multimodality, assessment, corridor, indicators, system approach

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HOW TO MEASURE CAPABILITIES WITHIN CORRIDORS?

Summary. Traditional methods of measuring the capacities of infrastructures are usually based on indicators like passenger car units (PCU). It is quite clear that these methods of capacity evaluation (categories of roads, calculation procedures, capacity limits, e.g. defined in the HCM – Highway Capacity Manual) cannot be used to picture the intermodality of the traffic system. The first step has to include the intermodality (modal split) in the cross section of a road (pedestrians, bicycles, public transport, private vehicles), and in a further step it is necessary to account for all alternatives within the corridor, like parallel routed railways or public transport lines, to reach an intermodal point of view. Finally it is also necessary to include the effects on the settlement structure. Beside intermodality, any new method also has to consider cost effectiveness, a comprehensive consideration of feedbacks in the traffic system, as well as compatibility to CBA. As a result it is necessary to find new indicators (instead of car units) to define passenger and freight flows. There are guidelines in progress auditing transport operations and infrastructure conditions of roadways. A revision of these guidelines aims to integrate different modes of transport by changing the key-indicators (e.g. incline, curviness, roadway width, capacity utilisation) and to use a system approach which includes indicators like modal split, car occupancy or utilised capacity of lorries. The procedure presented in this paper can be seen as one building block to meet the demands of future assessments within corridors.

JAK ZMIERZYĆ PRZEPUSTOWOŚĆ W OBRĘBIE KORYTARZY?

Streszczenie. Tradycyjne metody mierzenia przepustowości w infrastrukturze bazują na wskaźnikach, takich jak PCU. Wydaje się jasne, że takie metody oceny przepustowości (kategorie dróg, procedury kalkulacyjne, limity przepustowości zdefiniowane np.w HCM – Highway Capacity Manual) nie mogą być użyte do pokazania intermodalności systemu ruchu drogowego. Pierwszy krok to zawarcie intermodalności (podziału na jednostki ładunkowe) w przekroju drogi (piesi, rowery, komunikacja miejska, prywatne pojazdy). Kolejnym krokiem jest wzięcie pod uwagę wszystkich alternatyw w ramach korytarza (takich jak równoległe do danego korytarza trasy kolejowe lub linie transportu publicznego), tak aby dojść do intermodalnego punktu widzenia sprawy. Na koniec istotne jest również zawarcie wpływu na strukturę zasiedlenia terenu. Poza intermodalnością, w każdej nowej metodzie należy brać pod uwagę: skuteczność w kwestii kosztów, wszechstronną analizę odzewu ze strony natężenia ruchu, a także kompatybilność z CBA. W rezultacie należy znaleźć nowe

wskaźniki (zamiast jednostek samochodowych PCE), aby zdefiniować przepływ pasażerów i ładunków. Istnieją wytyczne, które znajdują się w audycie postępu operacji transportowych oraz w warunkach infrastruktury dróg. Sprawdzenie tych wytycznych ma na celu integrację różnych środków transportu przez zmianę kluczowych wskaźników (np.: nachylenia, zakrzywienia, szerokości drogi, gospodarowania przepustowością) i zmianę użycia systemowego podejścia zawierającego wskaźniki, takie jak: podział na różne środki transportu, liczba osób w pojeździe oraz eksploatacyjna ładowność ciężarówek. Zaprezentowana w niniejszym artykule procedura może być postrzegana jako jeden z elementów na drodze do sprostania zapotrzebowaniu i przyszłym zadaniom w ramach korytarzy transportu.

1. PRELIMINARY NOTES

The problem arises from an assessment of infrastructure construction in corridors as demanded by the European Commission. In principle, every building scheme in the transport infrastructure sector requires an extension of the viewed system and with that the necessity to extend the system borders correspondingly, particularly if it enables higher speeds. This applies to the construction of both roads and railway lines.

However, when extending the viewed system a number of control systems and feedbacks, which usually are not taken into account in a narrower section of the system, also becomes effective.

2. REQUIREMENTS OF FUTURE EVALUATION METHODS

When analysing corridors and deducing development decisions in these corridors, it is crucial to define general indicators which can provide a ranking of priorities. For example, the question arises whether a preferential development of the railroad would produce ecological and economical benefits in the corridor.

