Accessibility Standards – Discussion of their Necessity with the Example of the German "Guidelines for Integrated Network Design" (RIN)

Regine Gerike[1]
Jürgen Gerlach[2]
Andreas Rau[1]

Paper submitted to
1st Transatlantic NECTAR Conference 2009
Arlington, Virginia USA, 18-20 June, 2009

[1] Technische Universität München, Chair of Traffic Engineering and Control, mobil.TUM, Arcisstr. 21, 80333 München, Tel: +49 89 289.28575, Fax: +49 89 289.22333, regine.gerike@mobil-tum.de, andreas.rau@mobil-tum.de, www.mobil-tum.de

[2] University of Wuppertal, Centre for Traffic and Transport, Pauluskirchstraße 7, D-42285 Wuppertal, Tel.: +49 202/4 39-40 88, Fax: +49 202/4 39-43 88, Email: jgerlach@uni-wuppertal.de, www.traffic-transport.org

Abstract

The need to formulate standards for guaranteeing basic mobility is based on today's societal challenges and the goal of sustainable development as discussed in the first part of this paper. In the second part, requirements and possible criteria for such a system of standards are developed. These standards describe the opportunities provided by the transport and spatial systems as well as people's ability to make use of these opportunities. The concept of accessibility is put forward as a suitable concept to describe these components. Options for designing a system of accessibility standards are developed.

Next, the "Guidelines for Integrated Network Design" (RIN) are presented as a successful example of designing the transport components in a system of accessibility standards. The RIN deal with the design of transport networks for the following modes: private motorised transport, public transport, bicycle and pedestrian traffic. The RIN are structured in the following three parts:

1. Functional structure and hierarchy of the transport network
2. Quality requirements for the development of transport networks, network elements and linkage points
3. Assessment of transport routes in terms of connection quality

The system of standards that is established in the RIN is not only pragmatic but also presents the transport components of accessibility in a comprehensive and flexible way. It allows the freedom to adapt the standards to local circumstances. These standards for the transport system must be supplemented with standards for the spatial components of accessibility in order to comprehensively describe basic mobility.

1. Introduction – Why do we need standards for accessibility?

Today's societies are currently facing a number of ecological, financial and demographic challenges which have a strong impact on their future development. The transport sector both causes these challenges and has the potential to help solve them: Modern transport systems enable global trade and communication but at the same time are responsible for a significant amount of negative environmental, social and political effects; with issues of energy supply and climate change as examples of the most pressing problems.

Given that financial and natural resources are becoming scarcer, the question of how much and what type of mobility today's societies want gains significantly in importance. The goal is to increase the efficiency of the transport system while at the same time maintaining basic mobility for all people: The spatial and the transport system should enable all people to satisfy their basic needs even with the reduction in natural and financial resources, that is, to enable people to reach the destinations where they can satisfy their basic needs.

In addition to today's needs we must include future generations in this discussion if we base our argument on the goal of sustainable development as a politically driven and broadly accepted qualitative vision.

According to the Brundtland Commission, the qualitative vision of sustainable development can be defined as a development "*that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" (Brundtland-Commission, 1987, p. 24) Hence, the goal should not only be to ensure the satisfaction of basic needs for current but also for future generations.

Gerike (2007) argues that meeting people's needs is an ambitious goal because: human needs are variable; they are dependent on the individual and the context; they are instable and contradictory; and administrative planning is not flexible enough to promptly determine and satisfy human needs. There is always a lag between determining human needs (e.g. from surveys, observations, elections) and satisfying human needs (e.g. through transport policy measures).

The market mechanism embedded in an appropriate transportation policy is the only instrument that is able to simultaneously determine and satisfy human needs. With its ability to satisfy human needs in an efficient way the market is an important component for achieving sustainable transport development. A vital prerequisite for enabling the market mechanism to successfully satisfy needs is the right framework. Prices must send the correct signals, so that the market participants are able to correctly weigh up costs and benefits.

However, even with an optimal allocation of resources, the satisfaction of certain needs in certain groups of people might not be achieved because the market mechanism does not take distributional issues into consideration. It is conceivable that despite good market results (e.g., measured in terms of GDP), basic needs of certain groups of people are insufficiently satisfied due to imbalances in the distribution of market results. Efficient and profitable public transport (PT) that only serves profitable lines and does not provide an all-encompassing supply is an example of this. In this case there might be people who are unable to reach destinations where they can satisfy their basic needs even though the market functions properly.

From this line of reasoning comes the need to set administrative boundaries for the distribution of certain goods: basic mobilities should not fall below a certain level and consumption of natural resources should not exceed a certain level. The goal should be to provide basic mobility for all people while at the same time meeting ambitious environmental targets. This basic mobility should be defined by measurable standards in order to accurately document the degree to which goals have been achieved.

Hence, it can be stated that quantified goals that secure basic mobility for all people and thus enable all people to satisfy their basic needs represent a fundamental component of the concept of sustainable development. However, precisely defining basic needs is not any easier than defining people's needs in general. Which of the needs in Maslow's hierarchy can be regarded as basic needs? Human beings cannot survive only with food. They need contact with other people, a sense of belonging and esteem. Even if we focus on some very basic needs such as food, whose basic status seems to be beyond dispute, the question remains: What does this mean for the discussion on basic mobility? Should everybody have a supermarket within walking distance? What type of supermarket should this be? Should we set better standards for the availability of restaurants or of delivery services?

The definition of basic needs and basic mobility is a highly normative task that can only be done with the help of societal discussion. It is most likely that the level of mobility people claim in industrialized countries goes far beyond satisfying basic needs such as food or education. Each society has to decide on its own which "basic" mobility to provide.

Hence, concrete basic mobility might differ between countries and points in time; we could also call it society-driven mobility. We will nevertheless use the concept of basic mobility throughout this paper with respect to the claim and assumption that this basic mobility should at the very least guarantee satisfaction of needs whose basic status is beyond dispute.

The focus of this paper is the question of how to define the qualitative goals of such basic mobility, that is, how to make this concept manageable in terms of concrete planning. Thus, the goal is to develop requirements and possible criteria for describing this basic mobility and to illustrate them with the help of the German "Guidelines for Integrated Network Design" (RIN) as an example of transport components in a system of accessibility standards.

In order to reach this goal this paper is divided into four parts: The first section is a general discussion on the necessity and usefulness of basic mobility standards for today's transport policy. The second section includes: what type of standards we need to describe basic mobility; the concept of accessibility as a suitable concept to describe these components; and options for a system of accessibility standards. The third section presents the German "Guidelines for Integrated Network Design" (RIN) as a tangible example of transport components for standards of accessibility. In the final section implications for transport policy and areas for further research are presented.

