INTERZONAL FREIGHT TRANSPORTATION DEMAND MODEL IN HUNGARY

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1. Introduction

A comprehensive and nationwide transportation network development framework concerning all transport modes (railway, road, inland waterway navigation) is in course of elaboration in Hungary. This method is meant to be the most important instrument for making decisions concerning facility size, nature, programming, etc. of the several transportation network development possibilities. It contains different interrelated submodels as well as other mathematical and economic considerations. The purpose of the model is to achive the most efficient distribution of financial resources available for the development of transportation system. Therefore all transportation system development have to be investigated concerning their mutual dependence of each other.
The investigation and the traffic forecast will be carried out for the years 1990, 2000 and 2010.

As it is known, transportation planning must always have as its background the regional planning process. This means that transportation demand, which is necessary to make decisions about transportation network development, has to be derived from the spatial pattern configuration. A permanent feedback between land use and transportation network planning is therefore necessary.
The network planning framework presented below, fulfills these requirements.

This paper gives an outline of the theoretical structure of the statewide interzonal freight transportation demand model (excluding international freight transportation), of its data input, including the freight transportation behaviour characteristics, and some selected, more detailed aspects of the freight demand model building experience of Hungary.

2. Freight transportation model input data

The freight transportation demand model, showed below is based on analytical investigation theory. This expression in simple terms means, that changes in the future freight transportation demand can be derived from the forecasted changes of the total national socio-economy situation, of the macroeconomic production and structural dynamic linkages among its several branches, as well as - on a microeconomic level - the future economic activites of the regional units (traffic zones).
Based on this theory the freight transportation model has three main input data sets, which are:

- socio-economic structure data of the several regional units (traffic zones),
- freight transportation behaviour characteristics,

- and the parameters of the modelled transport network elements.

2.1 Data base and collection

The data collection system and the data inventory of the Central Statistics Office (KSH) are not satisfactory for developing disaggregated, interzonal traffic models, as well as some very important coefficients and information concerning the freight transportation process are not available. Therefore information has to be collected especially for getting evidences and data for quantifying the main freight transportation behaviour characteristics, as well as the socio-economic structure of the several traffic zones.

a/ Data collection for quantifying freight behaviour

In Hungary from around 130 000 "economic units" (industrial plants, agricultural farms, forestry enterprises, construction sites, warehouses, shops, etc.) some 35 000 generate and/or attract considerable freight movement. For the sake of statistical relyability, 4 000 "economic units" were planned to be interviewed, so as to achive sectoral and regional representativity. Due to organisational and financial reasons at some 3 200 "economic units" was data collected.

For the firm interviews a questionaire was developed, which consists of two main parts. In the first part, data were requested from the "economic units" concerning the following items:

- annual production broken down by quarters and expressed in monetary as well as physical units (tons),
- road, railway and inland waterway vehicle fleets,
- availability of connecting track to railway network,
- generated and attracted commodity traffic volumes transported by their own vehicles,
- size of warehouses.

The second part of the questionaire was meant to get quantified information about the transportation events, and thus data were collected about:

- origin and destination,
- commodity group transported,
- tonnage transported,
- manner of packing of the commodity transported,
- transportation mode,
- site (settlement) of the good transfer in case the transportation event was a combined one.

The firms interviewed were asked to give information about all transportations occurred within a fixed, preselected week. The interview was carried out in the years 1982 and 1983, by means of persone direct interview. The response proportion come to 85%. A "per-post-interview" check resulted in a response of only 8%.

Together with the "per-post-questionaires" information from some 3 200 economic units were made available. They contained data from 160 000 transportation events, which were used for quantifying the freight transportation behaviour characteristics. This amount of data made possible a comparatively high disaggregation and garanteed a representativeness required. The forecast of the freight transportation behaviour characteristics will be dealt with in chapter 2.2.

b/ Socio-economic indicators of the traffic zones

This data set has been received from the Scientific Institute for Town Planning (VÁTI), Hungary. The territory of Hungary was subdivided into 860 traffic zones. This makes possible a detailed transport network development. All of the socio-economic parameters listed below, are available for each traffic zone. This data file consists of the following socio-economic indicators:

- number of inhabitants,
- total number of employees,
- number of the industrial employees split into 60 industry branches,
- the measure of the planting area of the main crops (commodity groups),
- forest area,
- the number of domestic animals,
- the size of the warehouses and store areas of the several wholesale branches,
- sales-room area of the several retail branches.

