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KVALITA DOPRAVY A JEJ MANAŽMENTU V MESTSKÝCH OBLASTIACH

TRAFFIC QUALITY AND ITS MANAGEMENT IN URBAN AREAS

Príspevok poskytuje prehľad o kvalite dopravy v rôznych krajinách na základe dotazníkov a prehľadov uverejnených v literatúre. Základné otázky, na ktoré bolo potrebné odpovedať, boli: Čo je to kvalita dopravy? Aká je úroveň kvality dopravy? Ktorú oblasť kvalita nepokrýva? Ako sa uskutočňuje kvalita dopravy?

Navrhnuté dotazníky mali zhromaždiť údaje o uvedenej problematike. Zodpovední pracovníci výboru PIARC a miestnych sekcií boli s dotazníkmi oboznámení. Zhromaždili sme aj informácie týkajúce sa sledovaných miest. Na dotazník reagovalo 32 miest zo 16 krajín.

The purpose of the paper is to overview the status of traffic quality in various countries, based on a specific questionnaire and some literature survey by trying to give answers to the following questions: What is traffic quality? What is the level of traffic quality? Where is the quality gap? How is traffic quality managed?

To collect information on these issues a questionnaire was established and members of the PIARC Committee on Urban Areas or technical experts indicated by them were approached. Also general information was collected regarding the cities involved. There were 32 cities from 16 countries that replied to the questionnaire.

Quality has become an important issue of traffic management. People complain about traffic quality, while engineers try to improve or at least to manage it better.

In recent decades, the role of and the approach to industrial quality has changed completely. The new ideas appeared in the services with some delay. "While in the industry there are a lot of practical experiences available about quality management, this is certainly not the case in the area of services. Therefore, one has to consider a numbers of aspects, especially for people-related services" [1]. Traffic management, as a rather complex service, can probably use the experiences of other fields.

The purpose of this report is to give an overview of the status of traffic quality in various countries, based on a specific questionnaire and some literature survey, by trying to give answers to the following questions.

- What is traffic quality?
- What is the level of traffic quality?
- Where is the quality gap?
- How is traffic quality managed?

To collect information on these issues a questionnaire was established and members of the PIARC Committee on Urban Areas [9] or technical experts indicated by them were approached. Also, general information was collected regarding the cities involved. There was no preliminary selection of cities; the aim being to obtain the largest amount of data possible. The questionnaire was also designed to be brief, simple and easy to answer.

Accordingly, and with these conditions in mind, we believe we are in a position to provide interesting parameters for those wishing to make a more comprehensive study of this problem.

It should be noted that the data furnished represents the point of view of the Manager of the road system, and that such things are affected by political and cultural choices, and often by financial constraints. The results could outline a non-objective description, since they do not necessarily provide an expression of the needs of the users. At any rate, they give an accurate picture of the state of affairs of the single city.

There were 32 cities that replied to the questionnaire (Table 1.). Six cities only replied to a part of the questionnaire.

It is important to focus on the fact that experts answered for the general public and the answers of the questionnaire were based mostly on estimates rather than on sound data. This method could be questioned, and the interpretation of the results could also be different. However, it is reasonable to analyse the average of the estimates of 32 local experts.

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Countries and cities referred in the questionnaire Table 1

Ref. No.	City	Country
1	Bologna	Italy
2	Helsinki	Finland
3	Edinburgh	Scotland
4	Basel	Switzerland
5	Bern	Switzerland
6	Zürich	Switzerland
7	Kuala Lumpur	Malaysia
8	Montréal	Canada
9	Québec	Canada
10	Hull	Canada
11	Porto	Portugal
12	Vienna	Austria
13	Tokyo	Japan
14	Yokohama	Japan
15	Osaka	Japan
16	Oita	Japan
17	Győr	Hungary
18	Hong Kong	China
19	Nantes	France
20	Paris	France
21	Southampton	UK
22	Budapest	Hungary
23	Lille	France
24	Lisbon	Portugal
25	Brescia	Italy
26	Washington DC	USA
27	Brisbane	Australia
28	Sydney	Australia
29	Adelaide	Australia
30	Melbourne	Australia
31	Prague	Czech Republic
32	Bratislava	Slovakia

1. What is traffic quality?

According to one of the definitions, quality is the adequacy of a product or of a service for a certain purpose. This means that quality is always related to a specific goal.

Complex products or services, e.g. traffic, can be described by a number of quality indicators. "The best description of traffic quality requires the overall coverage of impacts and quality indicators. The most important criteria for road users are the speed, comfort, safety and price (related to the financial situation). It is recommended to use the above factors as the main criteria for the overall evaluation. Travel speed as the most important quality indicator can be used for purposes of a simplified assessment" [2].

Various road transport facilities can have different quality indicators. One of the possible systems is shown in Table 2.