2. Requirements and possible criteria for describing basic mobility

2.1 Requirements for basic mobility

Based on its Latin origin, "mobility" is defined in this paper as the ability to move and to reach certain destinations. Thus, mobility refers more to opportunities than to realised activities.[1] The opportunities people have are determined by the accessibility which the transport and spatial system provides:

- Quality and quantity of available destinations (spatial system)
- Quality and quantity of opportunities to reach those destinations (transport system)
- People's ability to make use of the available opportunities (individual characteristics such as car availability or reduced mobility)

Therefore, mobility refers in this paper to particular individuals, goods or information and focuses on a subject or object and its ability to move. Mobility does not necessarily require a destination; it is more a general measure of the ability to move. For example, people who are able to climb stairs have higher mobility than people who are unable to do so.

[1] See Becker, 2008 for a discussion on transport terms.

However, accessibility in this paper refers to certain locations or areas and their connection to other locations or areas. Thus, accessibility mainly takes the “system perspective” whereas mobility primarily takes the “individual perspective.”

Accessibility has been chosen for this paper as a suitable concept to describe the spatial and transport components of people’s mobility because accessibility effectively describes the two external system components of people’s mobility: The type and number of destinations available and the opportunities to reach these destinations. Hence, the goal of this paper is to develop options for a system of accessibility standards that guarantees basic mobility as initially discussed.

The benefit of measurable standards or reference values is a matter of debate in the literature. Fixed standards are rigid and therefore become outdated easily. Furthermore, it is difficult to find consensus regarding the selection of indicators, especially where quantitative target values are concerned. If values are set too high and are not achieved despite great effort, then criticism results. In other situations unrealistic goals might simply be ignored because there is no chance of reaching them. The danger of neglecting the standards also occurs if the standards are set too low and can be met without concerted effort.

Among the advantages of standards is the possibility to compare different areas and to determine degrees of goal achievement. If goals are vaguely formatted then it is not always clear what measures need to be put in place in order to achieve them.

These are the critical arguments for a system of measurable standards which describe the basic accessibility that the spatial and the transport system should provide. This goal remains an empty promise if it is not made concrete. Guaranteeing accessibility to satisfy basic needs is always related to cost and effort, and society must decide the scale of this cost and effort. “How much” basic accessibility should each individual be entitled to? This question can only be answered through quantitative standards.

Several of the aforementioned points of criticism concerning standards can be addressed through a flexible design of the standard system. However, it is always a challenge to find the optimal balance between flexibility and thoroughness.

2.2 Development of possible criteria for a system of accessibility standards

A good basis for the spatial planning component of minimum standards is the German system of central locations which is used at all levels of spatial planning. Under this system inhabited areas are assessed on their spatial significance and classified as either central locations (with different levels) or as areas which do not provide any central location functions. Central locations include those areas which provide service functions to both their own residents as well as to others within their catchment area; or those areas which fulfil a specific service function. They are favoured locations for public and private service facilities as well as centres of business, employment and education. Areas without a central location function are dependent on the central function areas for the provision of services.

In accordance with German federal spatial planning the following levels of centrality are usually defined:[2]

- Agglomerations (A): international or very large area of influence;
- Upper-level centres (UC): administrative, service, cultural and business centres and which provide more specialised services;
- Mid-level centres (MC): cover special needs and are focal points for business, industry and services;
- Basic centres (BC): provide basic services covering everyday needs to people within their own local area including sub-centres and small centres that must be specified in spatial planning at the regional level.

All other settlements are classified as communities (C) without any central location function. Higher level central locations always provide services to centres at the lower levels. Locations which provide some of the functions of a higher-level centre are treated as higher level centres.

Figure 1 shows upper-level and mid-level centres in Germany.

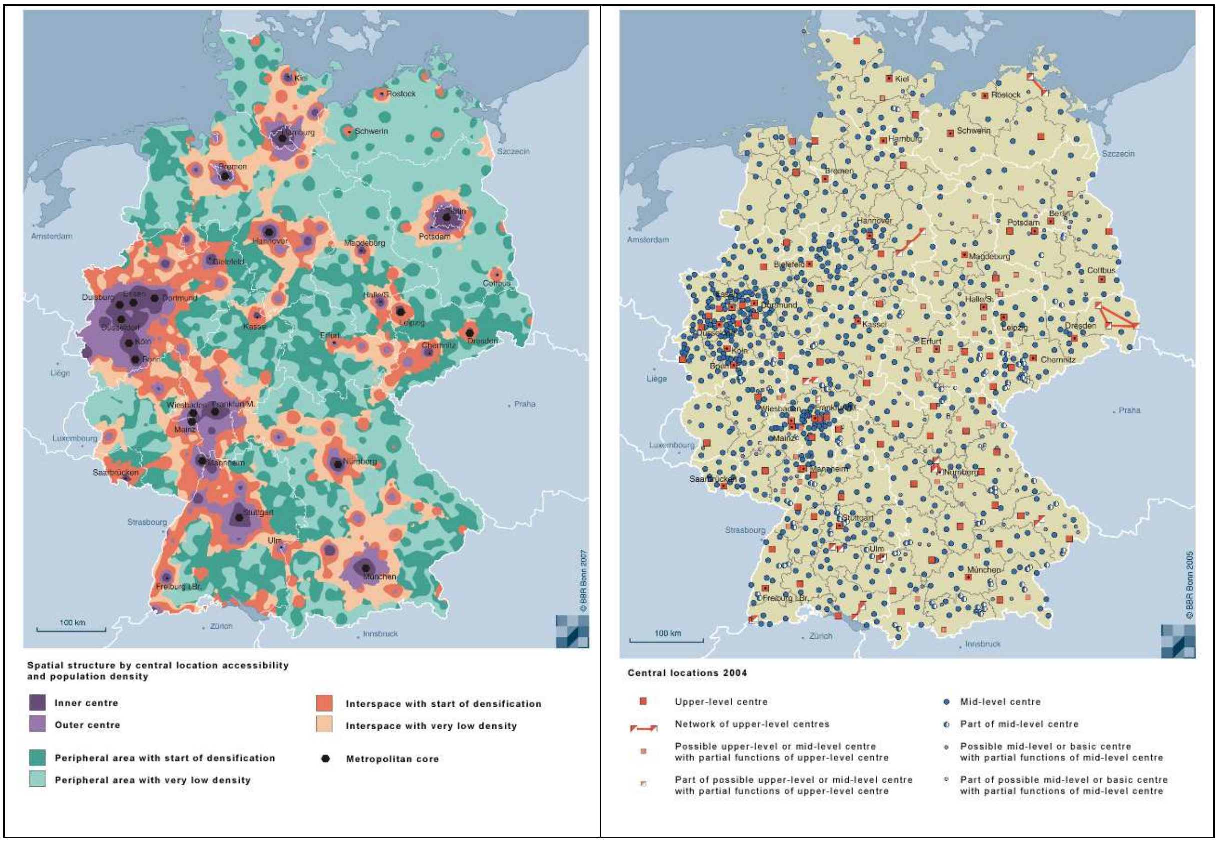

Figure 1: Spatial structure and agglomerations (left); upper-level and mid-level centres (right). Source: BBR, 2005, p. 20.