These socio-economic data for each traffic zones and for the forecast years of 1990, 2000, 2010 were forecasted by the Scientific Institute for Town Planning (VÁTI).

The forecast however had to take into consideration, that a prognosis at the same disaggregation level, like the analysis can not be realistic. Therefore a certain aggregation was made, especially concerning the industries. It means that industry input data in the analysis were split into 60, for the forecasting years only in 24 economic sectors (branches). Also a wholesale aggregation was necessary. This three-dimensional data block (time, traffic zones structure paramters) is stored on computer discs.

2.2 The freight transportation behaviour characteristics

One of the most important model input is the set of the freight transportation behaviour characteristics. At the same time the quantification and, especially, their forecast of them are perhaps the most difficult problems. A part of the behaviour characteristics was derived from the data of the firm interwievs, and another part was calculated on the base of the data system obtained from the Central Statistics Office (KSH), as well as from several freight transportation enterprises.
As already mentioned, commodity groups had to be aggregated, for which all of the behaviour characteristics were calculated. The disaggregation level is limited by two aspects: because of the extent of the data processing it must not be very detailed, otherwise the analysis of many commodity groups is difficult, requires much time and is rather confusing.

On the other side, in case of too low disaggregation level it would be impossible to derive real and characteristical parameters, because the several commodity groups would contain goods with very different transportation behaviour. Taking into

consideration all this facts, in course of the data collection and processing 136 commodity groups were distinguished. For each of these groups behaviour characteristics were calculated, and the - by means of a cluster analysis - two aggregation levels with 80 and 25 commodity groups were composed. The forecast of the freight transportation demand will be carried out on the 25 commodity group level.
It could raise the question why to make data collection much more detailed, if the model imputs are more aggregated. It is due to the fact that concerning the freight transportation behaviour, there is very poor information and evidence, so after a thorough analysis the research and the calculation can be continued on a lower commodity group disaggregation level. The freight transportation behaviour characteristics were forecast by a special research team of experts from various economic branches (industry, building industry, agriculture, commerce, transport and loading technology).
The freight transportation behaviour characteristics calculated for each commodity groups and used in the model are as follows:

- distribution of the commodity flows by transportation modes,
- distribution of the commodity flows by transportation distances,
- distribution of the commodity flows by manner of packaging,
- specific commodity output and input amounts:

  . industry: concerning the employees for the different branches,
  . agriculture: concerning the planting areas,
  . building industry: concerning the employees and the number of inhabitants,
  . wholesale: concerning the extent of the store-rooms,
  . retail: concerning the sales-room area,

- shipment size,
- ratio of round-trips to one-way trips
- utilization of the loading weight and/or volume capacity of the vehicles (distinguished by transportation modes),

  . transportation enterprises,
  . own vehicles,

- ratio of empty vehicle trips to the total number of vehicle trips for each transport mode respectively,
- transportation demand in dependence of time (annually, weakly, daily).

The number of the transportation events data being collected made possible a combination (ie. a higher disggregation) of the different behaviour characteristics.

2.3 Transport network model

As already mentioned the territory of Hungary was subdivided into 860 traffic zones. It means, that the average size of a zone is bout 110 km^2. This is a very detailed regional model, which requires a similarly detailed connection system (transportation network model), especially due to the fact that a traffic zone has generally three road traffic input nodes, two railway transportation and one inland waterway transportation input knodes. Some 70% of the total Hungarian highways have been drawn into the road network model. The railway and the inland waterway models contain the whole railway (excluding narrow gauge railways) and waterway networks, respectively. The road network model includes about 3000 nodes, the railway network model 600 and the inland waterways some 80. All of the links (sections) are characterized by indicators concerning their quality, which involves also the quality and capacity of each of the links. These calculated capacities will be the basis for the traffic assignment submodel.