Quality indicators of different road transport facilities [3] Table 2

Type of facility	Quality indicators
Motorway sections between junctions	travel speed
Weaving and merging areas	weaving traffic volumes
Two-lane roads	travel speed
Junctions with traffic signals	delay, number of stops
Junctions without traffic signals	delay
Roundabouts	delay
Urban main streets	travel speed
Mass transit facilities	quality of service
Cycle facilities	density
Pedestrian facilities	density

The evaluation of quality in road traffic shows some specific features as compared to other services:

- not only are the direct clients (road users) interested in the quality of the service (traffic quality), but also other people (e. g. people living in the area under consideration),
- the identity of the service provider (e. g. highway agency) is not evident for the client and there is no formal contract between the service provider and the client (except some special cases such as toll motorways or metered parking facilities).

Traffic quality can be described by a number of indicators / parameters. When speaking about quality, the general public might consider some of these parameters as more important or more relevant. The importance of a parameter and its quality level can be different: e. g. speed can be considered as a very important factor but its level can be both low and high.

In order to collect information about quality management in various cities, a questionnaire survey was undertaken. The survey method was described earlier.

Experts were asked to mark the given indicators of traffic quality, according to their *importance/relevance* in their urban area *for the general public* (1 = very high, 2 = high, 3 = medium, 4 = low, 5 = very low).

The average marks of the importance of various quality indicators are shown in Figures 1 and 2.

Both in road traffic and in public transport, the three most important factors are: travel time, delay and safety. In public transport, the service interval was also found to be among the most important factors. The least importance was attributed to those parameters which are only used by professional traffic engineers