[2] In Germany the states ("Länder") are responsible for determining the central locations so that the number and designation of the central locations differs slightly among the states. Here we use the classification that the RIN is based on so that we can build on this for the presentation of the RIN in Section 3.

The facilities available in central locations are a vital aspect of guaranteeing basic mobility and should reflect the importance of the centre. Lists of facilities that should be available in central locations according to their level are given in the spatial planning documents of some German states.[3] From the viewpoint of basic mobility such facility catalogues are necessary for central locations because only the combination of their position, their facilities and their connection to each other (and to communities) can guarantee that the required destinations are both available and accessible.

Literature regarding basic needs is helpful in the discussion of which facilities should be available in central locations in order to guarantee a basic spatial supply.[4] In German spatial planning the term "basic existence functions" (Grunddaseinsfunktionen) is used to specify the concept of basic needs (ARL, 2005). The following basic existence functions are commonly used (ARL, 2005): shelter, work, access to provisions, access to education, access to recreation, access to transport, communication.[5] In order to guarantee these functions and thus to guarantee a local supply of goods and services such as food and health care we need a very detailed system for central locations.

Such a system can be designed not only by assigning levels of centrality to municipalities and large populated areas such as cities and towns but also to areas within municipalities. There is no legal framework for this intra-municipal structuring as it is primarily for land-use planning in central locations. However, it is a suitable method of including basic needs that require local supply into the concept of basic accessibility.

The intra-municipal functional structure should be developed based on the significance of the land-use and the available facilities. Intra-municipal areas of concentration can be classified as main centres, city districts or city centres, district centres, and groups of shops (small centres). Main centres should be categorized one level below the central location itself with subsequent intra-municipal levels following in decreasing order starting from this level.

Using this procedure a system of intra-municipal central locations can be established that fits well into the system of inter-municipal central locations and that is able to ensure local supply to residential areas.

In addition to the advantages of the central locations system in guaranteeing the spatial components of basic accessibility the following problems are discussed in the literature (ARL, 2005; Gerike, 2007): The locations, the levels and the facilities of central locations are determined at the state and the regional level which leads to differences in the number, description and facilities of central locations. A further critical point is the sense of normative structuring of regions in general, since in many cases transport flow does not correspond to the system of the normatively-fixed central locations. Nevertheless, central locations system is an effective way of establishing the spatial components of basic accessibility: Their location ensures that the transport system can make them accessible. Their facilities ensure that the necessary quality and quantity of destinations is available.

The core element of making central locally-distributed facilities accessible to inhabitants is the connection of central areas to each other as well as to residential areas. Here, the transport components of accessibility standards are addressed.

---

[3] See Hessisches Ministerium für Wirtschaft, Verkehr und Landesentwicklung, 2000.

[4] See (Gerike, 2007) for an overview.

[5] The basic existence function "access to provisions" is sometimes complemented by "disposing". Some authors suggest the function of self-defense as the 8th basic existence function (ARL, 2005). These basic existence functions correspond well to the origin-destinations-groups used in transport planning (Cerwenka, 2007). Gerike (2007) argues that access to transport is not a basic existence function in its own right but a necessary activity to make basic existence functions possible. This is justified by the fact that basic existence functions are described as basic needs and that transport is not regarded as a need in and of itself, but rather as a means to satisfy needs. Transport is referred to as a secondary need because of this characteristic.

Target values for journey times between central locations are derived from spatial planning and have been used in transport planning for many years.[6] Table 1 and Table 2 show target values as found in the RIN.[7] Journey time includes getting to transport from home, waiting and travel time, and getting from transport to final destination. The listed target values are not quality criterion for transport planning on their own. However, they form the basis for assessing the quality of infrastructure supply with the help of speed-based target values for specific network elements (see section 3.3) and for assessing the quality of complete transport routes between central locations (see section 3.4).

Central location	Journey time [min]	
	Car	Public Transport
Basic centres (BC)	≤20	≤20
Mid-level centres (MC)	≤30	≤45
Upper-level centres (UC)	≤60	≤90

Table 1: Target values for accessibility to central locations from residential areas. Source: FGSV 2008, p. 11.

Central location	Journey time to nearest neighbour[min]	
	Car	Public Transport
Basic centres (BC)	≤25	≤40
Mid-level centres (MC)	≤45	≤65
Upper-level centres (UC)	≤120	≤150
Agglomerations (A)	≤180	≤180

Table 2: Target values for accessibility to central locations from neighbouring central locations with the same level of centrality. Source: FGSV 2008, p. 11.

A focus on public transport is recommended when designing the links between central locations as a component of basic accessibility. This is because travel times with private motorised transport are mostly quite low and bicycle and pedestrian traffic are not relevant to linking central areas with higher levels of centrality. Figure 2 shows that 88 per cent of the German population need less than 45 minutes to reach the nearest upper-level centre and less than 15 minutes to reach the nearest mid-level centre by car. Moreover, standards for private motorised transport are only useful for part of the population and thus, are unsuitable to provide basic transportation supply to all people.

[6] See Gerike, 2007 for an overview.
[7] The target values for cars were used in the predecessor of the RIN but no target values were given for Public Transport (FGSV, 1988).

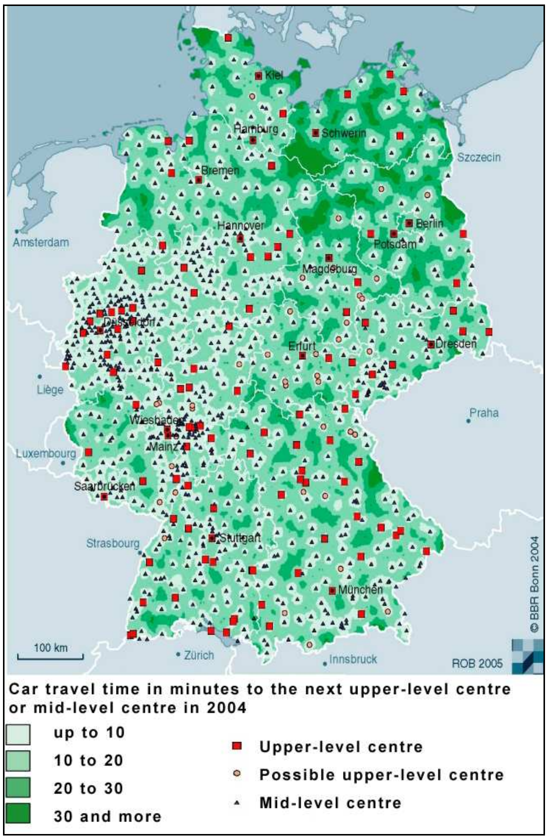

Figure 2: Accessibility of central locations by car. Source: BBR, 2005, p. 127.

