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COMPARISON OF THE RESULTS OF TRANSPORT-SOCIOLOGICAL SURVEYS AS A BASE FOR SIMULATION OF THE TRAFFIC-TRANSPORT PROCESS IN THE TOWN OF ŽILINA

ABSTRACT
The modelling of transportation and transport processes in towns is a current problem. Recently, new transport planning models have been formulated on the principle of dividing the inhabitants into the groups with similar behaviour in the transport process. They are called non-aggregative or individual and this model is to be tested under the particular circumstances of the town of Žilina. The introduction of these methods in Slovakia fails because of the lack of the necessary data about the transport process, as it is difficult and costly to obtain them. They are transport sociological surveys in the households of the area. They would bring the necessary information. Comparison of some basic data is described on this paper.

KEYWORDS
Technical conditions, junctions, transport survey, capacity, modelling

INTRODUCTION

In the last years transport problems in the cities have reached undesirable dimensions. Their solution is possible only with the application of modern modelling methods of transport engineering. These clarify the requirements of the population for their necessary transfer during the day. Modern transport engineering methods make it possible to model the whole process, which also means to seek the best solution for the given area so that the inhabitants do not perceive the transport process as a negative part of their environment.

Transport has a specific position in the process of regional planning. It provides a mutual connection of basic functions in an area through the necessary transfer of people and freight. The transport specificity is in its various system possibilities when meeting these demands in the given area, and in the dynamics of the transport process. [1,2]

1. MODERN MODELLING METHODS OF TRANSPORT ENGINEERING

Modern transport engineering methods require high quality hardware, software and more deatailed input data, especially on the population behaviour in the transport process. The introduction of these methods in Slovakia fails because of the lack of the necessary data about the transport process, as it is difficult and costly to obtain them. They are transport sociological surveys in the households of the area. They would bring the information on the dynamics of the population according to the journey purposes and used means of transport in dependance on different groups of population, because the necessary modelling parameters are set according to these data. However, there are also problems with achieving structural parameters for different zones of the area, which are relevant for various human activities.

The system analysis revealed that the transport must be seen as a function of the activities distribution in an area, which means that the urban planning must precede the transport planning. This relation, however, is not a subordinate one at all. On the contrary, the transport volume caused by urban planning and its distribution in the network, should be one of the main criteria of the urban planning quality. The transport in a town´s organism functions as a scale of the interaction between the parts of the area and their functional constituents. It provides the functional interconnection of these constituents into a single system The question of minimalizing the necessary transport is becoming one of the criteria for optimalizing the urban planning.

The models of transportation and transport processes serve as a simplified display of its whole course. With respect to the aims they serve, they have to be complete, with appropriate space and time differenciation. The whole modelling process consists of four steps:

- the calculation of transfer requirements volume
- the calculation of transfer flows direction
- setting the division of the transportation labour in individual disposable transport systems
- loading the transport systems networks (route selection)

In the last decades new transport planning models based on the principle of dividing the population into groups depending on their behaviour in the transport process, began to develop. They are called non-aggregative, or individual, or behaviour oriented models. They gradually improved and proved reliable in various applications. They demand high quality hardware and detailed input data. But those are ascertainable only through a survey in households. They mainly use the theory of probability.

It should be emphasized that the newer non-aggregative and the older aggregative models differ in their procedures only partially, namely in their calculations (modellings) of requirements of transfer, and they are nearly identical in their modellings of transport systems supply (calculations of transport networks loading).

The basic principle of these models is to divide the population into the homogene groups depending on their behaviour in the transport process. At present, the most frequently used division is into:

- economically active population with a disposable car (E+c),
- economically active population without a disposable car (E-c),
- economically non-active population with a disposable car (Ne+c),
- economically non-active population without a disposable car (Ne-c),
- basic school pupils (P),
- secondary and vocational schools students (SS),
- university students (possibly divided into groups with/without a car) (US),
- children under six (Ch).

It was revealed that these particular groups differ fundamentally in their dynamics during the day and in the performed activities. Naturally, this division can be more detailed according to the type of economic activities and in the sphere of education.

Another principle of these models is the assumption that the activities away from one´s residence are the cause of mobility (dynamics). The activities are the final aim of every trip. The final aims of trips can be divided in many ways, always according to the relevant structural parameter. For each group of the inhabitants there is a description of successive typical activities of one person during a day, which creates the basic activities strings. A string of activities implies the transfer. Take the string residence-work-shopping-residence (R-W-S-R). It represents the performance of three trips in this order: residence-work (R-W), work-shopping (service) (W-S), and shopping-residence (S-R).

To conclude the modelling and prognosis problems it should be said that the complex procedure of the planning process of the transport solution for an area is not simple. The original simple linear procedure with four steps of the transport process modelling (aggregative or non-aggregative) developed into a complex extended iterative process of a gradual specification of used parameters through the feedback to the previous steps. This iterative procedure is necessary because various influences of every planning variant must be examined and compared with the required aims. From this comparison, a requirement of a new variant solution can issue. [3,4]]

2. THE INPUTS AND DATA FOR THE MODELLING

Every method requires certain inputs, and the more detailed the modelling, the more extensive the data requirements.

