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# FUTURE MOBILITY DEVELOPMENT IN PASSENGER TRANSPORT

Vlastimil MELICHAR, Daniel SALAVA, Martin CHMELAŘ

Department of Transport Management, Marketing and Logistics

## 1. Introduction

Everybody spends certain daytime by travelling and devotes predictable part of his income to travelling. He has time and money budgets, which are evidently stable from the place and time aspects and they can be thought as factors for prediction of future mobility and transport mode volumes. Fixed travel money budgets require mobility increase nearly proportionally to real income. Long distance travels with the same fixed money budget and travel time budget require from passengers to transit to faster transport modes. Future transport modes selection is also constrained by used path dependence, because infrastructure changes only very slowly. Low-speed public transport demand is in addition partially determined by urban population density and land-use patterns.

By means of traffic volume prediction (car, bus, railway and high-speed transport, especially air and railway), the number of travels is estimated in distant future, used transport modes, e.g. within EU, in particular state or regions. Answers of these questions are decisive for long-term transport infrastructure planning and for mobility impacts assessment e.g. on environment. These matters are also the centre of interest by future market extension estimating for transport services technical equipment. We make efforts to create simple, but radical model, which shows probable answers of these questions.

Reply of these questions requires construction of large-scale long-term models of transport system. But this mobility need very sharply contrasts with capacities of existing modeling techniques. Regional and urban transport models which are the most intensive developed tools of transport planning must be orientated to prediction of local transport demand, flows and costs. These instruments optimalize direct traffic flows by cost minimization or consumer (passenger) utility maximization. They calculate with transport system details like e.g. numbers of cars using roads during several times and average speeds of location of lately built-up transport infrastructure. Essential detailed effect is also the fact that these models are based on big mutually related variables as car ownership, loading and vehicles utilization, travel banded charges, transport modes relative prices, urban travel speeds and passengers income. Regarding insufficient knowledges of relations among these variables, these multi-variation methods quickly degrade in distant future plans. Original requirements of transport planning models make these methods more inadequate tools for long-term scenarios development.

Generally mobility development models are projected to make possible formularization e.g. aggregate (regional or national) and long-term scenario. In essence we work on transport planning tradition and model explains how passengers can select particular transport modes by satisfying their demand for mobility (term “mobility” used in model represents traffic volume measured by personal kilometres). But this model requires aggregated data. The aim of this model is not calculation of detailed estimations of travel distances and vehicles speeds, but rather total mobility prediction and prediction of offered share of each transport mode (so called modal split) within state and in aggregated regions in distant future.

By model construction we examine at first two budget constraints of passenger – travel time budget and travel money budget, that are core elements of model methods. In further sequence we estimate future demand for services, that are offered by state, it means total mobility. Then we estimate share of offered mobility for each main mode of motorized transport (in CR conditions we speak about bus, railway and individual car passenger transport). These estimations are conducted overall for whole country or region and there are made scenario sensitivities form changes of the most important or uncertain presumptions.

## 2. Travel Budget

Mobility development model is e.g. in Yacov Zahavi´s opinion tool for transport policy aggregated planning. Zahavi (1981) has dicovered that passengers behaviour is considerably detemined by two basic constraints – by average fixed time and money budgets devoted to travelling. In next text of this paper we pay attention to two Zahavi´s constraints.

### Travel Time Budget

Travel time budget (TTB) represents budget of averege fixed time volume spent by people within daily travelling. Results of travel time consumptions surveys conducted in various cities and countries in the world proposed TTB value approximately 1,1 hour per capita per day in the process TTB stability depends on incomes levels, geographic and cultural conditions of country and region. E.g. average travel time of commuters in Pardubice region within particular districts was found out on the basis of results from census 2001 (ČSÚ, Pardubice 2005) in average level 1,3 hour per capita per day.