3. The freight transportation forecast model

The freight transportation demand submodels are similar to the passenger submodels, but naturally some specific freight model elements have to be used, which are not relevant for passenger models.

The main submodels are as follows:

- adjusted input-output statewide economic model,
- generation,
- distribution,
- modal-split,
- commodity-vehicle conversion,
- empty vehicle model,
  - . generation,
  - . distribution,
- assignment.

In the following section some of these main submodels will be described in details.

3.1 The economic input-output matrix of Hungary

The national economic input-output matrix was considered the starting point of the freight traffic generation and distribution. Every five years the Central Statistics Office of Hungary prepares a nationwide input-output matrix of the economic sector relationships. This matrix involves generally approximately ninety sectors. However, this I-O matrix is prepared only in monetary units and as such, can not be used directly in the freight transportation demand model. Another unsuitability factor for the unmodified use of this I-O matrix is that wholesale and retail are not split into branches, but they compose only one sector.
By means of complicated and sometimes approximative processes, a suitable split of this sector was implemented. For the transformation of the monetary matrix, commodity groups had to be fixed, which are characteristic for the different transportation relations. At the beginning 136 commodity groups were aggregated on the basis of the 572 three-digit goods class level being used in the Central Statistics Office. For each commodity group average prices were calculated taking into consideration the prices and the amount of the most important articles belonging to the same commodity group. At the same time data were available from the Central Statistics Office both in monetary and in physical units about the commodity selling and utilization of the several economic sectors. Using firm data and certain estimates, the wholesale and retail sector (commerce) has also been split into

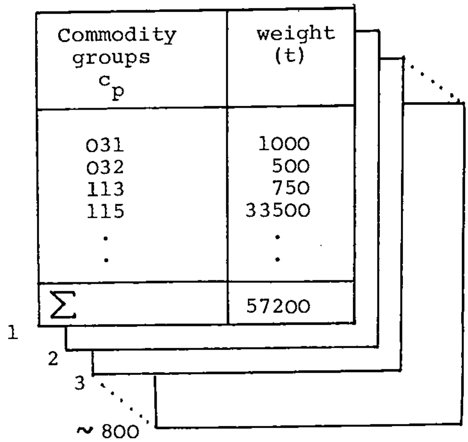
more subdivisions. After all these transformations an input-output matrix was obtained, which contains the following sectors: 60 industrial sectors, 1 agriculture, 1 forestry, 3 building industry, 26 wholesale and 10 retail sectors as well as one sector for some other branches, such as education, health service, etc. This I-O matrix was completed by two other data sets: the first one is the transported commodity amounts among the several plants belonging to the same firms. These transportations are generally not linked to a purchase, but they represent transportation connections among the several technological stations of a production process within a firm verticum. These commodity amounts in Hungary mean some 60 million tons transported within a year, and they are distributed across the elements of the I-O matrix main diagonal, considering the relativ ratio to the diagonal sum of the matrix. The other commodity flow represents an annual amount of 3 million tons. This is also a rest, wich - due to their small weights - was disregarded at the value-weight transformation of the I-O matrix.
This input-output economic matrix for the year 1981 is stored on a computer disc. The forecast of this matrix for the years 1990, 2000 and 2010 also was carried out, but only for 50 aggregated economic sectors.
From the 100x100 = 10 000 branch relations approximately 800 have an annual freight transportation connection of more than 10 000 tons. These relationships represent almost 90% of the sum of all tonnages involved in the I-O matrix. For all of the 800 macroeconomic relations a microeconomic (regional) balance was prepared (see chapter 3.2); the rest 10% of the tonnages, considering the nationwide modal split, was transformed in vehicles. The distribution of these vehicle flows was based on the relativ weight of the different traffic zones calculated by means of the number of inhabitants and industrial employees.