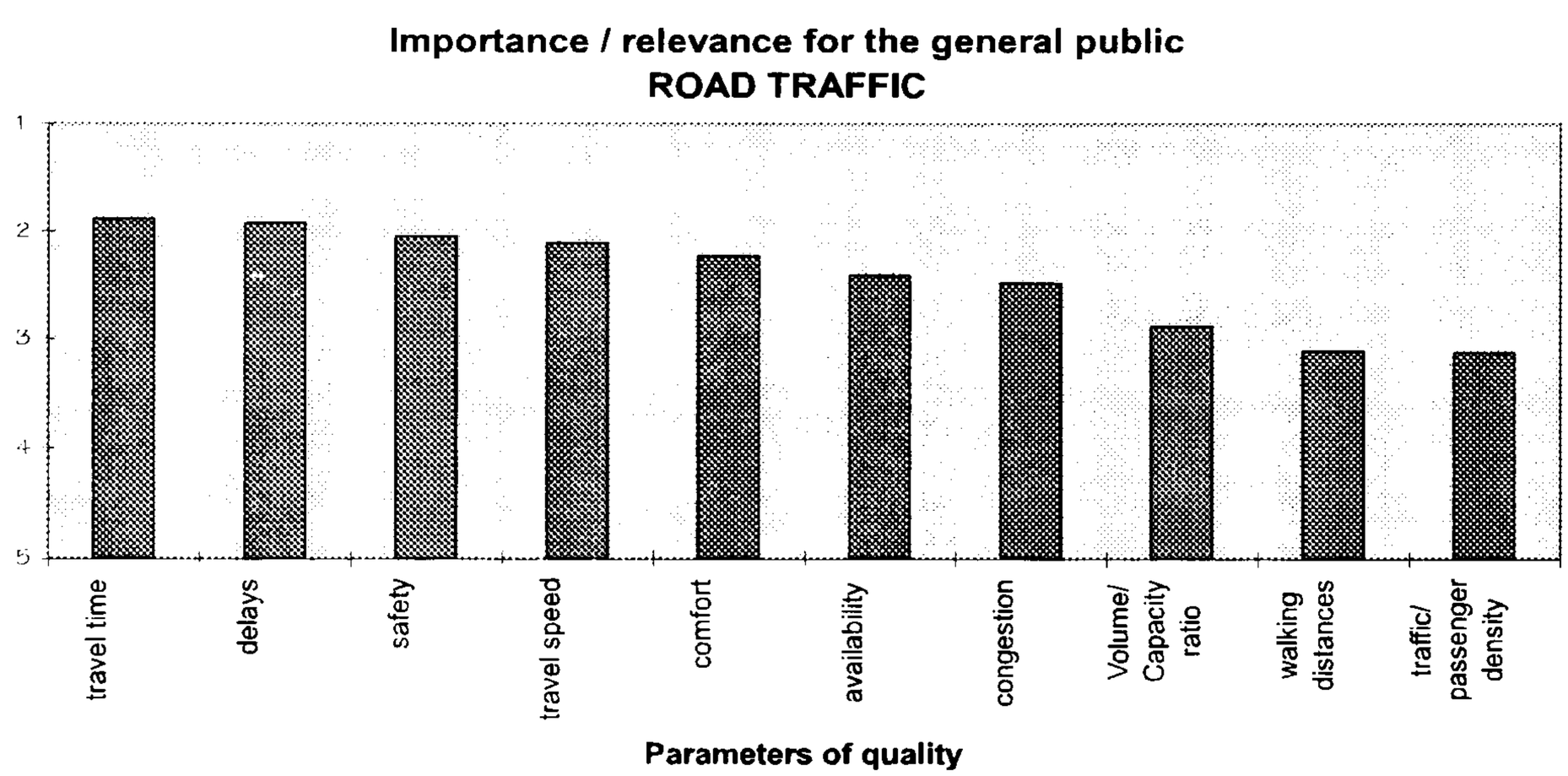

Fig. 1

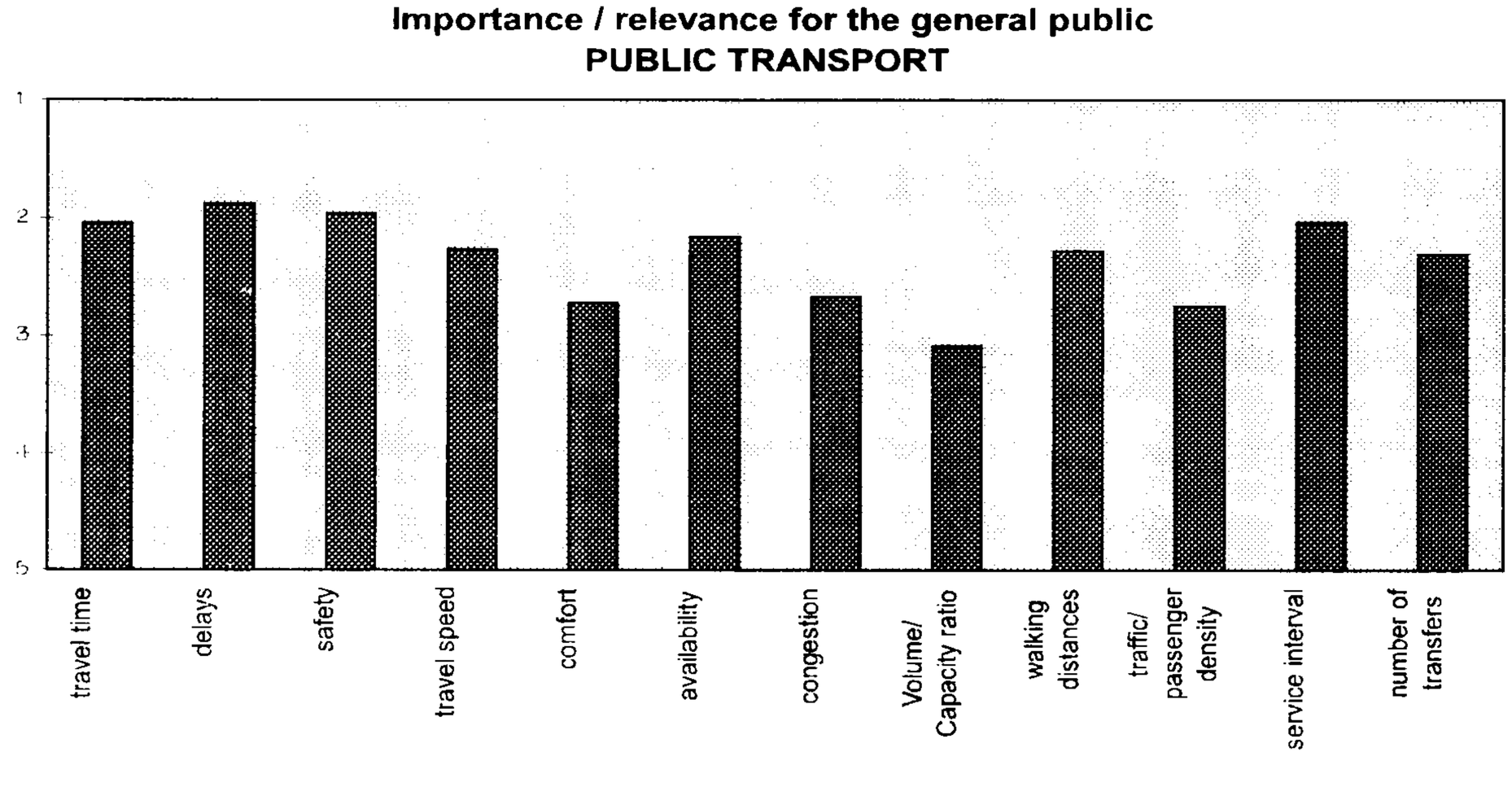

Fig. 2

(e. g. volume/capacity ratio, density) and are not relevant to the general public.

In road traffic, the importance of the parameters was found to be independent from the city size. In public transport, there are some variations according to the city size.

2. What is the level of traffic quality?

In the second part of the questionnaire experts were asked to mark the given indicators of traffic quality, based on their estimate, according to the *general quality level* in the urban area (1 = excellent, 2 = good, 3 = medium, 4 = low, 5 = very low).