Linking central locations to each other and to residential areas is often described by cost items such as journey times which take into consideration travel times, access times to and from transport, and operating frequencies.[8] In addition to travel times between centres, the quality of public transport services should be included (density of stops, operating times and amount of seating provided).[9]

An important domain of basic accessibility is the neighbourhood, because many basic needs are satisfied within this area.[10] In this domain, minimum standards for pedestrian and bike traffic are vital, since they represent the most favourable options for short distances, both from an ecological and economic viewpoint. Already 59 percent of all trips are shorter than five kilometres and in motorised individual transport this share is 43 percent.[11] The proportion of short distance trips can be further increased by good accessibility to nearby destinations. Distance measures are conceivable as minimum standards for the neighbourhood, but further criteria such as the quality of town planning should be included.

Thus, the following are possible transport components of basic accessibility:

- Distance measures of pedestrian and bike traffic in the neighbourhood, for instance, maximum distance of x meters to a shop (e.g. general store) for y per cent of the population.
- Measures of cost and effort such as time, money, comfort or combined measures for linking housing to central locations as well as central locations to each other.

8 These can be considered as average waiting times.

9 Qualitative aspects such as the range of products offered in shops should also be considered for the spatial components of basic transportation supply, since a comprehensive offer of facilities does not yield any benefit if it is not used due to a lack of quality.

10 Here, above all, functions are addressed that were assigned to the intra-municipal centres.

11 See http://www.mobilitaet-in-deutschland.de/engl/index.htm, 7/5/2009.

- Density of stops for public transport, for instance, maximum distance to stop of x meters for y percent of the population.
- Operating frequency of public transport, for instance, frequencies differentiated by different traffic times.

3. The German "Guidelines for Integrated Network Design" (RIN) as an example of standards for accessibility

3.1 Introduction

There are several approaches to implementing elements of the accessibility standards system as described above. These are found not only in spatial and transport planning but also in other political areas such as welfare policy.[12]

In the following section the "Guidelines for Integrated Network Design" (RIN) are presented as a successful and sophisticated example of using accessibility standards in transport planning.

The RIN formulate standards for all transport modes and for all spatial levels reaching from the macro level of connecting agglomerations to the micro level of securing a local supply of infrastructure for pedestrian, bicycle, public and car transport. The RIN mainly focus on passenger transport. They include car, public passenger transport (railways, underground rail, tram and bus), bicycle and pedestrian transport modes as well as the design of linkage points for intermodal transport (Park+Ride, Rail+Fly and Bike+Ride). The RIN orientate these standards directly towards the system of central locations that was identified in the previous sections as a suitable basis for the spatial components of a basic accessibility. Additionally the RIN are an attempt to integrate scientific knowledge of transport planning into a highly binding planning guideline.

The RIN are not explicitly orientated to guaranteeing basic accessibility but provide target values that build on the goals of land use and regional planning and derive standards for transport planning out of them. Based on the earlier argument from section 1, these standards can be interpreted as standards of a socially desirable and therefore basic accessibility. The system is designed as a flexible system that allows for exemptions in both directions.

The RIN suggest targets for connecting central locations to each other and to residential areas. The following are goals of the RIN:

- Guarantee the supply function for people living within the catchment areas of central locations
- Guarantee the exchange function between central locations
- Support the development of population structures that are concentrated on the system of central locations
- Support the special importance of the interconnection between national and international agglomerations

With this approach exactly this basic accessibility is addressed and described the necessity of which was derived in the first sections of this paper.

The RIN are assigned the highest category in the publications of the German Research Society on Roads and Transport (FGSV) and are thus strongly binding for German authorities and transport planners. They were announced by the German Federal Transport Ministry together with the request that they be applied to trunk roads. The RIN are the first part of a highly complex set of guidelines

[12] The most advanced example is the accessibility planning in the UK; see (Social Exclusion Unit, 2003; Keller, 2008).

which sets standards for all steps of infrastructure design; from network design to the alignment and assessment of specific street sections.

Figure 3 gives an overview of the three main parts of the RIN:

1. Functional structure and hierarchy of the transport network: A category is assigned to each section of a transport route. A transport route is defined here as the connection between two central locations or between a central location and residential areas. The category that is assigned to a specific section is based on the significance of the connections which use this section of the network and the level of demand from adjoining areas. The aim is to classify the sections of a transport route as appropriate to their functions.
2. Quality requirements for the development of transport networks, network sections and linkage points: General quality requirements are established for the transport routes of all included transport systems (beyond only single network sections) based on the general requirements coming from spatial planning and the functional structuring of the transport network. From these network requirements quality requirements for single network sections are developed depending on the classification of the section that was made in the first step.
3. Assessment of the connector-related quality of service: Characteristic values for the quality of service are developed for each relevant transport route within one individual transport system or for a combination of transport systems. A comparison of these characteristic values with target levels of quality allows the transport routes to be assessed as "good" or "bad" from the user’s point of view.