Next there was discovered that while TTB is in average constant, there exist significant variants by investigations of small populations and individualities behaviour. E.g. travel time budgets are higher in overpopulated cities and inhabitants of large cities e.g. spend by 30 % more travel time than people in rural areas. Value and variation TTB in cities are higher than average TTB for the whole country or region. Travel times are generally the highest in the largest cities and TTB also changes with socio-demographic group. Surveys in Germany detected variability of travel habits according to profession, e.g. average person travelled in average 1,09 hour per day, but university students and other employees spent much more time by moving (1,27 and 1,32 hour per day). On the contrary German pensioners were less mobile (0,94 hour per day). Proceeded studies showed that TTB per traveller is typically higher by lower income (passenger is defined in travel surveys as person, who makes at least one motorized travel during examined day). Passengers with lower income are anyway more constrained by choices of housing places and transport modes and they optimalize much more difficultly travel times by looking for these places. Share of passengers in total population is lower in societies with lower incomes and that is why average TTB per capita is more related to societies with high incomes.

Home and family safety also restricts exposing to travel risks. Travelling is also naturally restricted by other activities, which spend also some time as e.g. sleeping, work and relax. Even if other demands shift in the course of time, it is evident that TTB remains constant. In comparison with OECD countries, Japan workmen spend by 25 % more time in work, nevertheless their travel time budgets are nearly the same.

Travel time spent in particular transport modes increases with income and mobility increases according to passenger transition from slow to faster transport modes.

E.g. in compliance with Shafer, Victor it is possible to represent relation between mobility and TTB by equation (1):

$$\mathrm{TTB} = a + \frac{b}{(TV - c)^d} \tag{1a}$$

$$\mathrm{a} = -\frac{b}{(-c)^d} \tag{1b}$$

where: b is travel time budget per capita per day; TV is traffic volume in personal kilometres per capita, which is available through surveys in regions (in the process estimation of its value in region is dependent on used travel speeds); parametres d a c can be determined by regression analysis.

### Travel Money Budget

The second constraint represents fixed part of income, which is devoted by particular passengers to travelling – so called travel money budget (TMB). We assume stable budget on aggregated level, but in practice we can consider certain understandable variations, according to which TMB grows with motorization. It was uncovered, that households without personal car devote only 3-5 % of their incomes to travelling.

TMB increase is explained as effect of growing motorization in many studies and that is why TMB grows with car ownership increase until it is stabilized up to 10-15 %, when motorization rates exceed 200 cars per 1000 capita. TMB changes in particular countries and regions depend on social and economical factors, e.g. travel services price level.

Another examples which ilustrate and test travel money budget stability are petroleum shocks in 70´s of last century, which increased road transport costs during one night. In case of USA, country with the greatest share of total mobility offered by cars, the matter was monitoring of seven indicators related to car transport:

- travel money budget (calculated as share of consumption expenditures for passenger transport in gross national product),
- real selling price of petrol,
- annual travel distance per car,
- average fuel consumption of new car,
- average price of new car,
- traffic volume (mobility) per capita,
- gross domestic product per capita.

(Source: Davis (1994), Federal Higway Administration (1970 – 1991, 1992)

Due to reaction on fuel selling price increase, passengers decreased other transport costs, it means e.g. they demanded less expensive and from fuel viewepoint more effective vehicles. Despite rapid increase of fuel selling price (in the years 1970 and 1976), economical recessions multiplying and variations in new vehicles prices, travel money budgets remained nearly fixed in the years 1970-1990 and oscillated between 7,9% to 9% of income (GDP per capita).

## 3. Total Mobility Model and Scenario

By modelling and creating of total mobility scenarios, we start with monitoring of total mobility in past times and in next sequence we use historical data to constrain future mobility scenario.

Prognosticated TMB enables to assume fixed relation between income and total demand for mobility. If income grows, travel expenditures must increase as well according to share defined by TMB. On the contrary higher transport expenditures enable higher mobility. Relation between income and mobility can be quantified. Income data represent statistics of gross domestic product (GDP) development evaluated by stable prices of concrete year (e.g. 1995). Mobility statistics are available from statistical and transport yearbooks and on their basis we can compile time series. Complex composition of historical data e.g. from 1990 to 2004 allows to test the statement that TMB defines predictable quantified relation between income growth and total mobility[1].