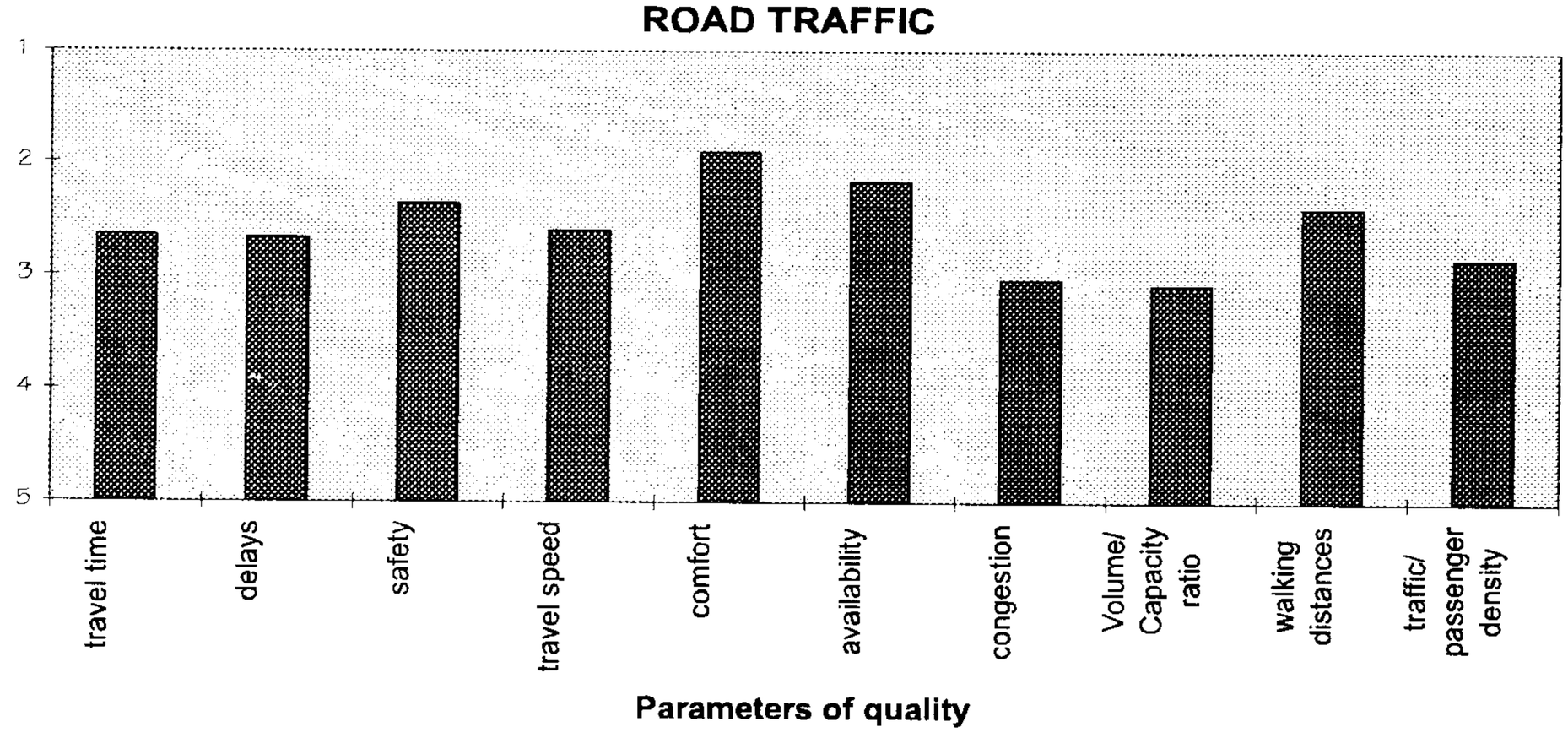

Fig. 3

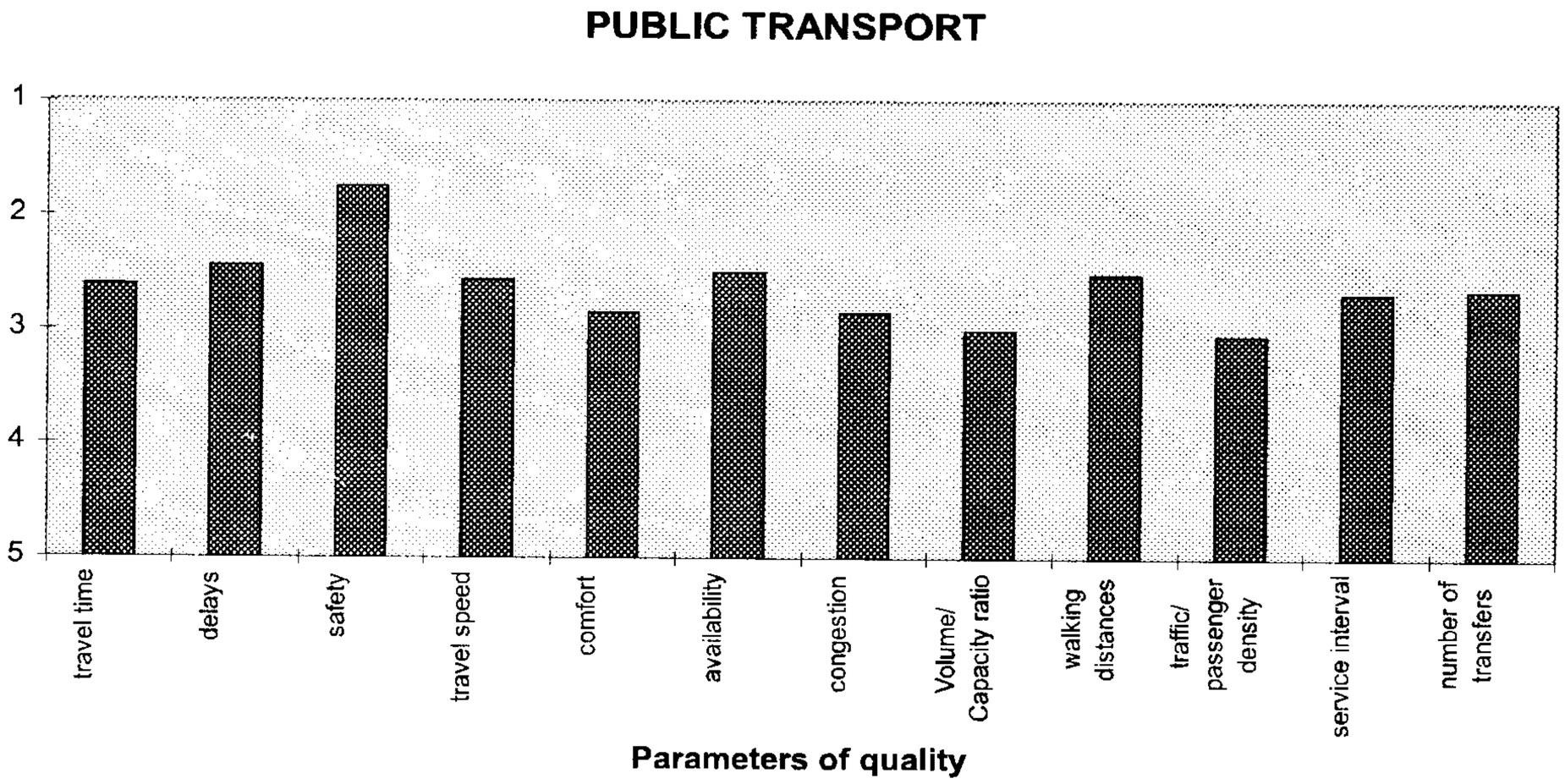

Fig. 4

The average marks of the quality level of various quality indicators are shown in Figures 3 and 4.

Both in road traffic and in public transport the quality level of safety and availability were among the three highest ones. Road traffic comfort was also found to be among the three best parameters, while in public transport the level of delays was found to be good (low).

The three worst parameters were also identical in road traffic and in public transport, namely congestion, volume/capacity ratio and traffic density. This part of the survey is also underlining the importance of congestion problems which are analysed in another part of the report.

When comparing the average marks for smaller and bigger cities, a large difference can be found. The average quality level in

cities under 1 million inhabitants is about 2.4, while for cities over 1 million this value is 2.9. This reflects the lower quality level in large cities both in road traffic and in public transport.

3. Where is the quality gap?

Comparing the importance of a parameter and its quality level one can define a quality gap as the difference between them. If on one hand the importance (demand) is high and on the other hand the quality (supply) is low then this parameter shows a quality deficit. In some other cases the actual quality of a parameter can be higher than its importance (this is a surplus situation).

Data are shown in Figures 5 and 6.

Both in road traffic and in public transport, travel time and delay are among the two parameters with the highest quality deficit. In public transport, service interval, while in road traffic congestion also has high negative values.

There are some parameters with quality surplus: in road traffic the walking distances, comfort and availability are much better than their importance. Somewhat surprisingly, in public transport the safety was found to be "too good".

Smaller and larger cities show a significant difference in this respect. The average mark is almost a half mark worse for large