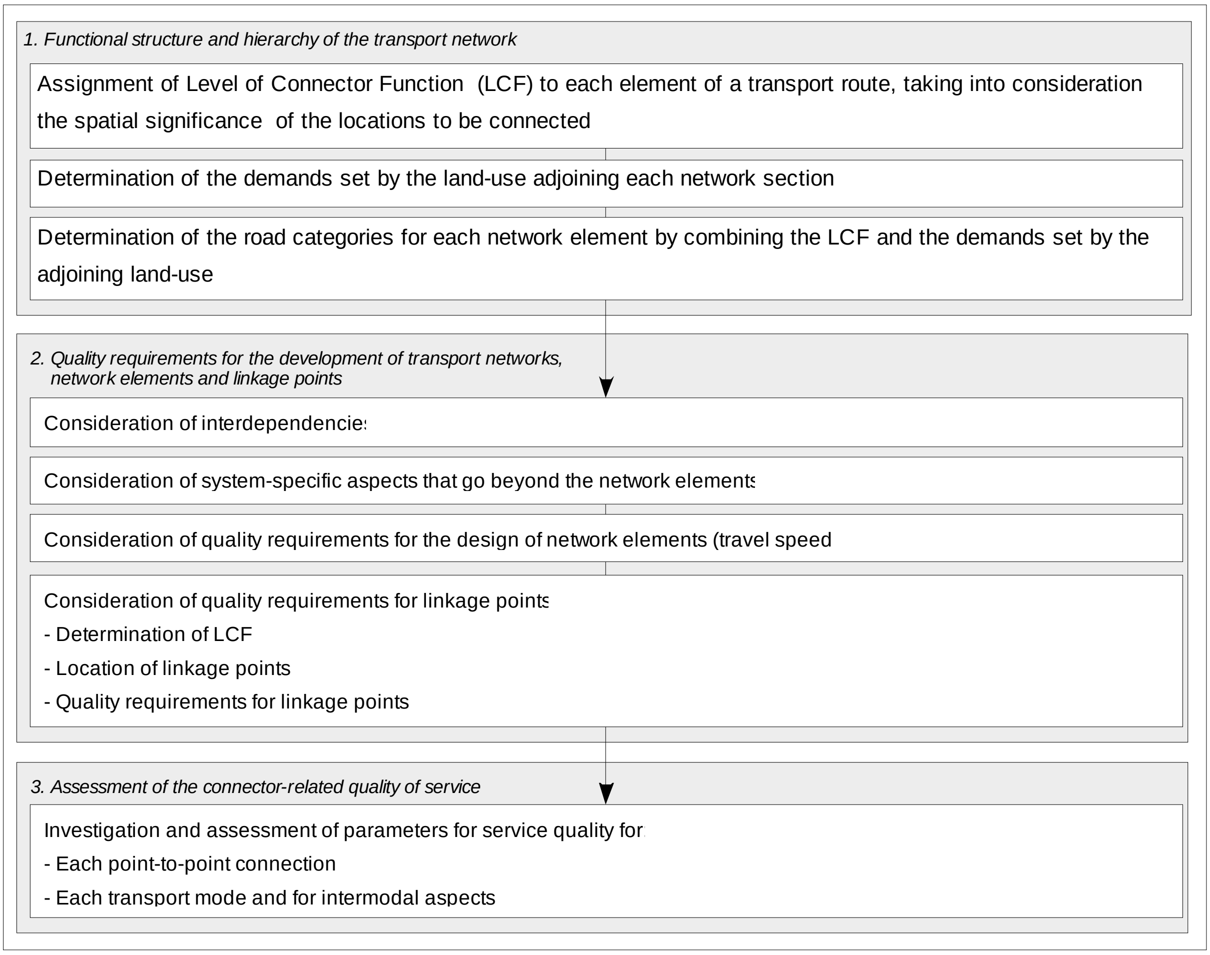

Figure 3: Structure of the RIN.

In the following, the three main parts of the RIN are described in more detail.

3.2 Functional Structure of the Transport Networks

Starting point for the RIN is the system of central locations as described in the previous sections. This system together with target values for journey times between central locations and residential areas build the basis for the functional structuring of the transport network. In addition it is the basis for the development of quality requirements for the transport networks and linkage points (see section 3.3) in the RIN. Each network section is classified according to:

- Its importance: Level of Connector Function (LCF) and;
- Its function (road category).

The LCF is derived from the level of central locations to be connected. Six levels of connector function (LCF) have been defined to describe the significance of connection routes. These levels of connector function are valid for all modes of transport as long as they are relevant for the respective mode. The importance of a connection results from the importance of the locations to be connected. The RIN distinguish between connections related to the service functions for residential locations in catchment areas and connections that enable exchange between central locations. Table 3 gives an overview of the LCF used in the RIN from level 0 to level V.

For each level of connector function the connections between the central locations can be described in a first step by point-to-point-speed matrices. The transfer of the LCFs from the point-to-point-speed connections to the transport networks is made separately for each transport system and for each relevant combination of transport systems. This transfer should preferably be made by using the existing transport networks. Those elements of the network should be selected which are suitable for taking on the LCF or which could be developed as such. Where necessary, network elements which have yet to be constructed may be included in this process. The criteria for the transfer (of the LCFs) to the transport network, should include – in addition to the directness of the connection and the journey speed - traffic safety, the relief of built-up areas or other areas worthy of protection, and the bundling of traffic streams.

Level of Connector Function (LCF)		Ranking Criteria		Description
Level	Designation	Service Function	Exchange Function	
0	Continental	-	A - A	Connection between agglomerations
I	Wide-area	UC – A	UC – UC	Connection between upper centres and agglomerations and between upper centres
II	Inter-regional	MC – UC	MC – MC	Connection between mid-level centres and upper centres and between mid-level centres
III	Regional	BC – MC	BC – BC	Connection between basic centres and mid-level centres and between basic centres
IV	Local	C – BC	C – C	Connection between communities without central location significance and basic centres and among communities with no central location significance
V	Small area	D - C	-	Connection between premises and communities with no central location significance and basic centres

A Agglomeration
UC Upper Centre
MC Mid-Level Centre
BC Basic Centre
C Communities without central location significance
D Premises
\- Not applicable

Table 3: Level of Connector Functions in the RIN.

In the second step a road category is assigned to each network section in addition to the LCF. Roads may have combinations of functions imposed on them in terms of the expectations set by the adjoining land-uses. A road category is assigned to each road section in accordance with the following criteria:

- Road type (motorways, country roads , urban roads)
- Location (outside built-up areas, bordering built-up areas, within built-up areas)
- Type of adjoining land-use (non-built-up, built-up)
- Main road or access road

Figure 4 provides an overview of the five road categories that are used in the RIN and their combinations with the LCF.

Road category / Level of Connector Function		Motorways	Country roads	Main roads (non-built-up)	Main roads (built-up)	Access roads
		AS	**LS**	**VS**	**HS**	**ES**
Continental	**0**	**AS 0**		**-**	**-**	**-**
Wide-area	**I**	**AS I**	**LS I**		**-**	**-**
Inter-regional	**II**	**AS II**	**LS II**	**VS II**		**-**
Regional	**III**	**-**	**LS III**	**VS III**	**HS III**	
Local	**IV**	**-**	**LS IV**	**-**	**HS IV**	**ES IV**
Small area	**V**	**-**	**LS V**	**-**	**-**	**ES V**

AS I	Existing category designation
(grey)	Problematic
-	Does not exist or is not tenable

Figure 4: Connection matrix showing the assignment of road categories in the RIN.
Source: FGSV, 2008, p. 15.

Table 4 shows those combinations which can be expected to lead to satisfactory solutions from both a constructional and operational point of view. Further road categories do exist in practice, but in these cases there are often significant conflicts between the transport and non-transport uses which can only (if at all) be resolved by design-related measures with considerable difficulty. In this case an effort should be made to separate the three types of connection functions, access functions and place functions. In general, high LCF should be combined with higher level road categories in order to minimize conflicts in their usage. Level I central locations are connected by motorways and secondary roads. Level II central locations can be connected by the road categories AS, LS or VS. Level III central locations can only be connected by the road categories LS, VS or HS. Lower LCF should be combined by road category LS, HS or ES.

Level of Connector Function (LCF)		Category	Description
Level	Designation		
0, I	Continental Wide-area	AS 0/I LS I	Long distance motorway Trunk road
II	Inter-regional	AS II	Inter-regional motorway, urban motorway
		LS II	Inter-regional road
		VS II	Cross-city road, non-built-up arterial road
III	Regional	LS III	Regional road
		VS III	Cross-city road , non-built-up arterial road
		HS III	Cross-city road , inner-municipal arterial road
IV	Local	LS IV	Local access road
		HS IV	Cross-city road , inner-municipal arterial road
		ES IV	Collector road
V	Small area	LS V	Link road
		ES V	Residential street

Table 4: Road categories for motor vehicle traffic in the RIN. Source: FGSV, 2008, p. 15.

The RIN develop similar systems for PT, bicycle and pedestrian traffic. Table 6 and Table 7 in section 3.3 show the categories for PT and bicycle transport. For pedestrian traffic two categories are introduced without any distinction between different LCF: The category AR includes pedestrian infrastructure outside built-up areas (mainly paths for leisure purposes). The category IR includes pedestrian infrastructure inside built-up areas that are mainly used for everyday purposes.