Investigation of relation between income (independent variable) and mobility (dependent variable) within state or region shows us whether mobility per capita and income grows with identical slope, which equals to one.

Total mobility projection is the function of stable TMB, which consists of two parts. The first part represents an amount alloted to mobility ($TMB_M$). The second part represents a share of money devoted to service quality – comfort, accomplishment, safety and engine power ($TMB_S$). Time series of studies in developed countries show that above-mentioned shares remain solely constant in the course of time. This fact reflects that it came to average real purchase price increase of new car (as representative of of quality service) with income growth per capita. E.g. in the USA in the years 1970 and 1990 both new cars prices and incomes increased by 40%. In Germany new car prices increased doubly while income grew by 52%. Thus German car buyers devoted increasing share of incomes to service quality and to taxes. Data, for illustration of TMB stability, represent sum of this two components, although we use only $TMB_M$ for determination of relation between income and mobility. This relation is described by following simple equations.

Traffic volume (TV) per capita depends on passengers expenditures (i) for transport (ii) and on inverse unit transport cost $\kappa$ (personal km/Kc). The first factor can be formulated as income product (GDP per cap.) and travel money budget ($TMB_M$). Factor $\kappa$ depends on several economical and technological parametres of used transport modes as capital costs and fuel efficiency. In general case:

$$\frac{TV}{cap} = \left( \frac{GDP}{cap} \cdot TMB_M \right) \cdot \kappa \tag{2}$$

If historical data for each variable on the right of equation are available, equation (2) can be used for estimation of future mobility volume. Relation between mobility and income per capita can be approximated by equation:

$$\log \frac{TV}{cap} = e \cdot \log \frac{GDP}{cap} + f \tag{3}$$

[1] TMB growth principially from 3-5 % up to 10-15 % with increased motorization should assume faster mobility growth, because higher part of income is devoted to travelling. It is shown in practice that growing travel money budgets are completely compensated by travel unit costs increasing, if passengers shift from public transport (bus, railway) to individual car transport. Then even by low mobility, there exists direct relation between increasing income and growing mobility. No data exist for exact verification of this relation. We must make partial test for demonstration of close correlation between income growth and total mobility. This test would confirm that the decisive fact for this prognosis is aggregate relation. Data also allow to make statistical regressions which are the tools of this model.

where $e$ is the slope and $f$ is intersection point on the y axis. It also follows from equation (3):

$$\frac{TV}{cap} = \left(\frac{GDP}{cap}\right)^{e} \cdot f^{*} \qquad (4)$$

Comparison with equation (2) indicates that factor $f^{*}$ corresponds to $TMB_M$ and inverse unit transport costs. There is need to determine estimation parametres (dispersion and standard error).

Future mobility total volumes calculation requires also population estimations. E.g. prognosis of World Bank from 1992 estimates world population growth up to 10,1 mld. in 2050. The most intense growth in this prognosis is in underdeveloped countries, where population multiplies more than doubly in the course of period and comprises 85% of world population.

## 4. Model and Scenario of Transport Modes

It is necessary to work on shares of particular transport modes by model and scenario creation, e.g. bus, rail, individual cars and air (including high-speed trains[2]) – operating on various speeds. We have four constraints for unambiguous determination of four variables. The main constraint is fixed travel time budget (TTB) which requires people to shift to faster transport modes according to their total mobility increase. Other presented constraints are path dependence, land-use patterns and balance equation.