3.2 Freight transportation demand generation

Taking also the manner of packaging into consideration, from the approximately 800 significant economic sector relationships about 3000 compacted regional balance have been created. The main sums of the several regional I-O matrices are the freight transportation amounts (broken down by commodity groups) in the nationwide macroeconomic I-O matrix.

Based on the size of the total annual transportation of each commodity, and the manner of their packaging, in an economic sector relationship (ESR) three size groups were distinguished:

- $ESR_{k-f,c,p}$ 100 000 t ($ESR_{k-f,c,p}$ = economic sector relation between the sectors "k" and "f", for commodity group "c" and packaging form "p"): for these commodities the concrete input and output traffic zones have to be determined. (The amount of these relationships is relatively small, so this work can be done by hand.)
- 100 000 t $ESR_{k-f,c,p}$ 10 000 t: for each origin and destination traffic zone within the ESR_{k-f} the same commodity structure ratio was assumed. This simplification at the aggregation level used causes comparatively small errors,
- $ESR_{k-f,c,p}$ 10 000 t: this amount can be summarized to the first size group, on can be handled in the same way as the 10% matrix rest mentioned at the end of the chapter 3.2.



ESR_{k-f} Economic Sector Relationships

c commodity group

p packaging form

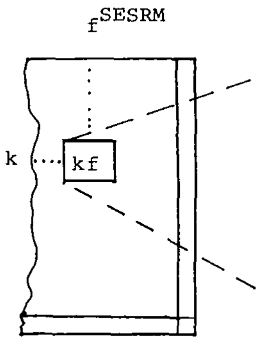
Figure 1.: Content of the Economic Sector Relationships

For the quantification of the input and output freight transportation demand generation specific input and output, commodity amounts were derived, broken down into economic sector relationships as well as into commodity groups and the manner of their packaging.
The structural units, on the basis of which the specific commodity inputs and outputs have been related are as follows:

- industry branches: one industrial employee,
- agriculture: one hektar planting area,
- forestry: one hektar forest area,
- building industry
    - . input: one inhabitant,
    - . output: one employee in the building, industry,
- wholesale branches: one m^3 storage area,
- retail branches: one m^2 selling area.

Specific input and output factors were obtained by means of division of the economic sector relationship commodity group flows by the number of the relevant structural unit (relationspecific flow of the commodity groups).
Dividing the whole commodity group in/output of an relevant structural unit, branch-specific commodity group flows can be created. The model theory of the freight transportation demand generation is very similar to the one of the passenger traffic generation, namely the transportation demand (related to a commodity group and a manner of its packaging) generated in a traffic zone is the product of the specific commodity output of a structural unit (for example one employee or one m^3 storage-room) and of the number of the structural unit mentioned. (As indicated earlier the Scientific Institute for Town Planning has prepared

a comprehensive data file about the socio-economic, indicators (parameters) of the 860 traffic zones).



c_p	weight	X_k (empl)	Y_f (empl)	$SQ_{c,p}$ (t/emp)	$SZ_{c,p}$ (t/emp)
o31	61 ooo			2,39	1,43
o32	44 5oo			1,79	1,o4
163	7 ooo			o,29	o,14
.	.	25 ooo	44 ooo	.	.
.	.			.	.
.	.			.	.
Σ	175ooo	25 ooo	44 ooo	7,oo	3,96

SQ, SZ - specific out/input related on relevant structure units.

Figure 2.: I-O matrix of the Specific Economic Sector Relationships (SESRM)

This consideration can be expressed as follows:

$$Q_{i,k-f,c,p} = F_{k-f,c,p} \cdot X_{k,i} \qquad (1),$$

$$Z_{j,f-k,c,p} = F_{k-f,c,p} \cdot Y_{k,j} \qquad (2), \text{ where}$$

Q; Z - output commodity flow; input commodity flow,
F - specific commodity flow,
X; Y - relevant structural units related on output and input, respectively,
i; j - traffic zone indices,
k, f - economic sector (branch) indices,
c - commodity group symbol,
p - index for the manner of packaging.