The transfer requirements (transportation demand) in an area depend on the attractivities localization in this area. The transportation requirements in a particular time unit (day, rush hour) which are expressed in a matrix of transportation relations (origin-destination), are dependent variables which are derived from the number of activities performed by the inhabitants in a period of time, and from the layout of individual attractivities. It means that the division of the territory into transport zones, the data about the average dynamics of the population in a monitored period, and the data about attractivities in individual transport zones, serve as the inputs for the calculation of transportation relations.

It can be said that all methods require the mentioned input data. The only difference of the presented methods is obviously the degree of details of these inputs, or their specificness for the given method.

The division of the solved territory into transport zones is the base of the transportation and transport process modelling. A transport zone is a precisely delimited territory which is created on the basis of territorial administration, urban, economic, transport,

planning, or other sides, with a definable centre which fictitiously aggregates all origins and destinations of the trips which begin or end on its territory. The transport zones must comprise the whole solved territory. Every transport zone, or its centre, is numbered with a positive integer from 1 to n. The number and the delimitations of transport zones are determined according to:
- the required precision and accuracy of the transportation process delineation, depending on the aims of the solved problem
- the size of the solved territory
- the urban structure of the solved territory
- the structure of transport networks in the territory
- possibilities of gaining the necessary demographic and other data about the activities in individual transport zones
- the limits of the hardware and software which are available for the processing, and also the term and capacity limits of compilers

To determine boundaries of transport zones of settlement formations, natural and technical divides, like rivers, railway lines, roads of higher category, terrain divides, etc. are used first of all. It is advisable to follow the census urban zones, appointed for regular censuses, or their incorporation into bigger units, as there are necessary statistic data for this division. It is also suitable to homogenize transport zones according to the territory function, and overbuilt areas should be divided precisely. In towns, it is advisable to create transport zones up to 5000 inhabitants or other structural parameters, which secures a sufficient precision of the modelling.

Consequently, the necessary data about structural parameters (attractivities), and basic characteristics of the transportation process must be gathered for the proposed territory division. If a prognosis is a part of the works, the data about structural parameters for the prognosis proposal periods must be available.

Modern methods of transportation requirements modelling require a detailed division of structural parameters in the territory, so that they cover all possible activities. Some population groups perform the activities, which other groups do not, e.g. only the group of economically active people go to work, and only the group of pupils and students go to school. On the other hand some activities are performed by all groups of the population.

At present, the common division of the population for the modelling of the transportation relations is into these basic groups:
- economically active population
- basic school pupils
- secondary school and university students
- economically passive population (pensioners, housewives, unemployed, physically or mentally disabled)
- pre-school children
- the total number of the inhabitants (as a sum of all groups)

In addition, among the crucial structural parameters expressing other activities there are:
- the opportunities of work in all
- the opportunities of work in the tertiary sector
- pupil places in basic schools
- student places in secondary schools and universities

From literature there are known even more detailed divisions of groups, e.g. according to the disposibility of a car, or the division of pupils into the first and the second grades and students into secondary schools, vocational schools and universities. [5,6]

3. THE BASIC RESULTS OF THE SURVEYS

The first survey was made in the months between October and December 1998 in the region of Žilina. In the course of 1999 questionaires were processed. The survey included a total of 1060 households with 3336 persons in the city of Žilina.
The second survey was made in 2015 in the city of Žilina. The survey included a total of 495 households with 1334 persons.
In the Table 1 are presented age groups of the population that are required for the modelling of the transportation relations. [7,8,9]

Table 1. Age groups

	First survey		**Second survey**		
	Number of persons	**%**	**Number of persons**	**%**	
0-5 years	103	3,09	53	3,97	+0,89
6-14 years	276	8,27	75	5,62	-2,65
15 years	83	2,49	16	1,20	-1,29
16-19 years	474	14,21	78	5,85	-8,36
20-25 years	484	14,51	155	11,62	-2,89
26-61 years	1705	51,11	737	55,25	+4,14
62-68 years	92	2,76	101	7,57	+4,81
69-70 years	30	0,90	30	2,25	+1,35
More than 71 years	89	2,67	89	6,67	+4,00
Total	**3336**	**100,00**	**1334**	**100,00**	

The following Table 2 shows the basic results and their comparison from the both of surveys.