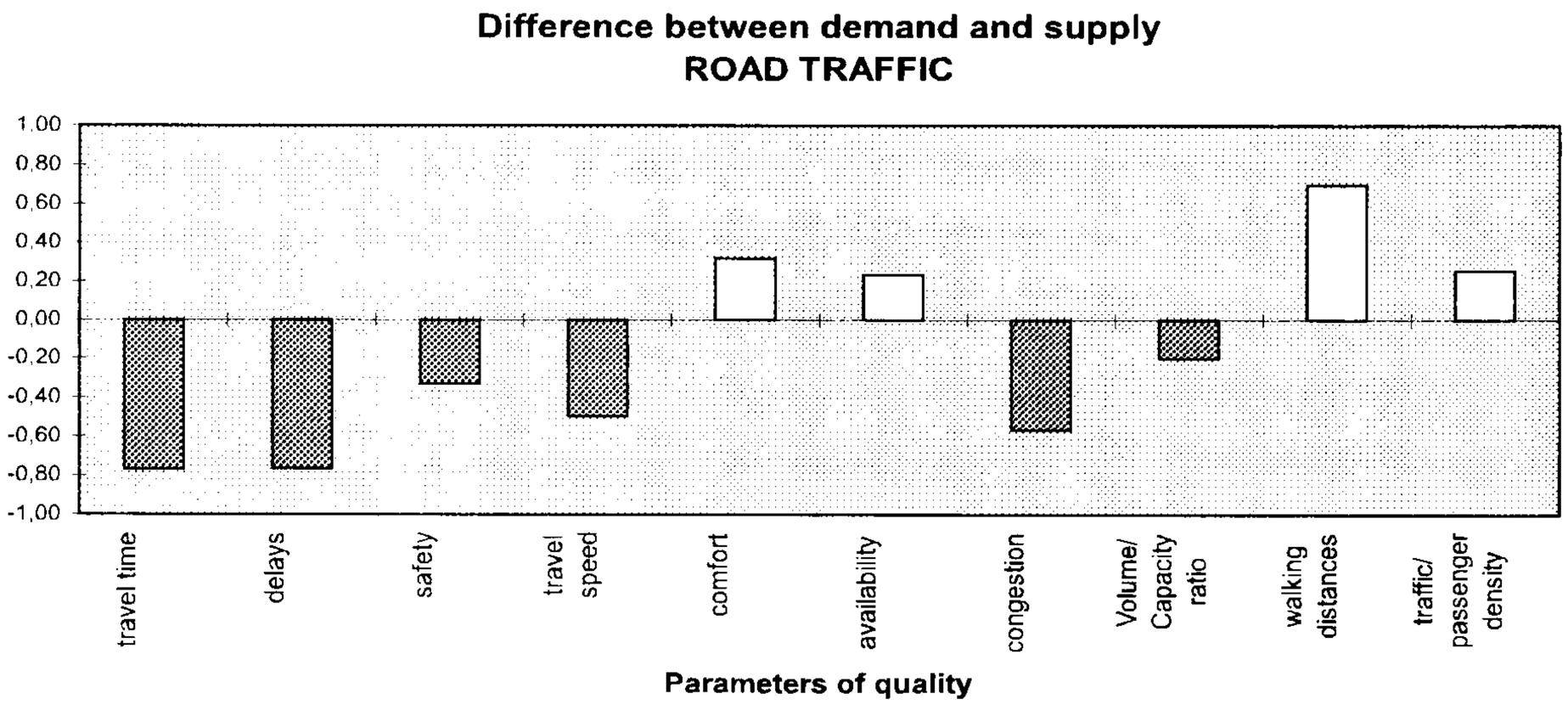

Fig. 5

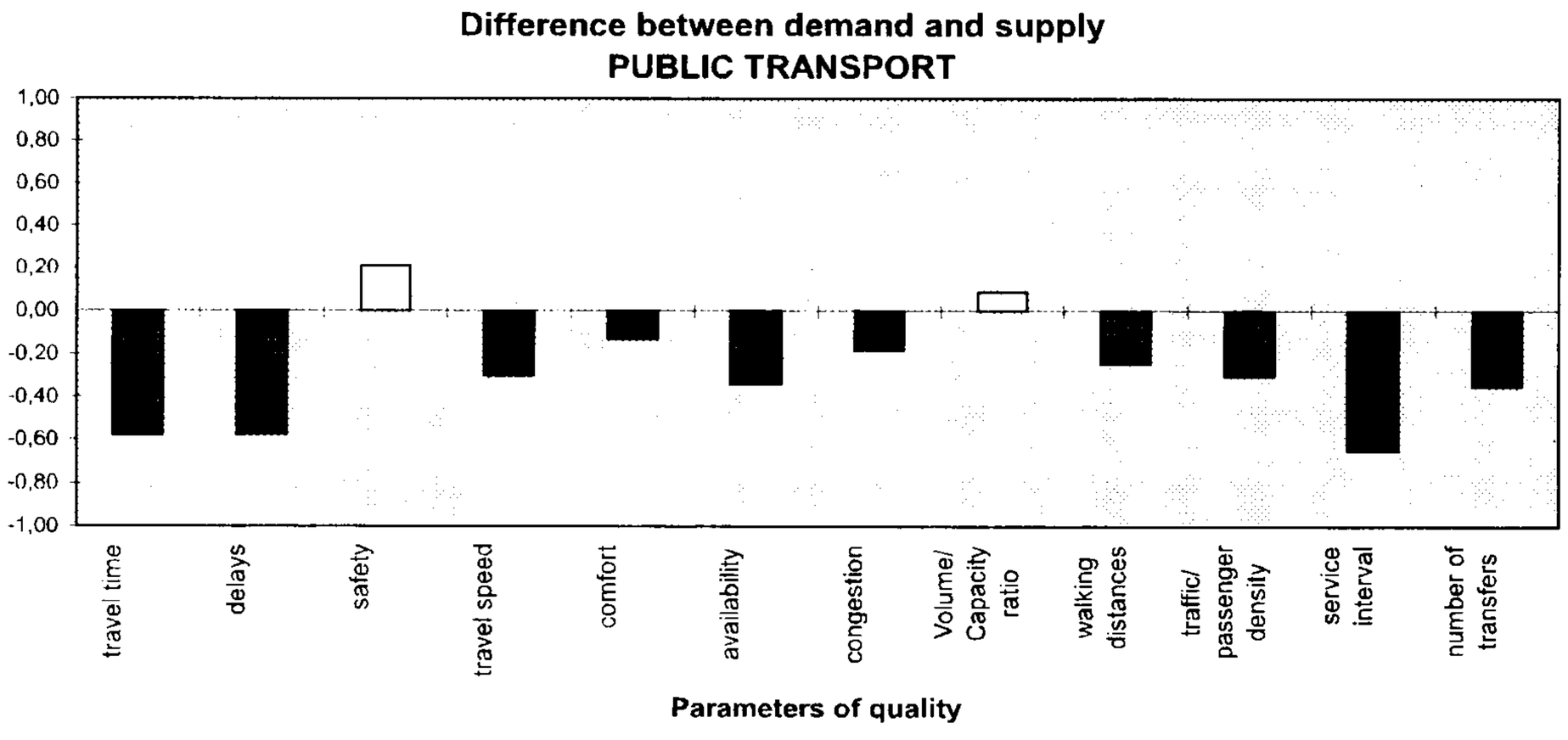

Fig. 6

cities both in road traffic and in public transport. Basically, the same parameters show surplus and deficit in smaller and in larger cities, but the magnitude of the gaps is always higher in larger cities.

This rating can be used by traffic engineers to identify the most important needs in terms of quality improvement and to show some areas where action is not so urgent. However, it can be noticed that most of the indicators are interlinked: when you do interventions regarding congestion, you deal also with delays, travel speeds, and volume-capacity ratios.

4. How is traffic quality managed?

The origin of organised quality control is linked to the beginning of mass production. Mistakes with namely large production series became too expensive. In order to set up a quality management system several components are needed:

- a system of measurements or visual observations (full-scale or sampling) and the comparison of actual values with the standards;
- a system of threshold values (goals, standards, minimal or maximal values, target values, quality classes);
- a set of actions to change quality.

In transport, these systems appeared much later than in the industry.

4.1. Changes in the HCM concept

In the area of car traffic, the concept of traffic quality can be traced back to the 50's. Based on the first edition of the Highway Capacity Manual [4] it was found that "the hourly traffic used in design (DHV) should be the 30th highest hourly volume of the year. Practical or design capacity is predicated on given speeds ... considered as satisfying the condition of operation without unreasonable delay or restriction to the drivers' freedom to manoeuvre" [5].

This means that the design hourly traffic volume should not be higher than the practical capacity of the road. The basis of this approach is that adverse traffic conditions should not be allowed too long on roads. There are only 30 or 50 hours per year with traffic volumes above the practical capacity, the latter being lower than the full capacity based on safety/quality consideration.

This early approach of quality control was also followed later in Europe. In the German version of the HCM [3] the following is mentioned. "Most guidelines [in Germany] are similarly structured. Each traffic facility type has one or more quality indicators and their related minimal requirements. Then three major assessment levels are defined:

- With traffic volumes lower than the practical capacity, the traffic quality is sufficient. The minimal quality requirements are met in this case. However, these minimal requirements are only partially mentioned in the guidelines.
- Between practical capacity and overloading, the capacity can be found. In this range one can speak about an unstable traffic flow.
