POLICY MAKING ON ROAD DESIGN STANDARDS

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In a modern society there are hardly any human activities on which the system of passenger transport whether public or private has not a direct or indirect influence.
Decision making concerning the road transport system e.g. on standardising geometric road design will generally affect many sectors of social life.

In the decision making procedure mutual weighting of all socially relevant consequences of decisions, including the economic consequences, will be necessary. In other words, the transportation and traffic policy should be consistent with the general social policy.

The prevailing political vision nowadays is that economic growth does not have a favourable effect on the level of common welfare under all circumstances. In controversial cases promotion of well being should have priority.

An attempt to define the term well being raised the supposition that it is a multidimensional quantity, i.e. a vector composed of a number of mutually independent welfare components.

The general social policy (and therefore all related sector policies) should then aim at a choice of measures such that, given the available resources a maximum outcome would be obtained in terms of a weighted sum of all effects on relevant welfare components.

The degree of well being is affected by passenger transport systems in a variety of ways, the most important of which are described below. Though travelling may be a pleasure in itself, the basic function of transport systems is to increase the mobility of the population, thus giving access to a greater variety of destinations, whether public or private facilities where the "visitors" can increase their amount of well being.
During travelling the well being of travellers can be affected by risks which are, to a degree, specific for the travel mode of their choice.

The level of well being of non-travellers is affected by the amount of travel in their vicinity, mainly in a negative way as a consequence of pollution, noise and vibration caused by traffic.

In view of limited time budgets of individuals it is evident that an increase in travel speed leads to an increase in mobility and consequently to an increase in well being.
Comparing two roads with equal design speeds, the one with a higher travel speed is likely to have a higher risk level.
Comparing two roads with different design levels, generally the one with a higher design speed will have also a greater capacity and will be of greater attraction to traffic, i.e. a higher intensity. The road with a higher design level will generally combine higher travel speeds with a lower risk level.
In both cases higher travel speeds are likely to correlate with greater adverse effects to the environment. The magnitude of these adverse effects, and consequently their importance for decision making will not only depend on the amount of pollution, noise and vibration produced by the traffic stream, but also on the sensitivity of the environment to these effects, which is the product of the population density in the area and the sensitivity per capita. The sensitivity per capita may vary widely with the character of the environment, whether domestic, industrial, commercial, recreational etc.

It should be noticed that travel time, safety, and environment all have an economic (welfare) as well as a social (well being) aspect. Both welfare and well being aspects can be quantified. Welfare aspects have a single (financial) dimension, whereas the well being aspects have all different dimensions.

In cost benefit analysis only the economic (welfare) consequences of decisions are considered. The outcome of the decision making procedures will hardly be affected by ignoring effects on well being aspects if these are small compared with the economic consequences of the choice. Too often, however, conclusions emerging from cost benefit analysis are overruled by responsible policy makers on the judgement that an alternate choice is indicated because well being impacts are too important to be neglected.

In the domain of policy making on road design standards three phases can be distinguished.
The gradual development of the road network over a very long period, combined with an equally gradual development of road design standards has led to existence of an almost unlimited number of road classes, practically each road section being a class of its own. Driving task analysis has provided substantial evidence that the predictability of downstream road and traffic situations will contribute to the smoothness and safety of the traffic stream. Road design standards can be useful to reduce the number of road classes, and especially to reduce or avoid differences in design standards between sections of a single road connection.
The second phase in policy making on road design standards is the decision as to which set of design standards should be applicable to a particular road connection in view of its functional requirements.
The third phase occurs only if some road connection is already available, which however does not meet he (new) design standards. Then a decision is to be made whether to upgrade the existing road to the desired level or to design and construct a new road.

In the Annex an analysis is made of the costs of car travelling on new built roads of various types.
The decision as to which design standards should be adopted for a planned road connection with a certain expected value of travel demand, can be facilitated considerably with the aid of such quantitative analyses. The critical values of AADT above which higher level design standards have to be used, are sensitive to the relative economic costs of road construction, travel time and road accidents. For optimal decision making accurate data are important.

In the example, environmental costs have been neglected, because no general values could be determined in relation to road characteristics. In fact, there is not much information available with respect to the effect of road traffic on the economic values of the environment, though research in this field is in progress. On the other hand, the environmental effect of two roads only one design standard level apart, carrying equal amounts of traffic, will not differ very much.
Environmental effects seem more relevant for decisions, as to whether or not a road should be built or as to whether it should be built through one environment or the other.
Well being effects were ignored in the example. However, assigning certain incommensurable costs to injury and fatal accidents would have the same effect as a relative increase of accident costs, namely a decrease of the critical AADT values. Similarly, assigning incommensurable costs to travel time would lead to a decrease of critical AADT values.

It should be noticed that environmental effects cannot be neglected in an important variant of the example in the Annex, when deciding whether to upgrade an existing road connection or to built a new one meeting the desired design standards.
Environmental considerations will often favour the building of a new road connection. This effect will again be increased if the incommensurable part of the environmental value is taken into account.

