by roads and railways as percentage of country surface
Exposure	Exposure of urban population to daily mean SO <sub>2</sub> concentrations of more than 125 mg/m <sup>3</sup> (in number of residents)

### 2.3. Quality of service indicators from the users' point of view

If the users' viewpoint is taken as the basis of consideration of the quality of service, the indicators that might be used in this context considerably differ from those used for the Government. They include, availability, accessibility, time, reliability, customer care, etc.

#### 2.3.1. Availability

Availability may refer to spatial availability (networks), capacity availability (modes and operations), or temporal availability. Availability relates to issues such as where and when service is provided, whether a sufficient capacity is available for passengers to take trips at the desired time, or whether a sufficient capacity is provided for freight transport services at the desired locations, etc. Availability may be expressed in terms of the average distance to boarding/alighting or loading/unloading points, need for transfers, coverage of the area, operating hours, frequency of service or vehicle load factors. Some of these indicators would be difficult to obtain even on the national level, and let alone in the international context.

Availability as a criterion of the quality of service is more related to the public passenger transport but could also be developed and used in evaluating the quality of service in the inter urban transport. For example, the availability of rail and road passenger transport services on a particular city-to-city link, might tempt a user to base his decision on taking one of the services on the basis of considering the frequency of service, hours of service, accessibility of stops or other considerations. Using these elements, proxy indicators as shown in the Table 2 might well serve the purpose of approximating for the availability indicator.

Table 4: Availability indicators

Name of the Indicator	Definition
Network coverage	Km of public transport routes (of all types of operators in the operational area)/km <sup>2</sup> or per capita
Station-density	Number of stops/stations (of all types) per km <sup>2</sup> in the operational area [number/km <sup>2</sup> ]
Park & ride supply	Park and ride spaces (for cars and powered two wheelers) [number/1000 inhabitants]
Hours of service	Time of the first and last departure/arrival
Frequency of service	Mean timetable headway of all lines in minutes (peak-time, off-peak-time on weekday, off-peak-time on Sunday)

#### 2.3.2. Accessibility

Indicators of accessibility should relate to physical accessibility (ease of access to transport service) and to commercial accessibility (ease of access to information about transport services). The physical accessibility depends very much on local circumstances and refers to the ease of access to transport services, terminals and transfer facilities of pedestrians, cyclists, taxi and public transport users, private car users, etc. For passenger transport, accessibility is an important criterion of the quality and decisions on taking a particular service are frequently based on considerations of accessibility.

In freight transport, accessibility is also an important consideration and it relates to both physical access to freight terminals and transfer points as well as to the access to information on a particular service.

Table 5: Accessibility indicators

<b>Name of the Indicator</b>	<b>Definition</b>
Accessibility to passenger terminals, transfer facilities, vehicles	Accessibility to and from terminals, transfer facilities and vehicles in the operational area; rate 1 (poor) to 6 (excellent)
Perception of transfer ease	The ease at which passengers needing to transfer to other modes/vehicles are able to do so; rate 1 (poor) to 6 (excellent)
Low floor vehicles	The percentage of low floor vehicles in the public passenger transport fleet [%]
Trip/service booking time in on-demand transport	Duration of telephone call to book a trip/service [min]
Accessibility of freight terminal	The ease of the access to freight terminal; rate 1 (poor) to 6 (easy)
Access to commercial information	Average number of personal/telephone contacts per order; Maximum number of personal/telephone contacts per order

### 2.3.3. Time

Time is an important criterion of the quality of service in transport and may refer to the length of the overall travel time and other aspects relevant to the planning and execution of journeys.

Table 6: Time indicators

<b>Name of the Indicator</b>	<b>Definition</b>
Boarding/loading time	Average boarding/loading time over all stops/stations [min]
Operating speed	Average trip length (km) divided by actual journey time (h) – measurement of real journey time
Stopping time	Average stopping time (min) related to average travelling- time

### 2.3.4. Reliability

Reliability is another important criterion that needs to be taken into account when considering the quality of service from the users' viewpoint. The indicators of reliability are:

Table 7: Reliability indicators

<b>Name of the Indicator</b>	<b>Definition</b>
Cancelled runs	Percentage of cancelled runs in relation to total runs
Starting punctuality	Percentage of late departures (equal to or more than 5 min. late) over total number of runs (representative sample) [%]
Stops/stations and end point punctuality	Percentage of late arrivals (equal to or more than 5 min. late) at a selected stops/stations and end-point over total number of runs (representative sample) [%]
Fleet reliability	Number of breakdowns [number/10 <sup>6</sup> vehicle km.]