Table 2. Individual population groups

The data observed	**Territory**	**E+c**	**E-c**	**NE+c**	**NE-c**	**Pupils**	**Stud.**	**Children**	**Total**
1. Total of persons evaluated									
First survey	Žilina city	960	785	119	355	270	742	105	3336
	%	28,78	23,53	3,57	10,64	8,09	22,24	3,15	100
Second survey	Žilina city	472	235	118	204	50	170	85	1334
	%	35,38	17,62	8,85	15,29	3,75	12,74	6,37	100
Difference	%	+6,6	-5,91	+5,28	+4,65	-4,34	-9,50	+3,22	
2. Average dynamics of the respective group (journeys/ population/day)									
First survey	Žilina city	3,243	2,979	2,806	2,712	2,624	3,114	2,649	3,037
Second survey	Žilina city	2,527	2,431	2,334	2,353	2,195	2,483	2,358	2,448
Difference		-0,716	-0,548	-0,472	-0,359	-0,429	-0,631	-0,291	-0,589

The modelling of the requirements for transportation using the disaggregated method is requiring to evaluate, on the basis of the transport sociological survey already done, the trip strings of individual population groups, the knowledge of which is indispensable and it is one of the basic conditions of using this method. Trip strings of all the groups are processed, and the proportion of the respective string with respect to the respective group is stated. Some strings can be found in several groups, obviously with a different proportion. The number of different trip strings totals 140 in first survey and 56 different trip strings in second survey. The following table describes the behaviour of individual population groups: [1,2,10,11] See table 3.

Table 3. The behaviour of individual population groups

Population group	Number of different departures		Difference	Maximum number of trips per string		Difference
	1. survey	2. survey		1. survey	2. survey	
E+c	82	36	-46	11	9	-2
E-c	50	20	-30	10	7	-3
NE+c	13	10	-3	9	4	-5
NE-c	22	13	-9	5	5	0
Students	48	18	-30	7	5	-2
Pupils	11	5	-6	4	3	-1
Children	13	10	-3	5	4	-1
Total	**140**	**56**	**-84**			

Modelling of the transportation process, i.e. the offer of transportation systems, requires the same methods, whether the transportation requirements are calculated via aggregated or disaggregated method. In fact, the modelling of transport consists in the modelling of the offer of transport systems in an area and the reflection of the requirements for transport into these systems. Generally, what is modelled is the road system and the system of public transport in the area subject to research. The system of public transport (railway, bus, or city public transport system) is modelled as a whole, because it is in this way that it is perceived by the public as an alternative to individual transport. The modelling of minor territories (small and mid-size cities, small districts) can also be done manually; the major territories require the use of software, because here transparency is lost, and the determination of minimum trips and distribution of loading can result in major incorrectness.

As a matter of course, the loading of individual sections of the system calculated by means of transport relations matrices must be verified via the actual loading. In case the calculated loading does not correspond with the actual loading, it is necessary to return to the preceding steps by way of feedback, and to use correction to achieve correspondence between the actual loading and the calculation. The feedback is actually used to calibrate the parameters used in the present state. [1,12,13,14]

CONCLUSION

At the end of the 20th century transport problems reached undesirable dimensions. The bigger and the more complex the given territory, the more difficult the solution. It is possible only with the application of modern modelling methods of transport engineering. These clarify the requirements of the population for their necessary transfer during the day depending on the arrangement of urban activities in the territory, and in the confrontation with the actual offer of transport systems attempting to meet these requirements. Modern transport engineering methods make it possible to model the whole process, which also means to seek the best solution for the given area so that the inhabitants do not perceive the transport process as a negative part of their environment.

It is necessary that the processed regional –planning and transport-engineering documentations solve the transport situation in an area using the latest knowledge, and

so help to improve it. Urban planning is a part of the system of the society development control. It needs to be based on the macroeconomic plan, socio-economic relations and given priorities of the society development. It must project these into the area, solve its complex exploitation, and arrange for the material and time coordination of all human activities influencing the area development. Transport has a specific position in the process of regional planning. It provides a mutual connection of basic functions in an area through the necessary transfer of people and freight. The transport specificity is in its various system possibilities when meeting these demands in the given area, and in the dynamics of the transport process.
The transport engineering as a major subject has been taught at our universities from the early 1960s, and transport situations of bigger cities were solved using at that time the latest methods and procedures. However, recently a reverse tendency is noticeable, that is solving the transport problems using simple methods without a thorough analysis of problems and an objective consideration of possible solutions. [15,16,17]

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PORÓWNANIE WYNIKÓW SOCJOLOGICZNYCH BADAŃ TRANSPORTU JAKO PODSTAWA SYMULACJI RUCHU - PROCES TRANSPORTU W ŻYLINIE

STRESZCZENIE

Modelowanie transportu i procesów transportowych w miastach jest problemem aktualnym. Ostatnio opracowano nowe modele planowania transportu, oparte na zasadzie podziału mieszkańców na grupy o podobnym zachowaniu w procesie transportu. Są one nazywane niełączącymi się lub indywidualnymi i taki model ma być testowany w konkretnych warunkach miasta Żylina. Wprowadzenia tych metod na Słowacji nie udaje się ze względu na brak koniecznych danych o transporcie, ponieważ ich uzyskanie jest trudne i kosztowne. Są nimi socjologiczne badania transportu w gospodarstwach domowych na danym obszarze. Zapewniłyby one potrzebne informacje. Artykuł opisuje porównanie niektórych podstawowych danych.

SŁOWA KLUCZOWE

modelowanie, modele agregujące, badania socjologiczne transportu