3.3 Quality requirements for the development of transport networks, network elements and linkage points

Central locations are connected by a series of network elements that together form a transport route. The quality of the transport route can only be improved by upgrading the elements that the route is composed of. Quality requirements for specific network elements can be derived from target values for the transport routes. The RIN operationalise these quality requirements by standard distance ranges and target values for car travel speed on the network elements. These requirements are formulated at a micro level of specific network elements. Nevertheless, they help to guarantee the exchange function and the provision function of central locations as they are derived from specifications from spatial planning.

Table 5 shows the classification of network sections for motor vehicle traffic including range and targeted car speed.

Level of Connector Function (LCF)		Road category	Standard range [km]	Target car travel speed [km/h]
Level	Designation			
0, I	Continental Wide-area	AS 0/I LS I	40-500 40-160	100-120 80-90
II	Inter-regional	AS II	10-70	70-90
		LS II	10-70	70-90
		VS II	-	40-60
III	Regional	LS III	5-35	60-70
		VS III	-	30-50
		HS III	-	20-30
IV	Local	AL IV	Up to 15	50-60
		HS IV	-	15-25
		ES IV	-	-
V	Small area	ES V	-	-

Table 5: Road categories for motor vehicle traffic and target values for median car speed. Source: FGSV, 2008, p. 23.

The RIN also include quality requirements for PT and bicycle transport which are shown in Table 6 and Table 7. These requirements are described by criteria for travel speed and for the quality of pedestrian infrastructure.

Category		Sub Category		Standard range [km]	Target speed [km/h]
FB	Long distance rail transport	FB 0	Continental long distance rail transport	200-500	160-250
		FB I	Wide-area long distance rail transport	60-300	120-160
NB	Regional rail transport outside built-up areas	NB I	Wide-area regional rail transport	40-200	50-110
		NB II	Interregional rail transport	10-70	40-100
		NB III	Regional rail transport	5-35	35-100
UB	Independent rail transport	UB II	Regional rail transport, metro, tram as main connection	-	30-45
		UB III	Regional rail transport, metro, tram as side connection	-	25-35
SB	Light rail	SB II	Light rail and tram as main connection	-	20-30
		SB III	Light rail and tram as side connection	-	15-25
		SB IV	Light rail and tram for accessing an area	-	10-20
TB	Tram/bus	TB II	Tram and bus as main connection	-	10-25
		TB III	Tram and bus as side connection	-	5-20
		TB IV	Tram and bus for accessing an area	-	-
RB	Regional bus transport outside built-up areas	RB II	Interregional bus transport	10-70	30-50
		RB III	Regional bus transport	5-35	25-40
		RB IV	Local bus transport	Up to 20	20-35

Table 6: Categories for PT and target travel speed. Source: FGSV, 2009, p. 25.

Category		Sub-Category		Standard range [km]	Target speed [km/h]
AR	Outside built-up areas	AR II	Interregional bicycle connection	10-70	20-30
		AR III	Regional bicycle connection	5-35	20-30
		AR IV	Local bicycle connection	Up to 15	20-30
IR	Inside built-up areas	IR II	Inner-municipal express bicycle connection	-	15-25
		IR III	Inner-municipal standard bicycle connection	-	15-20
		IR IV	Inner-municipal bicycle connections	-	15-20
		IR V	Inner-municipal bicycle connections	-	-

Table 7: Categories for bicycle infrastructure and target values for travel speed for daily traffic. Source: FGSV, 2008, p. 26.

3.4 Assessing the service quality of connections

In the previous sections the two phases of functional structuring of the transport network and of the development of quality requirements for network elements were discussed. Their combination enables a comprehensive description of the quality of connections between central locations and from central locations to residential areas. This is because the functional structure and the quality requirements are derived in a top-down-approach from specifications of spatial planning and are broken down into specific network sections.

In addition to these criteria that are related to specific network sections, the RIN introduce criteria for assessing the service quality of complete transport routes between central locations, and between central locations and residential areas. The goal of these criteria is to obtain a picture of the overall quality of the network for different transport modes.

Relevant criteria for connection quality at this macro level are journey time, costs, directness, temporal and spatial availability of transport services, reliability, safety and comfort. Table 8 shows the criteria that are used in the RIN:

Criterion	Indicator
Time	• Point-to-point-speed • Ratio of individual to public transport journey time
Directness	• Detour factor • Frequency of change

Table 8: Criteria and indicators for describing the quality of transport routes.
Source: FGSV, 2008, p. 19.

Two indicators are used for the criterion of time. The point-to-point-speed is calculated by dividing point-to-point-distance[13] by journey time. Thus, point-to-point-speed relates to the distance covered and therefore facilitates the comparison of connections over different distances. The ratio of individual to public transport journey time describes the relative quality of PT compared to private motorised transport.

The detour factor is defined as the ratio of travel distance to point-to-point-distance. The frequency of change is defined as the average number of changes that are necessary on a specific transport route. Changes may occur within one transport mode but also include transfers between private motorised road transport and PT. The two indicators for the criterion of directness should only be used if the criterion of time is poorly assessed. In this case the reasons for low point-to-point-speeds and/or bad journey time ratios of individual to public transport can be explained by the indicators found in the criterion of directness.

The RIN do not set target values for any of the indicators but rather work with the six levels of service quality which are shown in Table 9. These Levels of Service Quality (LSQ) are used in the diagrams for assessing connector-related service quality as a function of point-to-point-speed and point-to-point-distance. These diagrams were developed on the basis of analyses of numerous connections. The concept of LSQ is applied to all transport modes consistently and enables an easy and transparent assessment by political decision makers.

The RIN do not set target values for any of the indicators but rather works with the six levels of service quality which are shown in Table 9. These LQOS are used in the diagrams in addition to the well-known LOS system for single infrastructure elements for assessing connector-related service quality as a function of point-to-point-speed and point-to-point-distance. These diagrams were developed on the basis of analyses of numerous connections. The concept of LQOS is applied to all transport modes consistently and enables an easy and traceable weighing and decision finding by the political decision makers.

[13] The distance is measured as a straight line between point A and point B.

LSQ	Description
A	Very good quality
B	Good quality
C	Satisfactory quality
D	Acceptable quality
E	Poor quality
F	Unacceptable quality

Table 9: Level of Service Quality (LSQ). Source: FGSV, 2008, p. 20.

Figure 5 shows the levels of service quality for a comparative assessment of point-to-point speed of cars versus PT. With those levels of service quality it is possible to rate the quality of transport routes. The analyses show that differentiation between LCD is not necessary because point-to-point speed adequately describes the connection quality.

Service quality levels for separately assessing motorised traffic are more ambitious than those for separately assessing PT and than those for the comparative analysis shown in Figure 5. In addition service quality levels are given for the ratio between journey times of motorised transport and PT (see Figure 6) and for the assessment of detour factors (see Figure 7).