Considering a concrete economic sector relation, in its interregional matrix only those traffic zones were taken into account, which have employees (or other relevant structural units) in the considered output and input sectors, respectively. It means that for the next model steps (distribution, modal-split) reduced interzonal commodity flow matrices were calculated. In them none of the dements is equal to zero.

3.3 Freight transportation distribution model

The data file of the appraximatelx 160 000 transportation events did not make possible a disaggregation level, on which transportation distances distribution, broken down by commodity group, manner of packaging and at the same time in economic sector relationship could have been analysed. Therefore freight transportation distance distributions have been calculated only for the different commodity groups, and its packaging forms. The feature of the transportation distance distributions concerning the greater part of the commodity groups can be described by equation (3) (see also figure 3, curve "a"):

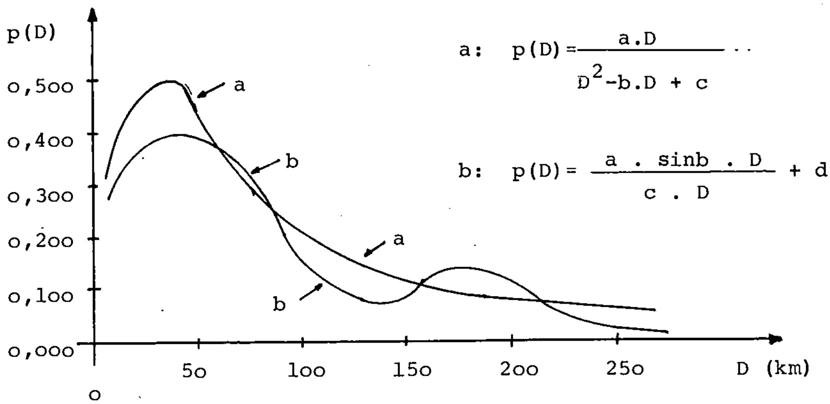


Figure 3.: Usual freight transportation distance distribution curves

$$p(D) = \frac{a.D}{D^2-b.D+c} \qquad (3), \text{ where}$$

p(D) - the relative frequency of the occurrence of the different transport distances,
D - transportation distances,
a,b,c- parameters.

The rest of the commodity groups (and packaging forms) has a distribution indicated by curve "b" in the figure 3. Concerning the mathematical equation, by which mean the curve "b" can be described, is the examination still in course. The curve will be split into two intervals, and for each, equation (3) will be used, or it will be tried to use the following term:

$$p(D) = \frac{a.\sin b.D}{c.D} + d \qquad (4),$$

a,b,c,d - parameters.

The relatively exact desription of the transportation distances by mathematical equations is very important, because the calibration of the mathematical model has to be used in the commodity flow distribution.
For the distribution the well known gravity model was used:

$$f_{i-j,k-f,c,p} = Q_{i,k-f,c,p} \cdot z_{j,k-f,c,p} \cdot w_{i-j}^{-\alpha_{c,p}} \cdot k \quad (5),$$

where

- f - commodity flow,
- w_{i-j} - resistance against transportations between the traffic zones i and j,
- $\alpha_{c,p}$ - degree of dependence of transportation from the resistance factors concerning the commodity group c, and the packing form p,
- k - coefficient.

The k coefficient has the following form:

$$k = \frac{U_{c,s}}{\sum_j (z_{c,p,j} \cdot w_{i-j} \exp(-\alpha_{c,p}))} + \frac{U_{c,d}}{\sum_i (Q_{c,p,i} \cdot w_{i-j} \exp(-\alpha_{c,p}))} \quad (6)$$

were

- u - weighting factor, depending on the market situation of commodity "c",
- $u_{c,s}$ - supply market situation factor for commodity "c",
- $u_{c,d}$ - demand market situation factor for commodity "c".

The coefficients $u_{c,s}$ and $u_{c,d}$ can be chosen freely. During the calibration of the distribution model these factors can also be varied with the condition:

$$u_{c,s} + u_{c,d} = 1 \quad (7).$$

The most important and difficult problem in the quantification of the distribution model is the determination of the resistance function w.