### Travel Distance and Railway

Transport infrastructure as many massive technologies and infrastructures does not grow and drop fast. Older mobility choices and contemporary mobility volume influence possible future development in the process they limit degree by which one transport mode can substitute other. Financially demanding and long-term infrastructures block initial choices and it means it can come to substitution among infrastructures during up to several decades. Due to this fact future of some transport modes can strongly prove in contemporary developmental models. It is intended primarily for conventional railways, which decline systematically in all regions. Therefore we can prognosticate future railway transport shares by hyperbolic regression function of last (degressive) trajectory that reach zero share of railway by traffic volume y km per capita (e.g. 100 000 km per capita).

$$S_R = i.\left(\frac{1}{(TV-j)^k} - \frac{1}{(y-j)^k}\right) \qquad (6)$$

[2] High-speed trains (e.g. Shinkanzen) form a part of aircrafts cathegory. These trains already number 5% of total mobility and 30% of all high-speed transport modes mobility in Japan. Shinkansen operates on 220 kmph which forms 37% of average speed assumed for HST. It is considered that next train generation (also maglev trains) will operate on speeds close to supposed air speeds 600 kmph.

Parametres i, j and k are determined by regression of minimum squares.

### Urban Land-use Patterns and Low-speed Public Transport

Even if we can expect share of all low-speed transport modes to be declining essentially to zero in far-distant future („in target point"), transition from present time to their definitive removal can run by many ways. In the countries of former „European fifteen", e.g. low-speed transport modes mobility share (trains and buses) was markedly higher than in North America, but lower than in Asia by the same traffic volumes per capita. These differences in low-speed public transport shares in mentioned areas follow from transport infrastructure, which was constructed to be convenient for important urbanization models, population density and land-use patterns. North America cities are the least dense settled (14 people / ha) and people exploit the lowest number of low-speed public transport (8% of total mobility falling on traffic volume 10 000 km per capita). Density of settlement in European cities is fourfold higher than in North America and therefore low-speed public transport share is higher (19%) as well. Asian cities have typically higher settlement density, with average density triplicate higher than in western Europe and thus 30% share of low-speed public transport (Newman and Kenworthy – 1989).

These three experiences assume constraints for scenarios of low-speed public transport growth in regions with lower incomes that have identical urban, population and land-use characteristics. Land-use statistics could be used ideally for comparison of characteristics of particular regions and it could gradually repress the scope of possible scenarios of low-speed transport modes future shares. Unfortunately these statistics are not available and prognosis does not exist. Curve for trajectory of low-speed public transport in regions with comparable land-use patterns of urban areas can be generally represented by:

$$S_{LS} = l.\left(\frac{1}{TV - m} - \frac{1}{y - m}\right) \tag{7}$$

Parametres l a m are determined by regression of minimum squares.

With regard to the fact that railway shares were determined by equation bus travel share works on relation:

$$S_B = S_{LS} - S_R \tag{8}$$

### Travel Time Budget

Fixed travel time budget requires average travel speed to increase proportionally with prognosticated total mobility growth per capita and larger travel distance must be overcome within the same time period. Because carriers operate only within certain speed range, increasing average speed requires people to shift to faster transport modes.

Generally sum of daily motorized travel time per capita (TT) within all transport modes (i) that operate on average speed ($V_i$) by traffic volume ($TV_i$) must equal travel time budget for motorized transport modes ($TTB_{mot}$).

$$\sum_i TT_i = \sum_i \frac{TV_i}{V_i} = TTB_{mot} \tag{9}$$

Using constraint TTB from equation (9) requires average speed estimation of each transport mode. It is possible to assume that average speeds of buses, trains and aircrafts are identical in particular regions. To the contrary car average speed varies in regions. $TTB_{mot}$ can be derived from equations (1a) - (1b).

### Balance Equation – Total Traffic Volume

The fourth constraint lies in fact that traffic volume of each motorized transport mode (i) must be summarised according to total projected traffic volume for each region:

$$TV = \sum_i TV_i \tag{10}$$

Equation for shares of high-speed transport modes in future can be derived from equations (9) and (10).

$$S_{HST2050} = \frac{1 - S_B\left(1 - V_C / V_B\right) - S_R\left(1 - V_C / V_R\right) - V_C \cdot TTB_{mot} \cdot 365 / TV}{\left(1 - V_C / V_{HST}\right)} \tag{11}$$