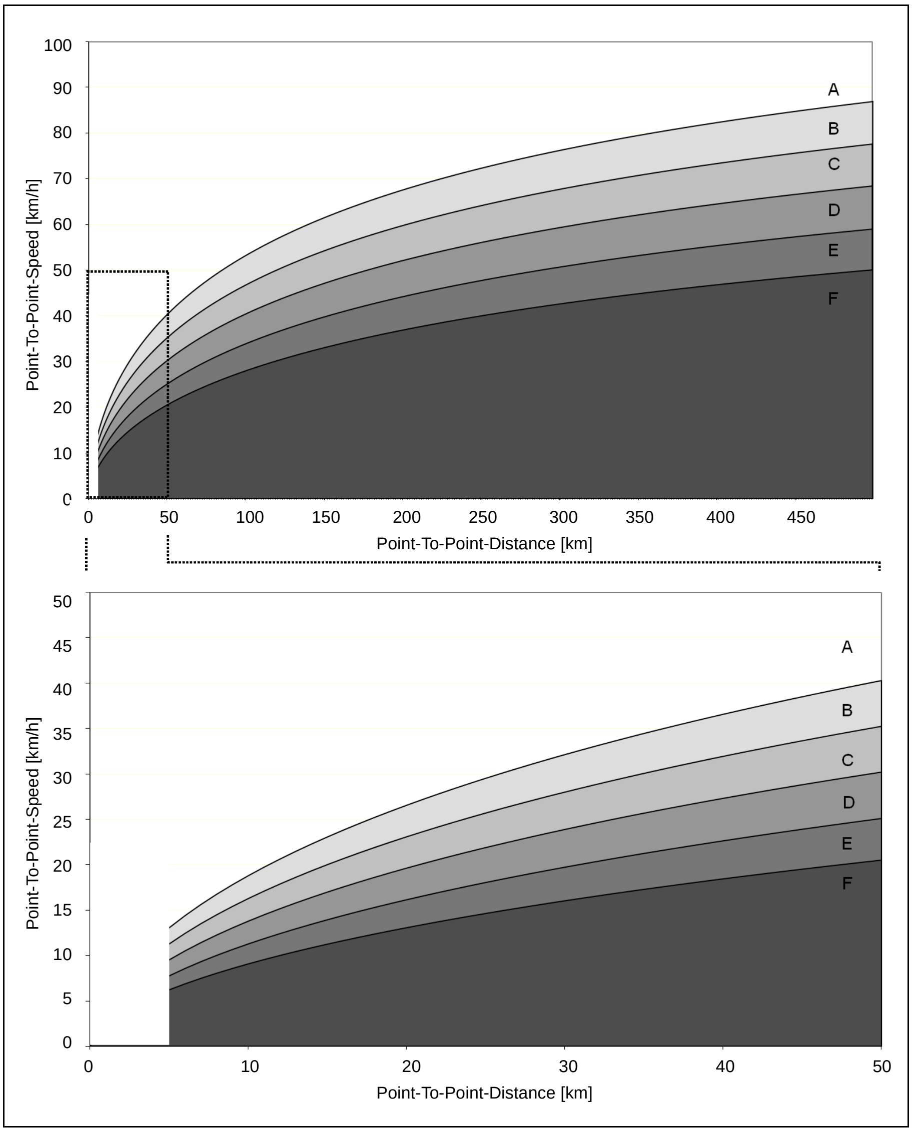

Figure 5: Service quality level for point-to-point speed for a comparative assessment of motorised individual transport and PT. Source: FGSV, 2008, p. 43.

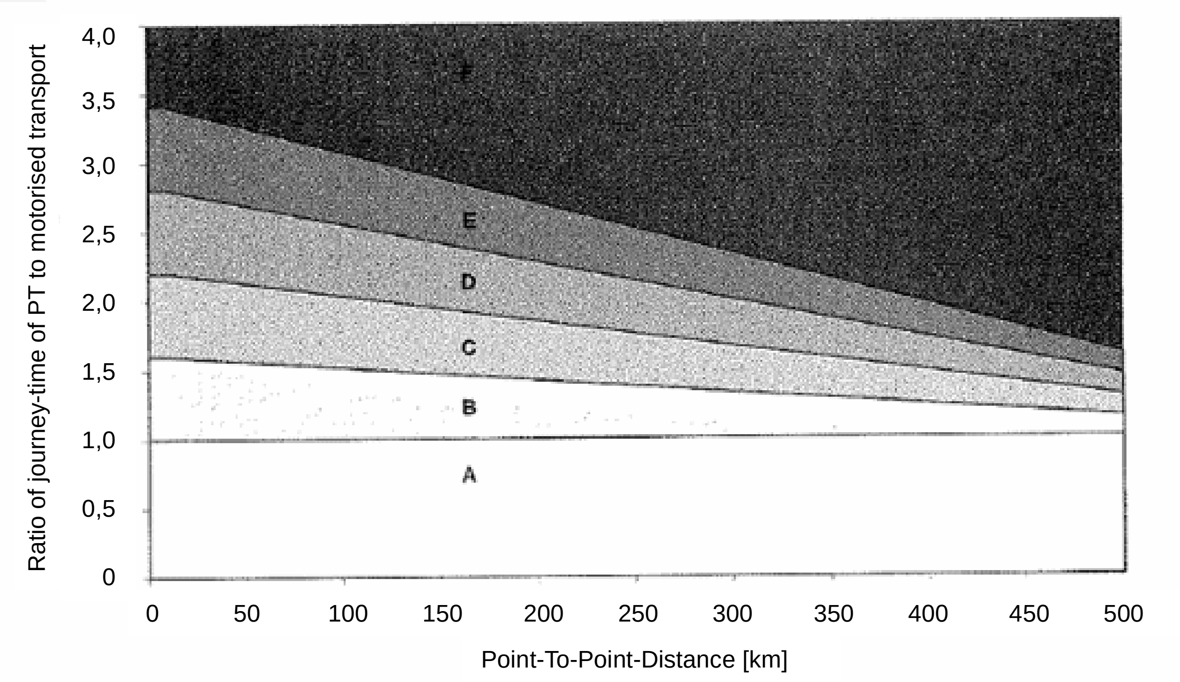

Figure 6: Benchmarks for the ratio of journey-time of PT to motorised transport.
Source: FGSV, 2008, p. 44.