Therefore, at first comprehensive indicators have to be defined as well as development limits assessed. A multimodal philosophy will be necessary when assessing measures in corridors.

3. INDICATORS DEPEND ON THE SIZE OF THE SYSTEM

When widening the viewed system, the indicator fitting best is changing with every step. When trying to assess a new bypass it is common practice to include only this newly built bypass-section into the assessment (Step 1, see tab. 1 [1]). At this stage, an indicator like the number of vehicles is used. The expansion of the viewed system and the accompanying choice of different indicators is shown with the help of this schematic infrastructure network (roads, railway) [1].

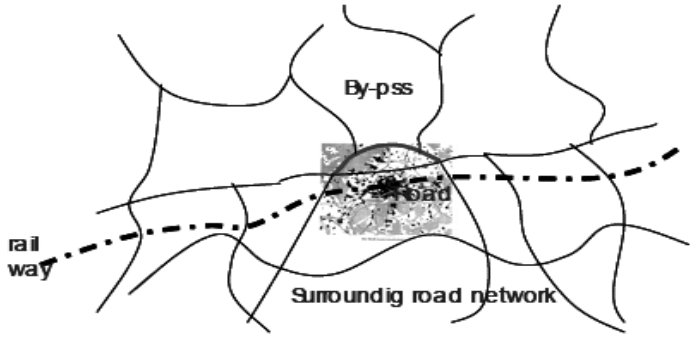


Fig. 1. Schematic infrastructure network (roads, railway)
Rys. 1. Schematyczna sieć infrastruktury (drogi, kolej)

One has to be aware of the fact that the application of a corridor approach, and by this the necessary expansion of the system, is one small part of problem complex "internalisation of external effects". The extension of the viewed system has to be carried out stepwise.

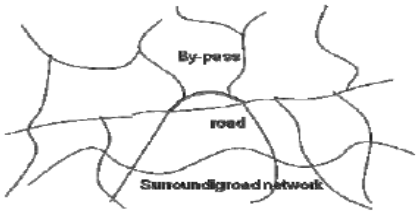
- **Exclusive consideration of the bypass section**

Normally, development decisions and their assessment focus on a single street section (for example a bypass).

- **Including the unburdened road section**

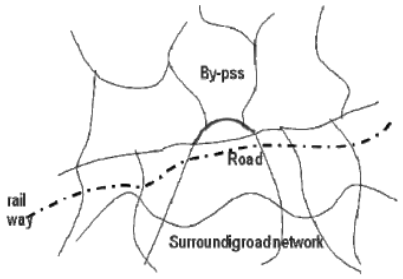
At least it is necessary to widen the viewed system to include the "old" through road due to the fact, that the original mobility demand is now satisfied by two roads. Also both road sections now have to face problems like noise, exhaust gases and will have to be maintained. In such a wider corridor (Step 2), the indicator has to be changed to "traffic volume" or "persons/h".

- **Including the surrounding network**



The next step is to include the surrounding network (Step 3), taking into account the distribution of trip lengths.

- **Including other modes**



The next step is to include alternative modes like railways, etc. (Step 4).

- **Including time and spatial structures**

A further step is to extend the time scale regarding the development of the surrounding network (Step 5) and the development of the settlement structures (Step 6). Beginning from the step 4 on a comprehensive indicator has to be based on modal-split or at least on person flows.

- **Including global aspects**

In the future it also will be necessary to include global aspects (global thinking, local acting) (Step 7), especially regarding global limits of development. At this level energy might be a better indicator than modal split.

The current objectives of city and regional planning all feature the need to accelerate the connections between functions at a local level, as well as within regions or even continents, to raise the accessibility of areas and by that to gain advantages in a free market. This assumption and the deduced goal, however, lead to the separation of functions and the spreading of settlements followed by considerable negative effects, also concerning ecological and social aspects.