Comprehensive foreign investigation as well as Hungarian experiences have shown already that in the course of the decision making about the choice of origin or destrination the following main factors have been taken into consideration:

- transportation time,
- transportation costs,
- local price of commodity to be transported,
- transportation distance.

The local price of a certain commodity can have an important influence on transportation distributions. However the general market situation in Hungary indicates a comparatively similar price structure in every part of the country. Thus a differenciation by local prices has been dropped.

In our opinion the transportation distances, in comparison to the transportation time and costs, play a secondary role, in the distribution and the time and the costs show a tight stochastic cornection with the distances. The role of other less important influence factors are small. Therefore, two factors have been considered in the resistance function: the transportation time and the transportation costs. Transportation reistances can be calculated only for the road, the railway and inland waterway network, thus the theoretical resistance quantified by the weighting of the partial resistances of each relevant transpor-

tation mode. The weighting has been carried out based on the nationwide share of the used transportation modes concerning the several commodity groups and their manner of packaging. Other factors are the weights of the transportation costs and time, where the sum of the two factors, considering a certain commodity group, must be equal to 1.
Because of the summation of two different resistance factors (transportation time and transportation costs) the elements of the two partial resistance matrices have to be normed to their grand total sums respectively. The mathematical term of the resistance function is:

$$w_{i-j} = b_T^{(c)} \cdot \left[r_{R_w}^{(c)} \cdot T_{R_{w,i-j}}^{(n)} + r_{R_o}^{(c)} \cdot T_{R_{o,i-j}}^{(n)} \cdot r_{Sh}^{(c)} \cdot T_{Sh,i-j}^{(n)} \right] + b_C^{(c)} \cdot \left[r_{R_w}^{(c,p)} \cdot C_{R_{w,i-j}}^{(c,p,n)} + r_{R_o}^{(c,p)} \cdot C_{R_o}^{(c,p,n)} + r_{Sh}^{(c,p)} \cdot C_{Sh}^{(c,p,n)} \right] \quad (8)$$

where $b_T^{(c)} + b_C^{(c)} = 1$. (9), and

b_T - weighting factor for transportation time,
b_c - weighting factor for transportation cost,
$r^{(c)}$ - share of the nationwide transport amount of the commodity group "c" by railway (Rw), road (Ro) and ship (Sh),
h - normed quantity.

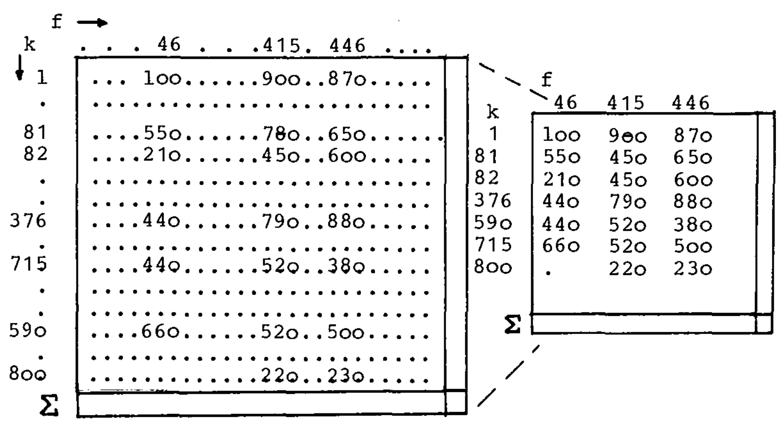


Figure 4. The reduction of the interregional commodity flow matrix within the ESR_{k-f}