It is difficult to estimate especially future average car speed, because we have available no relation for description how speed can vary in dependence on incomes and mobility. That is why we cannot create continuous prognosis in whole time period (e.g. 2005-2050) using equation (1) and we use equation (11) with previously estimated speeds for calculation of high-speed transport share in target year. Then we will prognosticate fluently share by asymmetric logistic (Gompertz) regression equation by mean of historical data of this transport mode:

$$S_{HST} = s \cdot \exp\left(e^{-t(TV-u)}\right) + v \tag{12a}$$

Parametres *s* and *v* will be determinated for construction of trajectory through projected value e.g. year 2050 and target point from relations:

$$s = \frac{S_{HST2050} - 1}{\exp\left(e^{-t(HST_{2050}-u)}\right) - \exp\left(e^{-t(y-u)}\right)} \tag{12b}$$

$$v = 1 - m \cdot \exp\left(e^{-t(y-u)}\right) \tag{12c}$$

Parametres *t* and *u* are estimated by least-square regression.[3]

Finally we can derive car transport share $S_C$ according to relation:

$$S_C = 1 - S_{LS} - S_{HST} \tag{13}.$$

[3] Results of this regression enable us to calculate average car speeds. It could be needed for fluent projection of high-speed transport share. This use brings average car speed, which rises by 0,8 % per year and it is in accord with historical data in USA (1968-1988). After 2015 calculated average car speeds decrease back to their 1990 values till 2050, which is consequence of external presumptions of vehicles speeds, but it is in accord with expectation that majority of car travels will be short-distant and in urban areas. Longer-distance travels will be substituted by higher-speed transport modes.

### Market Niches of High-Speed Transport

Principially we can derive all regional projections for high-speed transport shares (HST) from equation (11). All terms in this equation are determined by external assumptions of speed or calculations except last term in numerator. Value of this term depends on $TTB_{mot}$ value, which is sensitive especially in regions with low incomes (with low traffic volume). $TTB_{mot}$ decreasing in certain region e.g. by 10 % could cause only e.g. 6% increase in HST share, to the contrary the same change in other region would cause e.g. 50% HST share increase. Besides transport mode speeds data and $TTB_{mot}$ in regions with low traffic volume practically do not exist and for that reason it would not be suitable to use this method. Marginal value of traffic volume, by which unit change of $TTB_{mot}$ would lead to the same unit change of $S_{HST,2050}$, will be calculated by following way: we set the first derivative of equation (11) to -1 (e.g. $dS_{HST,2050}/dTTB_{mot}$). Also calculated marginal value will vary according to average car speed in particular regions.

In regions where equation (11) cannot be used models in historical development of HST market niches in industry regions are identified for HST share determination. Commercial air transport was developed in North America and that is why growth rate is comparably slow in this region but it will have long-term character. In regions where high-speed technologies were introduced later propagated inovations were less costly and were introduced more easily. This fact enabled faster growth in market niche. Other factors which influence demand comprise travel length and policies that regulated market share (e.g. subsidies). E.g. HST introduce rate in Western Europe (represented as HST share as total traffic volume function) was the same as in North America. On the contrary in Asia HST share grew markedly because dense settlement impedes using of long-distance road transport and subsidies to Shinkanzen stimulated travellers. Initiate growth rates in market niches can be used for HST share calculation e.g. for 2050 year which corresponds with certain region and also with urban land constraint. Generally equation can have following form:

$$S_{HST,2050} = SHST_{HST,2005} \cdot w^{(TV_{2050} - TV_{2005})} \tag{14}$$

During results sensitivity investigation of HST share e.g. in 2050 we change factors which influence equation (11), i.e. transport speeds and $TTB_{mot.}$

## 5. Conclusion

Future mobility development is determined by specific values of each transport mode in certain region or state. Within global mobility air transport share will increase in future, but other transport modes shares will decrease. In compliance with Schafer, Victor it is estimated that total mobility will grow fourfold in 2050, in the process in comparison with 1990 e.g. car mobility will grow by 260% and HST mobility 28 times. Estimated strong growth in air transport can appear unrealistically because air corridors are already dense and in some regions congested. However we can expect that in future five decades array of technological possibilities will be developed and they will be generally easily used. Airplanes with capacity

1000 persons can be operated before 2020 (e.g. Covert et all, 1992). In addition scenario for air transport consists of all HST modes operated with average speed 600 kmph and can comprise ground HST systems as „wheel on track“ and maglev trains. Nowadays such trains serve minority (4%) of global mobility HST but range of plans for wider networks building does exist.