Table 1

Seven steps of enlarging the viewed system accompanied by changing the appropriate indicators, effects on the aspects “time”, “space” and “causalities”

	Indicators	Temporal boundaries	Spatial boundaries	Methods
1	Number of vehicles	Status quo simulation	Street section	Counts in cross sections
2	Traffic amount	Mainly status quo simulation, linear forecasts or motorization rate	Corridor	Counts in cross sections
3	Traffic amount	Forecasts or motorization rate	Boundaries by distribution of trip length	Counts in cross sections, calculations
4	Modal split, person flow	Scenarios	Distribution of trip lengths	Simulation results, trip chains
5	Modal split	Scenarios	Distribution of trip lengths, ecological footprint	Simulation results, trip chains
6	Modal split, Energy	Scenarios	Settlement or regional area	Models
7	Energy, CO_2	Scenarios	Global	Models

4. THE STATE-OF-THE-ART

In contrast to these considerations from an intermodal point of view, current development decisions are based on a monomodal assessment. Guidelines, which exclusively deal with the transportation sector, are common in all countries.

Existing guidelines build on the assumption that an increase of traffic takes place anyway. Merely the function of a street (as a standard) and the forecast of the traffic volume usually exert an influence on the assessment.

The corresponding Austrian guideline uses the so-called operational speed as basis for the assessment and as an indicator for the level of service in the street section. The operational speed is the average speed of the car traffic at the significant traffic load (fig. 2, 3 [2]).

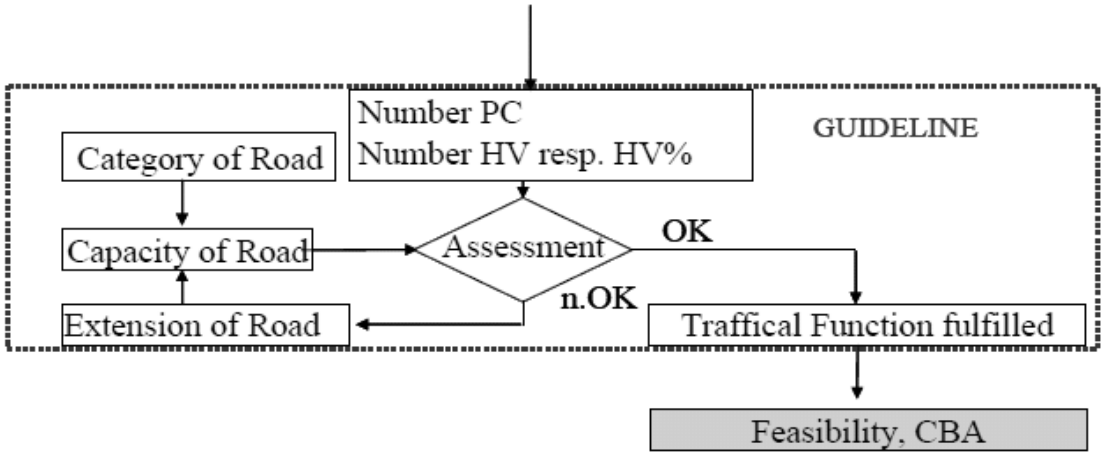


Fig. 2. Schematic representation of the sequences of existing guidelines in Austria
Rys. 2. Schematyczna prezentacja sekwencji istniejących wytycznych w Austrii