The railway resistances have been calculated from the first and second best way resistances:

$$T_{Rw} = 0,8 \cdot T_{Rw1} + 0,2 \cdot T_{Rw2} \quad (10),$$

$$C_{Rw} = 0,8 \cdot C_{Rw1} + 0,2 \cdot C_{Rw2} \quad (11).$$

3.4 Modal split

As the result of the distribution, matrices have been obtained, broken down by commodity groups and by packaging forms. The commodity flow ratios transported by the several modes depend on the transportation resistances of these modes:

$$F_{i-j}^{(Rw)} : F_{i-j}^{(Ro)} : F_{i-j}^{(Sh)} = \left[w_{i-j}^{(Rw)}\right]^{-1} : \left[w_{i-j}^{(Ro)}\right]^{-1} : \left[w_{i-j}^{(Sh)}\right]^{-1} \quad (12),$$

where $F_{i-j} = f_{i-j,k-f,c,p}$ (13), and

$$w_{i-j}^{(Rw)} = b_T^{(c)} . T_{i-j}^{(Rw,n)} + b_C^{(c)} \cdot C_{i-j}^{(Rw,c,p,n)} \quad (14),$$

$$w_{i-j}^{(Ro)} = b_T^{(c)} . T_{i-j}^{(Ro,n)} + b_C^{(c)} \cdot C_{i-j}^{(Ro,c,p,n)} \quad (15),$$

$$w_{i-j}^{(Sh)} = b_T^{(c)} . T_{i-j}^{(Sh,n)} + b_C^{(c)} \cdot C_{i-j}^{(Sh,c,p,n)} \quad (16).$$

The capacity restraint influence on transportation time and transportation cost of the road network are taken into consideration by the following equation:

$$T_{i-j,Ro} = 0,9.T_{i-j,Ro1} + 0,1.T_{i-j,Ro2} \quad (17),$$

$$C_{i-j,Ro} = 0,9.C_{i-j,Ro1} + 0,1.C_{i-j,Ro2} \quad (18),$$ where

the calculation were made by commodity tariff classes (TC).

As example the quantifying of the railway resistances will be shown below. It involves also the resistances arising from the road feeder and distributor transportations to/from the railway stations (if necessary). The main points of the resistance quantification are:

1. Fixing the origin railway station in the origin zone j, and in the destination zone i;
2. Calculation of the resistance between the O/D railway stations;
3, If for the commodity group transported there is a connecting track to the railway network, then in the course of the resistance calculation the connecting track traffic costs and ratios have been taken into account. For the rest of the transportations the road resistances to/from the railway

station will be considered. The system of the "Connecting Track Data File" are shown in the figure 5.

traffic zone	branche	connecting tr.		total		CONNECTING ratio tr.	
		output flow (t)	input flow (t)	output (t)	input (t)	output	input
1	1113	30 000	10 400	415000	10400	0,076	1,000
	1421	-	3 300	67000	4700	0,000	0,711
2	2112	67 000	15 000	67000	345000	1,000	0,060
.	.						
.	.						
.	.						
860	3111	97 000	35 000	445000	215000	0,254	0,062

Figure 5: Connecting track data file system

For calculating the transport costs to/from the railway stations, road tariffs were used broken down into several commodity tariff classes. Because of the comparatively similar transportation tariff system of the transportation enterprises reliable average costs were calculated. The same corcerns the transfer costs. As example the mathematical equation of the railway transportation cost is presented below:

$$SC^{(Rw)}_{i-j,c,p} = SCT^{(Ro)}_{c,p,i} + SCL^{(Ro-Rw)}_{c,p} \cdot (1-SCTR_{i,p,c}) + SCT^{(Rw)}_{i-j,p,c} + $$

$$+ SCL^{(Rw-Ro)}_{c,p} \cdot (1-SCTR_{j,p,c}) + SCT^{(Ro)}_{c,p,i} \qquad (19),$$

where

SC - specific cost T-transportation, L-loading, TR-connecting track.

The way of the calculating the transportation time as well as the resistance for the inland waterway navigation is similar to equation (19). The quantification of the road transportation resistances is based on the transportation time and on the transportation costs derived from road transportation tariffs.