### 2.3.5. Customer satisfaction

Customer satisfaction is probably the most important single indicator of the quality of service. However, almost the only way to get relevant information on customer satisfaction is to carry out a survey among the transport users (both passenger and freight). In addition to customer opinions, some hard measure indicators are also relevant for comparison exercise (like the number of complaints, for example).

Table 8: Customer satisfaction indicators

<b>Name of the Indicator</b>	<b>Definition</b>
Travel comfort	Travel-comfort consists of: vehicle vibrations, accelerating/ decelerating-behaviour of the vehicle, noise, heating and airing, design of seats, supply of seats available, place in the vehicle-cabin, etc. Rate 1=poor to 6=excellent
Complaints to passenger ratio	Positive and negative statements by 1000 passenger journeys [number/1000 journeys]
Image	Public transport-operator's image from the passengers' point of view. Rate 1=poor to 6=excellent
Information in case of delays or cancellation	Percentage of stations with real-time information in case of delays or cancellation [%]
Service-facilities	Services on board (litter-box, newspaper-service, radio-plugs, telephone, coffee-service etc), ticket-selling systems (intelligibility), telephone-information-centres, other services on the station (shops). Rate 1=poor to 6=excellent.
Vehicle-equipment	Illumination, ventilation, heating, air-conditioning, on board passenger-information, design of entries and exits, equipment for disabled people. Rate 1=poor to 6=excellent
Condition of vehicles supplied	Cleanliness, maintenance, damages on the vehicles. Measured by customer survey. Rate 1=poor to 6=excellent
Visibility of signs in vehicles	Measured by customer survey. Rate 1=poor to 6=excellent
Luggage consideration	Is there enough luggage room in vehicles? 1=poor to 6=excellent



### **3. Modal aspects of the quality of service**

Quality of service could also be treated from the modal perspective. In this case, the quality of infrastructure and interplay of parameters become the determining factors of the quality of service. It is possible to develop different indicators for different transport modes taking into account their operational and infrastructure specificities. In this part, the aspects of the quality of service based on infrastructure specific for each mode will be considered.

The approach developed below suggest a possible way for determining indicators of the quality of service from the modal view point and comparison of different levels of the quality of service offered by infrastructures of the different quality

#### **3.1. Roads**

In the case of roads, the term “quality of transport service” is used to refer to a number of parameters. The most important of these are:

- (a) travel speed and travel time;
- (b) traffic interruptions;
- (c) freedom of manoeuvre;
- (d) safety;
- (e) comfort and convenience;
- (f) cost of vehicle operation.

Between these different parameters of influence, there are multiple interrelations. The most important and most used parameter is the travel speed which correlates at least partly with the other parameters and can thus also be used to stand in place for the evaluation of the quality of transport.

On the one hand the quality of transport service depends on the infrastructural situation, as there are horizontal and vertical alignment, number of lanes, width of lanes and quality of road surface. Furthermore, there are traffic regulations, such as speed limits and no overtaking signs.

On the other hand, the volume and composition of traffic plays a decisive role. The higher the traffic volume, the higher the share of slow vehicles such as e.g. trucks, the lower the average travel speed and consequently the quality of transport service.

For example, the United States’ definitions of level of service as they are included in the “Highway Capacity Manual” may be summarized roughly as follows:

##### **Level of service A:**

Free flow, low volumes, high speeds (100 km/h or more), freedom to manoeuvre in the traffic stream is extremely high.

##### **Level of service B:**

Stable flow, freedom to select desired speeds is relatively unaffected; slight decline in the freedom to manoeuvre within the traffic flow.

**Level of service C:**

Stable flow, high volumes, operation of individual users becomes significantly affected by interaction with each other.