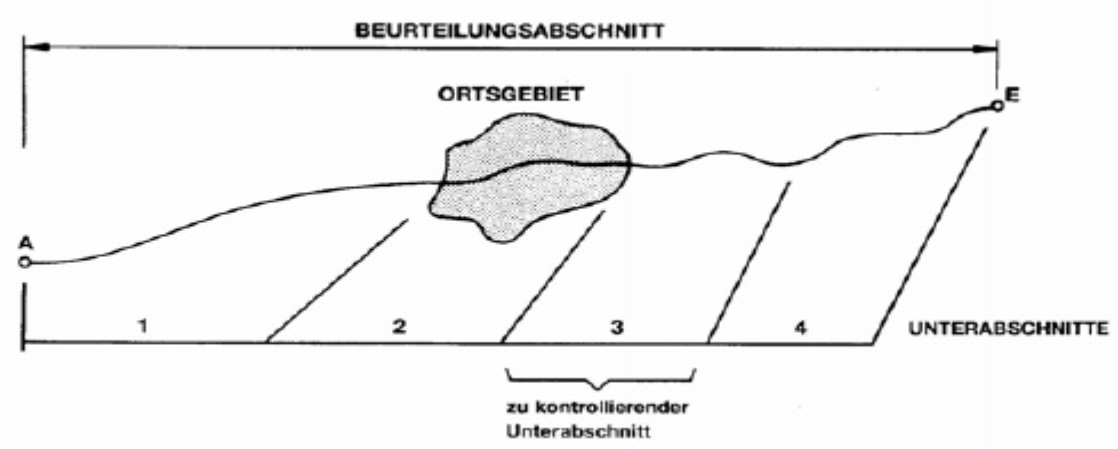


Fig. 3. Principle layout of the partitioning of a street into assessment sections
Rys. 3. Podstawowy rozkład podziału drogi na oceniane odcinki

The determined operational speed is a function of the calculational traffic volume and the significant hourly traffic volume, the ideal ground speed of a motor vehicle as well as the fraction of road section in built-up areas.

For rural roads the calculation rule of the guideline also takes into account parameters of routeing (profile, curviness, sight distance, gradient) as well as the composition of traffic (fraction of heavy traffic).

The guideline in this form is a simple dimensioning instrument. One could say that the current guidelines are a means to boost attractive transport infrastructure (by unburdening roads and thus raising speeds) and the speed of the system. Among other things, this causes a solid competitive advantage for great centralistic structures mostly situated in the periphery of large cities. Along with the concurrently emerging urban sprawl, the traffic volume increases and with it the need to employ the guideline (as input parameter). In turn, the guideline influences (with a considerable time lag) the traffic volume of the system (and by that justifies its usage).

Speed as dominating key indicator becomes superfluous, as soon as the constancy of the travel time budget is taken into account, because the previously calculated travel time savings (through speed increases) in the system cease to exist [3, 4].

5. APPLICATION APPROACH FOR A REVISION UNDER CONSIDERATION OF A CORRIDOR ANSATZ

The main aim of a corridor approach would be to include the principle of demand oriented planning by including all road users, esp. public transport. From a multimodal point of view it does not make sense to use an indicator like “speed” for the assessment of the transport infrastructure.

The expansion of the viewed system has to include:

- All transport modes (multi-modality);
- The consideration of limited resources in the dimensioning of infrastructures;
- The integrated consideration of feedbacks, e.g. effects on settlement structures.

An expansion must be done by including:

- Multi- modality;
- Economy in dimensioning considering limited resources;
- Integrated consideration of feedbacks, e.g. effects on settlement structures.

Schematic strategic positioning of a new guideline is in [2].

The degree of utilisation could serve as a new benchmark. Therefore, a guideline incorporating the corridor approach must emphasise the indicator “efficiency”. Because of the multimodal approach, the indicator “passenger car unit” (PCU) as measure and is no longer serviceable. The reference units

must be applicable to all means of transportation similarly. This is only possible by replacing the PCU by indicators like “person units” or by “tons” in the freight traffic.

In summary, the indicator “operational speed” in existing guidelines used as target value *and* as check value is opposed by the indicator “capacity utilisation”. Multimodal approaches use “capacity utilisation” as target value and “occupancy rate” as check value.

The corridor assessment requires a two-step approach, which is shown in Fig. 4 [2]. Basically, the assessment of a street section comprises the comparison of a “qualification profile” and a “performance profile”. The target value “operational speed” is changed as described above.