In case of regional prognosis it is estimated that traffic volume share operated by conventional railways and HST has identical development in all world regions. However this uniform trend is estimated in no scenarios of cars and buses, although transparent trends are evident for these transport modes in majority of regions.

In compliance with mobility future development slower transport modes will be substituted by faster. It is estimated that low-speed transport will prevail on levels of mobility under 5000 – 7000 pkm per capita. Demand for travelling will increase in each region with economical growth with the fact that longer travel distance must be covered within the same fixed time budget and therefore faster cars share will grow. Cars dominate already on mobility level approximately 10000 pkm per capita. On permanently higher mobility levels then car share decreases according to growth of faster transport modes need (especially air transport) for satisfaction of increasing demand for mobility within fixed travel time budget. This relative decrease must lead to total decrease of car traffic volume on sufficiently high level of total mobility. In spite of prognosticated total decrease of car mobility in OECD countries and strong growth of air transport, cars still will remain decisive transport mode. Travellers hereafter will spend continuously majority of their travel time in car.

Multiple growth in mobility per capita cause demands of extreme mobility which proves by more frequent commuting for longer distances from place of living. Because extreme mobility depends on approach to high-speed transport modes, sparse inhabited areas will remain in certain regions. It relates to areas where travelling to traffic junctions (airports and stations of high-speed trains) is time demanding in HST system.

Future mobility development modelling is nowadays simplified by fact that neither model nor historical data set distinguish between urban travelling and rural travelling and neither rate of travels nor their length is calculated. Thus model scenario cannot be used to adapation of transport mode to particular types of the most appropriate transport services. We need prognosis for improving as well which depends on TTB. This constraint can be more fully implemented only with improved data and means of transport speeds prognosis and $TTB_{mot}$.

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## Resumé

### VÝVOJ BUDOUCÍ MOBILITY V OSOBNÍ DOPRAVĚ

Vlastimil MELICHAR, Daniel SALAVA, Martin CHMELAŘ

Tento článek popisuje základní faktory vývoje a modelování budoucí mobility v osobní dopravě. Modely vývoje mobility jsou omezeny dvěma základními faktory, které reprezentuje rozpočet cestovní doby a peněžní rozpočet cestování. Model a scénář vývoje celkové mobility je funkcí fixního peněžního rozpočtu cestování a rozpočtu cestovní doby. Při tvorbě modelu a scénáře vývoje budoucí mobility v jednotlivých dopravních oborech se vycházelo z podílů jednotlivých dopravních oborů a ze čtyř omezujících faktorů. Tyto faktory jsou fixní rozpočet cestovní doby, závislost na cestě, vzorky záboru půdy a rovnice rovnováhy celkové dopravní intenzity.

## Summary

### FUTURE MOBILITY DEVELOPMENT IN PASSENGER TRANSPORT

Vlastimil MELICHAR, Daniel SALAVA, Martin CHMELAŘ

This article describes basic factors of development and modelling of future mobility in passenger transport. Mobility development models are constrained by two basic factors, which represent travel time budget and travel money budget. Model and scenario of total mobility development is function of fixed travel money budget and travel time budget. By creation of model and future mobility development scenario in particular transport modes, we work on determination of particular transport mode shares and on four constraining factors. These factors are fixed travel time budget, path dependence, urban land-use patterns and balancing equation of total traffic volume.