**Level of service D:**

Approaching unstable flow, fluctuating and relatively low volumes, speed and freedom to manoeuvre are severely restricted.

**Level of service E:**

Operating conditions are at or near the capacity level, speeds are reduced to a low but relatively uniform value.

**Level of service F:**

Forced or breakdown flow, formation of queues, operations within the queue are characterized by stop-and-go waves, which are extremely unstable.

### **3.2. Railways**

The quality of transport service on railways can, for example, be described by parameters:

- (a) average travel speed
- (b) travel comfort

The average travel speed on railroad sections depends mostly on the construction parameter, such as the horizontal and vertical alignment and the structural condition of the rails. Furthermore, numerous technical factors such as, for example, existing signal installations, distance of blocks etc. are important and may play a decisive role in determining the quality of service.

Also, the structural condition of the rails could especially influence the travel comfort.

### **3.3. Inland waterways**

For this transport mode, in addition to speed as a less decisive parameter, the costs that are influenced by loading factors are of crucial importance. Here, on the one hand the permissible maximum draught due to the constructional situation has to be taken into consideration and on the other hand the losses of time due to the time at locks (waiting time and the time it takes to pass through a lock). If waiting time in front of the locks occurs, the quality of transport service has to be seen as influenced by traffic densities.

The level of transport service decreases immensely in case of temporary closures or limitations of transport routes due to floods, low water and ice, as a reliable and calculable transport can no longer be guaranteed in such situation.

## V. Transport infrastructure aspects of quality of service

### 1. Thresholds regarding the quality of transport service

A number of operational parameters are, for example, included in the UNECE international transport agreements on infrastructures (AGR, AGC, AGTC, and AGN) that may be taken into account when examining the quality of transport services. Among those parameters in the AGTC for example, the following were noted: (i) operating speed; (ii) average time for formation of trains; (iii) average waiting time for lorries; (iv) accessibility by road; (v) accessibility by rail; (vi) average length of stop at border crossing points.

As noted earlier, the quality of transport service could be described by operational parameters such as:

- (i) average travel speed
- (ii) safety
- (iii) security of passengers and goods
- (iv) punctuality
- (v) frequency
- (vi) comfort
- (vii) transport costs.

and traffic flows parameters such as:

- (i) traffic volume
- (ii) traffic performance
- (iii) split into vehicle categories.

A number of interrelationships and dependences between capacity, quality of transport service and traffic flows considerably vary for the specific modes. The varying importance of these elements for the evaluation of infrastructure bottlenecks, missing links and insufficient quality of network have to be taken into account when considering coherence and complementarity among modal networks.

When considering the *quality of transport infrastructure* relevant to the concept of the *quality of service*, one approach could be to consider the following aspects in more detail and develop appropriate indicators and benchmarks for modal networks:

- General aspects:** Planning process (response to transport demand, participation of public)  
Accessibility (organizational, spatial), geographic coverage  
Integration within a mode,  
Interoperability  
Intermodal integration (links between modes, integration of systems)  
Availability of information systems
- Costs:** Investment costs  
Maintenance costs

**Traffic aspects:** Safety  
 Speed (maximum and system speed)  
 Capacity, capacity-demand relation, congestion  
 Service availability (nodes)  
 Demand management  
 Pricing systems

**Environmental impact:** Noise  
 Land take  
 Water and soil pollution  
 Fragmentation (habitat and nature)  
 Visual intrusion and architectural quality (nodes)

A number of benchmarking projects in different countries have analysed the quality of infrastructure network and transfer points. Benchmarking infrastructure provision should go beyond transport supply and include economic aspects such as investment costs in relation to transport demand as well as the relationship between supply and demand and the impact of transport such as safety, environmental effects and spatial development.

Possible transport benchmarks for transport infrastructure at aggregate level

Area	Indicator	Possible benchmark at country level
Efficient utilization of infrastructure	pkm per (mode)-km	Country X
	tkm per (mode) km	Country A
	Availability of lanes for high occupancy vehicles	Country Z
Infrastructure pricing schemes	% of infrastructure equipped with road pricing systems	Country B Country D
Infrastructure Quality	Infrastructure quality perception (survey results)	Country F