- Once the traffic volumes exceed the capacity, the facility is overloaded, i.e. the traffic quality is insufficient.

This approach has the disadvantage that only sufficient and insufficient traffic qualities are defined, a more precise assessment of quality is not possible."

In modern production management the approach to quality has changed. It is not enough to define sufficient and insufficient qualities and it is not enough to accept or reject a product at the end of the production line. One speaks about required quality levels and about quality-price relationships. In order to meet the new requirements, nowadays not only is the quality of the products is a subject of control, but also the production process and the system should be designed to avoid possible mistakes and to reach the required quality.

In the field of highway traffic, quality was defined in the Highway Capacity Manual 1965 [6] through the term "level of service".

This is a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists. A level of service definition generally describes these conditions in terms of factors such a speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and safety. Six levels are defined from A to F, with level of service A representing the best operating conditions (free flow) and level of service F the worst (forced or breakdown flow). The appropriate descriptions are well known for traffic engineers.

The speed - flow relationships provide a possibility to estimate the traffic quality from given traffic volumes or to calculate from a given traffic quality the appropriate traffic flow. This way the traffic planners and the decision-makers received a tool for the evaluation of consequences of decisions concerning quality. Once they are able to evaluate consequences of decisions, they can also influence or manage traffic quality.

In later editions of the HCM, this approach has been further developed, quality indicators were defined and their relationships were set up for various facilities: i.e. motorway and road sections, junctions with and without traffic signals, public transport, cyclist and pedestrian facilities [7, 8]. As a result of German studies in 1994, this approach has been adapted to European conditions [3].

The most important advantage of this concept is the uniform evaluation basis for partially loaded facilities. Therefore, the procedure can also be used besides the original design for other purposes, such as traffic assignments, cost-benefit analyses, environmental impact assessments of traffic management schemes.

4.2. Monitoring system

In the *questionnaire* survey experts were asked about the existence of a *monitoring system* of the given indicators/parameters in their country. The answers are summarised in Table 3.