By model construction we examine at first two budget constraints of passenger – travel time budget and travel money budget, that are core elements of model methods. In further sequence we estimate future demand for services, that are offered by state, it means total mobility. Then we estimate share of offered mobility for each main mode of motorized transport (in CR conditions we speak about bus, railway and individual car passenger transport). These estimations are conducted overall for whole country or region and there are made scenario sensitivities form changes of the most important or uncertain presumptions.

Generally mobility development models are projected to make possible formularization e.g. aggregate (regional or national) and long-term scenario. In essence we work on transport planning tradition and model explains, how passengers can select particular transport modes by satisfying their demand for

mobility (term “mobility” used in model represents traffic volume measured by personal kilometres). But this model requires aggregated data. The aim of this model is not calculation of detailed estimations of travel distances and vehicles speeds, but rather total mobility prediction and prediction of offered share of each transport mode (so called modal split) within state and in aggregated regions in distant future. Future mobility development is determined by specific values of each transport mode in certain region or state.

Within global mobility air transport share will increase in future, but other transport modes shares will decrease. In case of regional prognosis it is estimated that traffic volume share operated by conventional railways and HST has identical development in all world regions. However this uniform trend is estimated in no scenarios of cars and buses, although transparent trends are evident for these transport modes in majority of regions. In compliance with mobility future development slower transport modes will be substituted by faster. On permanently higher mobility levels then car share decreases according to growth of faster transport modes need (especially air transport) for satisfaction of increasing demand for mobility within fixed travel time budget. Multiple growth in mobility per capita cause demands of extreme mobility which proves by more frequent commuting for longer distances from place of living. Because extreme mobility depends on approach to high-speed transport modes, sparse inhabited areas will remain in certain regions. It relates to areas where travelling to traffic junctions (airports and stations of high-speed trains) is time demanding in HST system.

By means of traffic volume prediction (car, bus, railway and high-speed transport, especially air and railway), the number of travels is estimated in distant future, used transport modes, e.g. within EU, in particular state or regions. Answers of these questions are decisive for long-term transport infrastructure planning and for mobility impacts assessment e.g. on environment. These matters are also the centre of interest by future market extension estimating for transport services technical equipment. We make efforts to create simple, but radical model, which shows probable answers of these questions. Reply of these questions requires construction of large-scale long-term models of transport system. But this mobility need very sharply contrasts with capacities of existing modeling techniques. Regional and urban transport models, which are the most intensive developed tools of transport planning must be orientated to prediction of local transport demand, flows and costs. These instruments optimalize direct traffic flows by cost minimization or consumer (passenger) utility maximization. They calculate with transport system details like e.g. numbers of cars using roads during several times and average speeds of location of lately built-up transport infrastructure. Essential detailed effect is also the fact that these models are based on big mutually related variables as car ownership, loading and vehicles utilization, travel banded charges, transport modes relative prices, urban travel speeds and passengers income. Regarding insufficient knowledges of relations among these variables, these multi-variation methods quickly degrade in distant future plans. Original requirements of transport planning models make these methods more inadequate tools for long-term scenarios development.


## Zusammenfassung

## ZUKÜNFTIG PERSONAL VERKEHRSENTWICKLUNG

Vlastimil MELICHAR, Daniel SALAVA, Martin CHMELAŘ

Der Artikel beschreib primär Faktoren der zukünftig personal Verkehrsentwicklung. Die Mobilitätsentwicklungmodelle sind limitiert mit zwei primär Faktoren. Die Reisezeitkalkulation und die Reisegeldkalkulation. Das Modell und das Szenar der Mobilitätsentwicklung ist die Funktion der stabil Reisezeitkalkulation und der Reisegeldkalkulation. Bei dem Bildung des Models und Szenar der zukünft Mobilitätsentwicklung ins einzelnen Verkehrszweigen gehen wir von Ermittlung der Beteiligungskalkulationen und vier restriktiv Faktoren aus. Die Faktoren sind fixe Reisezeitkalkulation, die Streckeabhändigkeit, die Musterware des Landnahme und die Gleichgewichtsgleichung der Totalverkehrsmenge.