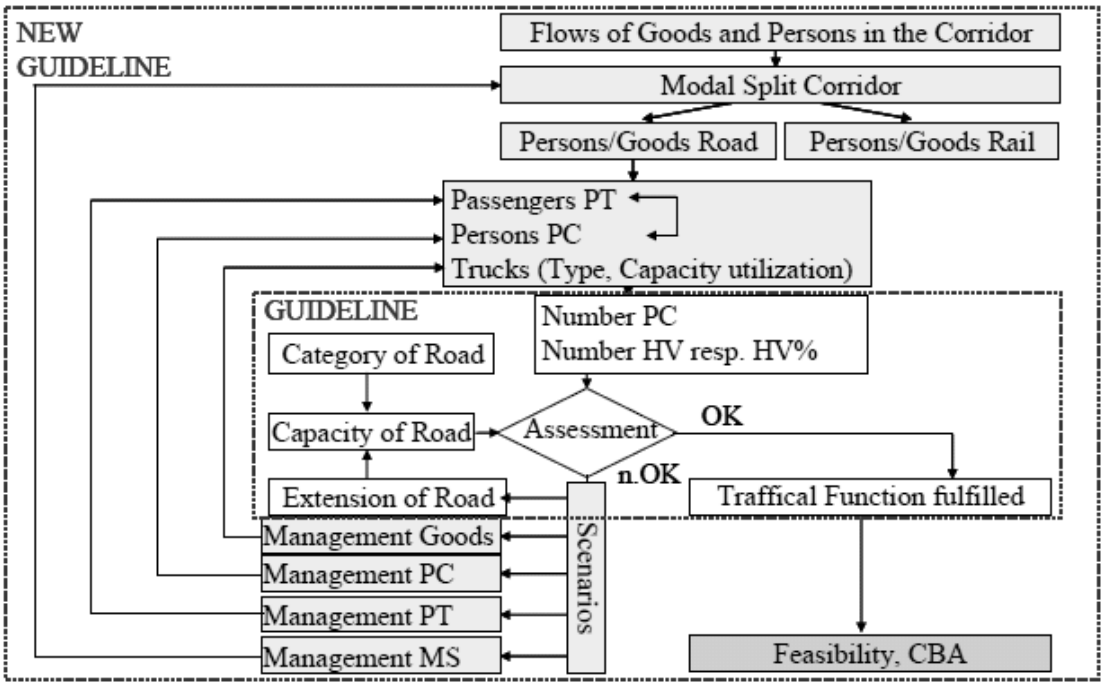


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Fig. 4. Schematic illustration of the two parts of the proposed new guideline
Rys. 4. Schematyczna ilustracja dwóch części proponowanej nowej dyrektywy

5.1. Multi-modality on the street

In principle, when using a multimodal approach which presupposes a system expansion, the indicator fitting best to describe the system behaviour changes with every step (see section 3). The currently used “passenger car unit” (PCU) reveals a completely wrong connection between individual and public transport. The correspondence of a bus to two PCU is purely arbitrary. For reasons of comparability the preferential indicator of multimodal approaches would be “frequency of persons”.

The actual performance of busses regarding the number of transported persons in comparison to cars is about 5 to 6-fold above the assumptions represented in Fig. 5. The “inner” capacity reserves of a street have to be reviewed concerning their suitability for representing the efficiency, as well as all other indicators for their suitability of representing multimodal conditions.

5.2. Multi-modality in the corridor

In this context, research works about the efficiency of transport systems are crucial, also the exemplary interaction of different modes of transport. In Germany, there exists a framework directive for integrated net design. The methodical approaches to the organisation of road networks are expanded by the other modes of transport as well as the spatial component.

The fundamental difficulty lies in the exemplary determination of the unburdening caused by added public transport facilities, which is different in diverse parts of the road network.

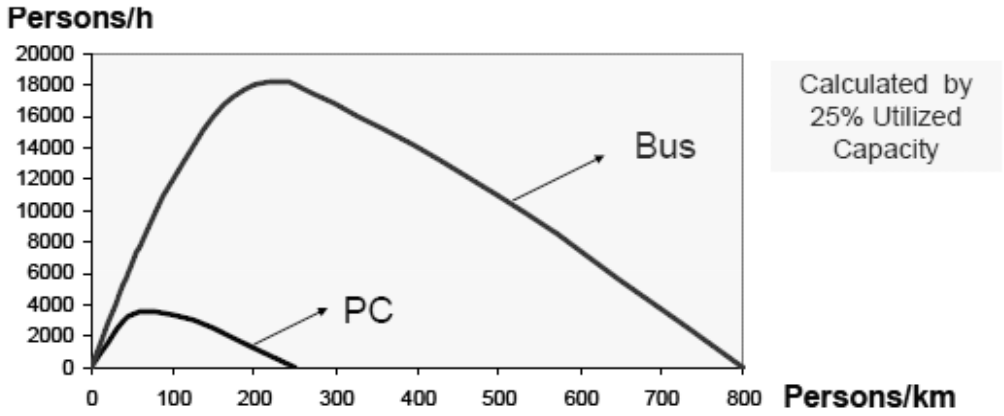

Fig. 5. Calculated connection between "frequency of persons" and "person density" transported by cars and busses