Categorisation of roads and road design standardisation are rather different concepts. Road design standards can be formulated independently for most characteristic elements of the lateral and longitudinal road profile, the road surface quality and the geometry of intersections. The aim of road categorisation is to determine a limited number of sets of road design standards for a variety of road characteristics, each set corresponding with a particular road category and the number of sets being as small as is practical in view of the various functions of the road network.

In fact the roads of a network have only two fundamental functions:
1. The access function, i.e. the opportunity to approach some domain adjacent to the road assigned to functions other than traffic.
2. The flow function, i.e. the opportunity to cover distances not starting or ending at some domain adjacent to the road considered.

The majority of the roads in a network is used for both functions.

Even in countries with a high degree of motorisation only a small percentage of the road network have an exclusive flow function. These roads, however, are able to carry a flow volume far greater than proportional at high travel speeds and low risks, and with relatively little damage to the environment due to ground use policy along these roads.
A fully motorized society of the future will need separate networks for the flow and the access functions with a flow network of about twenty percent of the total carrying eighty to ninety percent of the total motorized transport.

Annex: Cost analysis for a number of road classes

Though standards have been developed for many geometric and physical aspects of roads, road categorisation has not progressed much beyond the concept phase, that is, no standards have been formulated on how to combine these elementary standards. Each theoretically possible combination can be considered as a separate road class and a great number of all these possible classes are found in a road network.
Of course, road and traffic engineering concepts such as design speed and level of service might have advantaged particular classes which were the most numerous in the network. These effects, however, have at least partly been erased by the permanent progress of technology, both in vehicle and road construction which, in combination with increasing economic power, has pushed road design standards upwards.

Taking account of the preceding observations, the five types of roads selected for calculation purposes in the following example could be considered at best as rather arbitrary representatives taken from groupes of not too different road design classes. The descriptions of the five road types are kept rather vague as follows:

1. Narrow roads for mixed traffic with frequent discontinuities and sharp curves.
2. Roads for mixed traffic with rare discontinuities and smooth curves.
3. Roads for motorized traffic or with separate lanes for slow moving traffic.
4. First generation dual carriageway motorways.
5. Modern dual carriageway motorways, with at least 2 x 3 lanes.

In the upper line of the table, road widths are given followed by some other data relevant for the calculations. These data should be considered as indicating the order of magnitude rather than being accurate values.

The following cost components were assumed equal for all road types.

Unsafety	f 40,000.00	per injury accident
Travel time	f 15.00	per vehicle hour
Road maintenance	f .05	per vehicle km
Vehicle operation	f .35	per vehicle km

All costs of fatal, injury and damage only accidents divided by the annual number of injury accidents were taken as the measure for unsafety costs, because the registration of damage only accidents is poor, while the number of fatal accidents affected by specific measures is generally too small for a fairly accurate evaluation.
Travel time costs are assumed about f 11.00 per traveller hour and car occupancy at approximately 1.4.
Annual costs for investments in road construction were calculated on a ten percent interest base.
At the bottom of the table the results of the calculations: total travel costs per vehicle km are given for the five road types in relation to traffic intensities. The intensities chosen are critical AADT values at which inversions occur in the choice between two adjacent road types.
The results reflect the qualitatively rather trivial fact that higher traffic intensities require roads meeting higher design standards.
Travel costs due to congestion have been ignored in calculations. However, the critical AADT values found remain far below congestion level.

Road class		1	2	3	4	5
Road width		7	7	14	20	30
m^2 price f		100	150	200	250	300
Travel speed km/h		40	55	70	85	100
Injury rate 10^6 veh. km.		6	3	1.5	0.75	0.375
Construction costs per km		f 700,000	f1,050,000	f2,800,000	f5,000,000	f9,000,000
Dayly interest of construction costs per km		f 191.65	f 287.50	f 766.60	f 1368.92	f 2464.00
Cost per vehicle km						
Vehicle operating & road maintenance cost		0.40	0.40	0.40	0.40	0.40
Travel time cost		0.375	0.273	0.214	0.177	0.15
Accident costs		0.24	0.12	0.06	0.03	0.015
Total usage cost		1.015	0.793	0.674	0.607	0.560
	AADT					
Interest of	431	0.445	0.667	1.779	3.176	5.717
construction	4026	0.0476	0.0714	0.1904	0.340	0.612
costs per	10600	0.0181	0.0271	0.0724	0.129	0.232
vehicle km	26000	0.0074	0.011	0.0296	0.0528	0.0952
	AADT					
Total	431	1.460	1.460	2.453	3.783	6.282
travel	4026	1.063	0.864	0.864	0.947	1.177
costs per	10600	1.043	0.820	0.736	0.736	0.797
vehicle km	26000	1.032	0.804	0.694	0.660	0.660

Comparison of travel costs for five road classes.