3.5 Freight - vehicle conversion

After the modal-split model step some 9 000 commodity flow matrices will exist, which contain the commodity group flows by

economic sector relationship, by the manner of packaging and all these broken down by transportation modes (railway, road and inland waterway navigation.
But the assignment will be carried out on the basis of vehicles. Therefore a freight-vehicle conversion is necessary. This submodel still needs further research. The conversion of the railway transportations will be made by a convenient conversion table being developed by the Hungarian State Railways. With the help of this conversion, the number of rail cars needed for a certain commodity flow can be obtained by a simple division:

$$V^{(Rw)}_{k-f,c,p,i-j} = ESR^{(Rw)}_{k-f,c,p,i-j} \cdot LC^{(Rw)\,-1}_{c,p} \qquad (20)$$, where

$V^{(Rw)}$ - number of railway vehicles,

$LC^{(Rw)}_{c,p}$ - loading capacity of the railway cars for a specific commodity groups and its manner of packaging.

The conversion of the commodity flows in road vehicles is based on that assumption, that the transporter tries to use vehicles, from which transport room as well as loading weight capacity are utilized optimally. The first experiences show that industry, the building industry and agriculture utilize the loading weight capacity rather than the transport volume capacity. In the retail trade the opposite is the case. This is indicated in the figure 6.

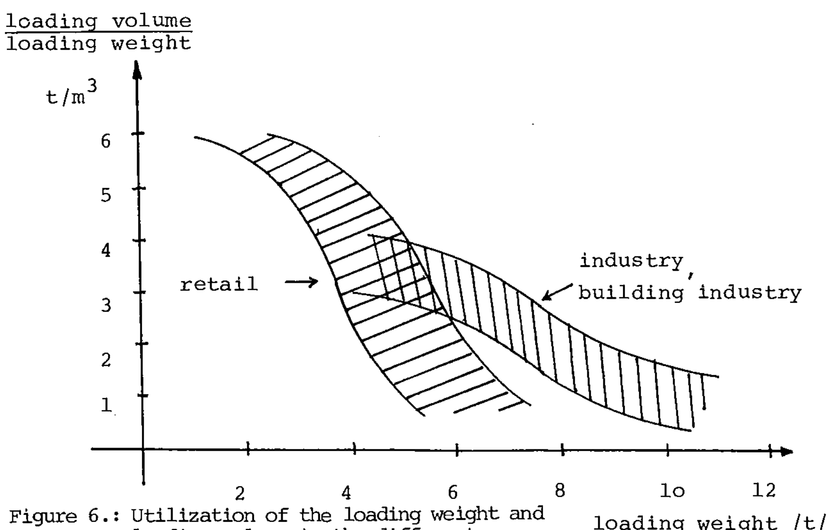


Figure 6.: Utilization of the loading weight and loading volume in the different branches /road transportation/

The road vehicle conversation is made theoretically also by means of the equation (20). Due to the comparatively uniformed ship fleet, the commodity-vehicle conversion concerning the inland waterway navigation will be carried out by using the equation (20) too, where always 1000 t ship loading capacities will be assumed.

4. Summary

In this article a short outline has been given about the research in the field of the nationwide transport network development and especially on the field of freight transport demand modelling and forecasting. This research project is still in progress, and presumably will be finished in 1987. In the framework of this paper only a brief ontline of the models could be provided. However, there are a lot of important detail problems, whose solution is sometimes the most interesting for experts.

REFERENCES

1. Schmidt, H.G. (1977) Die Erfassung des Güterverkehrs zum Zwecke seiner expliziten Berücksichtigung in Verkehrsplanungsprozessen, RTWH Aachen, Germany.
2. Vörös, A. (1984) "Analysis and Forecast of the Road Freight Transport Demand Based on Economic Factor Changes", Routes et Developpement, Paris, May 22-25.
3. Roberts, P.O. (1977) "Forecasting Freight Demand" World Conference on Transport Research, Rotterdam April 26-28.
4. Giannopoulos, G.A. (1982) "The Transport Infrastructure Reguirements in Greece after her accession to the European Communities", University of Thessaloniki, Greece,
5. Gomes, L.F.A.M., Neto, M.C.S.: "The Multiobjective Assignment of Multicommodity Flows to a Network", Ciencia e Cultura 37 (11) November 1985.