Is there a monitoring system of the quality parameters? Table 3

Number of answers / Parameters of quality	Yes		No		No answer	
	in road traffic	in public transport	*in road traffic*	in public transport	*in road traffic*	in public transport
travel time	*13*	18	*8*	1	*11*	13
delays	*8*	18	*10*	0	*14*	14
safety	*16*	15	*7*	3	*9*	14
travel speed	*13*	17	*7*	2	*12*	13
comfort	*4*	3	*14*	12	*14*	17
availability	*3*	8	*11*	7	*18*	17
congestion	*17*	11	*4*	5	*11*	16
Volume/ Capacity ratio	*16*	12	*6*	6	*10*	14
walking distances	*2*	5	*15*	10	*15*	17
traffic/ passenger density	*11*	12	*6*	4	*15*	16
service interval	*2*	16	*10*	1	*20*	15
number of transfers	*2*	8	*9*	7	*21*	17

In public transport, about half of the cities are monitoring travel speed, travel time, delays, service interval and safety. In general no monitoring system exists for walking distances and comfort.

In road traffic, volume/capacity ratio, congestion and safety are monitored in about half of the cities. Speed and travel time are also among the frequently monitored parameters. Most of the cities are monitoring 5 to 8 parameters (Table 4.)

Number of parameters monitored in cities Table 4

Number of parameters monitored	Number of cities monitoring	
	in road traffic	in public transport
1 to 4	8	2
5 to 8	14	13
9 to 12	1	5
-	23	20

4.3. Threshold values

In the questionnaire survey experts were asked about the existence of quality limits or threshold values of the given indicators/parameters in their country. The number of responses to this question was very low to this question, probably because there are no quality limits in most of the cities. The answers are summarised in Table 5.

Typical quality threshold values Table 5

parameter	in road traffic	in public transport
travel speed	min. 20 km/h	20 km/h
Volume/Capacity ratio	0.9 at intersection 90 % 0.75...0.9 1.0	
walking distances	500 m	500 m, 5 minutes 800 m 200 m 10 minutes 300 m 300...700 m
traffic/passenger density		70 people per bus 0.2 m^2/person 75...55%
service interval		20 minutes 6...60 min
travel time		30 minutes to centre
delays		1 min. before 3 min. after scheduled time
number of transfers		2 1...2

a) for road traffic Paris, Oita, Tokio
b) for public transport Paris, Tokio, Edinburgh, Zürich, Helsinki, Hull

4.4. Approaches to quality

In the *questionnaire survey* experts were asked about the existence of *any formal system of quality assessment in urban areas.* The number of positive responses to this question was very low. They are listed below:

A transport company, a traffic authority or a traffic planner deal with traffic quality for various reasons. Even the simple goal to *describe quality* might be not so simple, as there are a number of quality indicators which are inter-related and their measurements need a lot of effort. The previous tables are only very compact compilations of the most important quality indicators.

One can also *evaluate* the *quality* of an existing transport system. The problem in this phase is to find the appropriate quality levels which can only be produced from a broad expert and social consensus following discussion in professional bodies and a certain amount of practical testing.

Companies (also transport companies or highway agencies) usually emphasise that they are *improving* their *quality* for their clients. Traffic *quality* can thus be considered *as a goal* of traffic management. Through various transportation planning and traffic engineering measures, the required quality levels can be reached.

For the traffic planner, traffic *quality* can also be seen *as a tool.* The required goals (e.g. relieving of an area or of certain road sections, improving environmental quality) can be reached through influencing traffic quality. Other, more direct influencing tools (e.g. tolls, full restrictions) can not be used in many cases or they are not acceptable by the public. As the number of captive riders has became smaller and more people have a choice, quality plays a more important role in modal split decisions.

Increasing quality can *pull (attract) traffic* (e.g. the case of a new pedestrian street). Through improving the quality of a link, traffic loads can be *shifted from one link to other links.* Examples are the traffic restructuring impacts of a new motorway section, a new main road or a high quality public transport line.

In other cases, the opposite measure, i.e. the deliberate *decrease in quality* of a link (for specific road users e.g. for through traffic or car traffic) can be the tool leading to a *push (decrease) in traffic* (keyword: traffic calming or parking restrictions). This way quality is created for other purposes, e.g. higher environmental quality for people living in the area. The relation of quality to the goals is emphasised here again.

It is found that traffic quality can be an important goal on one hand. On the other hand, traffic quality can be used to influence many decisions of road management and planning and, thereby, to reach other goals. This is the reason why traffic planners should be more interested in quality management.

A traffic quality management system should consist of the following components:

- a monitoring system of the quality parameters,
- a system of quality goals and objectives,
- a set of possible actions / measures to change / improve quality.

These components should be interlinked with each other, i.e. if a difference between goals and actual values is observed, an appropriate action should be taken, which in turn results in changes of the values of the quality parameters.

In general, cities have not yet reached a complex system dealing with traffic quality. However here are a number of elements which can be integrated later to quality management systems.

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