Rys. 5. Skalkulowane połączenie „częstotliwości osobowej" i „zagęszczenia osobowego" transportowanego samochodami i autobusami

The public transport network reaches its performance not until the road network is already overburdened (cp. [5]). In principle one could derive from that the lack of a direct interrelation (substitution) because public transport does not additionally increase the efficiency of the net. However, the supply of additional public transport considerably increases the quality of the traffic offered (in terms of average accessibility).

The circumstances within the corridor must allow for alternative modes of transport and the choice of transport. Therefore, knowledge about the interrelations of rail and road is crucial. Furthermore, the determination of the individual's transport is necessary.

The possibilities of shifting the mode choice are also dependent on transport management. This can be carried out on the levels:

- From a limited point of view, the demand for change of place is an unalterable fact and the traffic is divided onto the different transport modes. For this form of transport management the "Verkehrswert" ("value of traffic") [6] is the adequate methodical instrument.
- Traffic management can also stem from a specific change in the settlement structure. Four groups of measures can be identified (see Fig.6 [2]).

The desired structure of the area under investigation can be attained by implementing the well-known measures of transport management.

6. SUMMARY

A corridor approach represents the first step of a system extension. When analysing corridors and trying to derive preferential development areas, it is crucial to define general indicators which permits the formation of a priority ranking on which development measures can be based. These indicators must be key indicators which represent the system behaviour best. However, this most appropriate indicator changes with the system size. E.g. the indicator PCU has to be replaced by "person units" in an intermodal corridor approach.

A multimodal review of the dimensioning of roads widens the approach of existing guidelines by including present or possible transport performance of all means and modes of transport within the corridor. A multimodal approach requires the traffic assessment in "person units" or "good units" as well as the treatment of traffic as link of sources and destinations in the form of traffic spiders or

OD matrices. On the street level the interaction of existing and possible transport performances of the diverse transport carriers results in widening of the service offer. Thereby, the decisive characteristics of the different modes of transport (e.g. availability, accessibility, capacity utilisation, OD matrices, travel speed, costs, etc.) have to be taken into account.

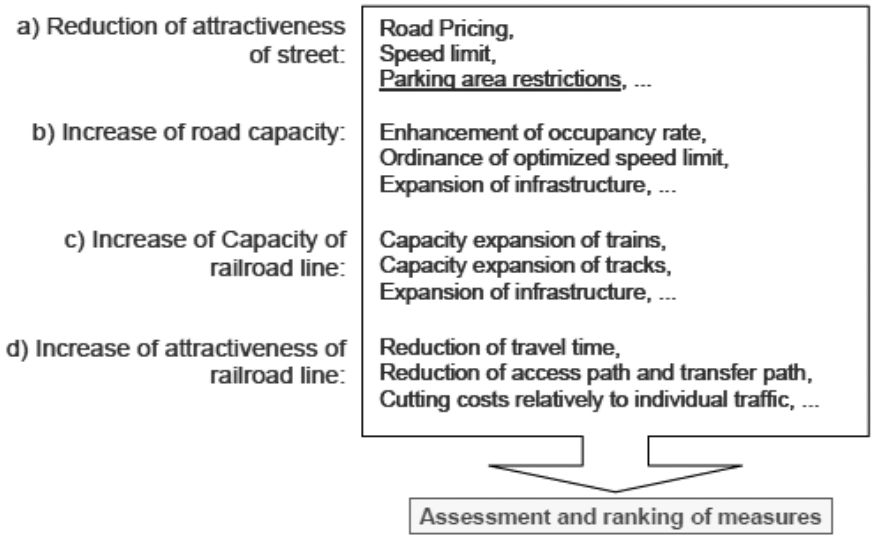

Fig. 6. Classification of approaches to transport management
Rys. 6. Klasyfikacja podejść do zarządzania transportem

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