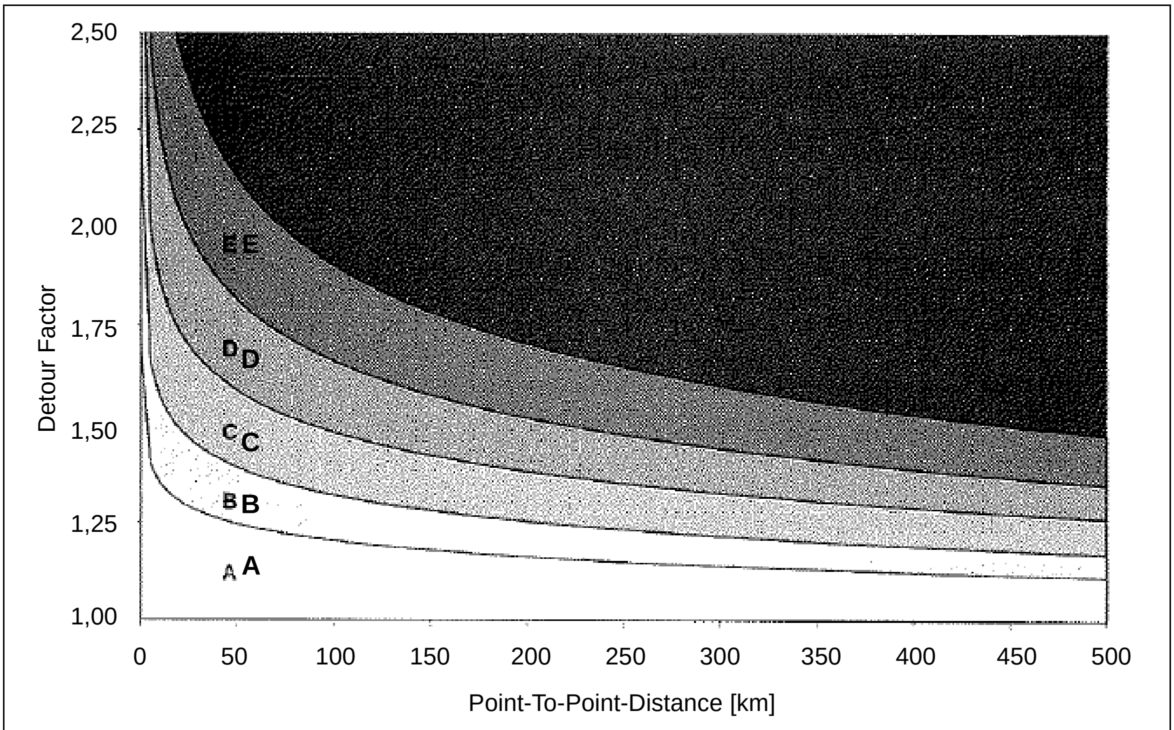

Figure 7: Orientation values for the assessment of detour factors. Source: FGSV, 2008, p. 45.

4. Conclusions

The first important conclusion of this paper is that the provision of basic accessibility is an important part of achieving the goal of sustainable transport development and an important prerequisite for meeting current societal challenges.

Transport policy should not concentrate primarily on improving traffic but rather on the underlying purpose, that is, on the activities that can be carried out with the help of transport and on the needs that can be satisfied by those activities. The definition of the concepts of basic needs and basic mobility is a normative task and changes over time and between regions. However, it is needed in order to formulate concrete standards that guarantee the satisfaction of some needs the basic status of which is beyond dispute.

These standards should describe opportunities provided by the transport and the spatial system as well as specific needs of certain groups of people. Accessibility standards are a suitable means of describing these components of basic mobility.

The system of central locations is an appropriate basis for designing the spatial components of the standards system. It must be broken down into spatially low levels of centrality in order to guarantee the local supply of daily goods and services. Standards are necessary for the system's structure and the facilities of central locations.

The transport components of the system should describe the quality of the connections between central locations, and from central locations to residential areas. The focus of these transport system standards should be on PT and on the "slow modes" (pedestrian and bicycle) in order to enable all people to make use of the standards and in order to reduce the environmental impacts of transportation.

The "Guidelines for Integrated Network Design" (RIN) are a successful example of designing the transport components of such a system of accessibility standards. The RIN deal with the design of transport networks for public, private motorised, bicycle and pedestrian modes of transport. Firstly, the RIN establish the functional structure and hierarchy of the transport network. Secondly, the RIN develop quality requirements for the development of specific network elements. These are derived from the general requirements which result from spatial planning and functional structuring of the transport network. Standard distance ranges and car speed are used as criteria to describe these quality requirements. Thirdly, the RIN develop indicators for assessing the service quality of complete transport routes (connections between central locations and to residential areas). Service quality levels are determined for point-to-point speed and the ratio of private to public travel time. This approach allows the transport routes to be assessed as "good" or "bad" from the user's point of view.

Hence, the RIN show that it is possible to develop a comprehensive system of standards that is not only clear and pragmatic, but that also includes all transport modes and all spatial levels from a detailed micro level to the macro accessibility of agglomerations. As such, the RIN are an important component of basic mobility and thus an important component of sustainable transport development. This component must be supplemented with criteria for the spatial elements of basic mobility and by criteria for the environmental and economic aspects of sustainable transportation development.

The main goal of further research is to define in more detail the requirements for the transport system in guaranteeing the satisfaction of basic needs. The link between original human needs and basic mobility is complex but important to understand. Further criteria covering areas such as reliability and comfort might be necessary in order to comprehensively describe basic mobility. The goal should be to identify key criteria that facilitate a simple system of standards with an accurate and comprehensive description of basic mobility.

References

Academy for Spatial Research and Planning (ARL) (2005). *Concise Dictionary of Spatial Planning*. Hannover. In German.

BBR - Federal Office for Building and Regional Planning (Ed.) (2005) *Report on Spatial Planning 2005.* http://www.bbr.bund.de/cln_007/nn_22548/BBSR/DE/Veroeffentlichungen/Berichte/2000__2005/Bd21Raumordnungsbericht2005.html, 20/5/2009. In German.

Cerwenka, P.; Hauger, G.; Hörl, B.; Klamer, M. (2007) *Handbook of Transport System Planning*. Österreichischer Kunst- und Kulturverlag: Wien. In German.

Brundtland, G. (Ed.) (1987). *Our Common Future: The World Commission on Environment and Development*. Oxford: University Press Oxford.

FGSV - Road and Transportation Research Association (2008) *Guidelines for Integrated Network Design" (RIN)*. Cologne. In German.

FGSV - Road and Transportation Research Association (1988) *Guidelines for the design of roads (RAS), part: Manual for the functional form of the road network (RAS-N)*. Cologne. In German.

Gerike, R. (2007) *How to make sustainable transportation a reality – the development of three constitutive task fields for transportation*. München: Oekom.

Hessisches Ministerium für Wirtschaft, Verkehr und Landesentwicklung (2000) *Regional development plan for the state Hessen 2000*. http://www.hessenrecht.hessen.de/gesetze/360_Landesplanung/360-16-LandesentwicklungsplanVO/sonstiges/LEP2000.pdf, 4/4/2009. In German.

Keller, J. (2008) *Accessibility planning in UK and Germany*. Diploma Thesis at Technical University Dresden, Chair for Transport Ecology. In German.

Social Exclusion Unit (2003) *Making the Connections: Final Report on Transport and Social Exclusion*, Cabinet Office, London.

Acknowledgements

The authors would like to thank the members of the FGSV committee "Network Design" for developing the RIN method and for their comments and advice concerning this paper.