

Theses of a university doctoral (PhD) dissertation

**EVALUATION OF THE TRANSPORT MODELS IN TWO MIDDLE CITY
CATCHMENT AREAS (KARLSRUHE AND DEBRECEN)**

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1. PRELIMINARIES AND OBJECTIVES OF THE DOCTORAL THESIS

The competitiveness of a region is basically determined, in addition to external transport connections, by the development level of intra-regional transport connections, the availability of adequate inner networks. The accessibility of the regional centres and sub-centres from their catchment areas, the access of the respective settlements within the region, and the connections among the sub-centres are all factors that influence the economic and social life in a region and the quality of life of the inhabitants (*Erdösi, 2002; Fleischer, 2004*).

Following the systemic change some suburbanisation processes were also visible in the catchment areas of big cities of East-Central Europe, including Debrecen, as a result of the fact that the demand for space by economic activities and residential areas could no longer be satisfied within the city boundaries. Since the late 1990s, big city middle class has regularly shown up in the suburbs, but the pace of moving out was not followed by the intensive enough development of communal infrastructure and services.

This means that the workplaces and schools and training places of the middle class moving out, the health or public administration institutions are usually still in the similar or different towns with some central functions or in the smaller sub-centres, in the towns of the different catchment areas. This has inevitably increased the travel demand of the population of the agglomeration between the place of residence and the centres of the catchment areas (travels may be daily travels and less frequent ones). Parallel to the boom in the number of private cars allowing rapid displacement, the intensity of commuting traffic has considerably grown between suburbs and big city centres, in which individual transport tools have gained an ever larger share (*Enyedi, 2011; Illés, 2009; Jászberényi, 2008*).

In the countries of Western Europe these processes took place in the 1960s, already, to which the organisation of public transportation responded by integrated solutions, in order to decrease the proportion of the means of private transport. The first transport associations that were founded at this time in the federal Germany offered competitive community transportation solutions in the suburban and peri-urban transportation, stopping thereby the penetration of the means of private transport. The presently existing associations, based on the strong deconcentration of public tasks and public financing, have already moved beyond the suburban space to the regional level to offer integrated and single network services, contributing to the improvement of intra-regional accessibility and regional competitiveness (*Sparmann, 2009; BVBW 1999*).

In the organisation of the public transportation in suburban areas in Hungary, including Debrecen, no such integrated solutions at regional level have appeared since the systemic change. Parallel to the appearance of the transport impacts of suburbanisation and desurbanisation processes and the spread of environment conscious thinking, the *demand for the development of public transportation at suburban and regional level is more and more in the foreground of the researches*. Some researches are focused on transport associations as an organisational solution, especially in relation to the agglomeration around Budapest (Berényi et al., 2009, Monigl, 2000). Another group of researches deal with the adaptation possibilities of the technical and technological innovations of the Karlsruhe suburban public transportation model to Budapest and other big countryside cities in Hungary (Jéger, 2011; Kazinczy et al., 2004; Keserű et al., 2009; Szűcs, 2007).

However, up to the time of the writing of this dissertation no academic research work has been done on the direct adaptation of the Karlsruhe model to Hajdú-Bihar county. *Indirect preliminaries* of the thesis are two further researches whose thematic focus is not on the Karlsruhe model but they analyse the special processes going on in the towns of Hajdú-Bihar county and its urban catchment areas, with the consideration of the aspects of community transportation (Bujdosó, 2004, Kecskésné, 2012). The work of the author of this present dissertation, written in German language on the possible adaptation of the Karlsruhe model to the suburb of Debrecen is available in a manuscript form; it was used as the starting point of the thesis, as it was written on the planning and financing possibilities of a regional suburban railway system in Hajdú-Bihar county (Bói, 2003).

Although they are not academic basic researches, four studies have been completed recently with the co-financing of the European Union and the support of the City of Debrecen which may be considered as preliminaries of the research, on the one hand, and will probably be fundamental documents in case of their future implementation, on the other hand (Table 1).

The most important thing about these studies is, in addition to the useful information and empirical results in them, is that they all are planning documents that take the application of the Karlsruhe model into consideration in the suburbs of Debrecen, creating thereby the chance for a future EU co-financing for implementation.

Some parts of the study have preliminaries then; however, they either do not make a complex unit or are based on findings that are partially obsolete by now. This dissertation was written, in addition to gaining scientific achievements, to upgrade and synthesise the findings of the previous works, using the methodology of interdisciplinary researches.

Table 1

Community transportation projects implemented with EU financing in the catchment area of Debrecen

Name of project	Type and year of plan	Project owner	Connection to this thesis
Development of suburban high speed train transportation system in Debrecen and its hinterland	detailed feasibility study (DFS) 2012	Debrecen City of County Rank (DCCR)	The study contains the <i>Karlsruhe model as an alternative to be implemented.</i>
Integrated community transportation development plan of the Debrecen agglomeration until 2020	founding study 2012	Debrecen Transport Inc.	The study deals with the <i>federal transport organisational model of Karlsruhe.</i>
Planning of a transport system with cross-border impact between the pole cities of Oradea and Debrecen	founding study 2013 (underway)	DCCR – Oradea Metropolis Zone	The study touches the <i>cross-border dimensions of the Karlsruhe model.</i>
Creation of an intermodal passenger transportation centre in Debrecen	DFS and design contest	DCCR	The study and design contest see <i>connection of railway and tram tracks as a development chance.</i>

Source: by the author, based on DCCR (2012a, 2012b), DTI (2012).

The *primary objective* of the research is the systematic assessment of the organisation of public transportation in the peri-urban zones of Karlsruhe and Debrecen. In order to achieve this goal, and also due to the character of regional science, an interdisciplinary approach is needed for the in-depth research of the issue. For this reason, besides analysing the content of international and Hungarian literature on the issue, the research also focuses on works written on demography, urban researches and the organisation of public services, and also looks at the framework conditions of regulations. A special attention is paid to the analysis of the sources on the Karlsruhe model beyond the technical and technological aspects.

In Debrecen and its hinterland the shift to market economy led to fast and fundamental changes, whereas the whole of the public transportation system was left untouched, or only a few quantitative and qualitative parameters changed. The *secondary goal* of the dissertation is the detailed mapping of the demographic and economic factors influencing transport demands, and the demonstration of the dynamism of the change in the public transportation services at regional level and in the suburbs, analysing statistical data. The analysis allows, in addition to the survey of the reasons for the disequilibrium between supply and demand factors, the exploration of the factors with a negative impact on efficiency and also gives ideas concerning

whether the introduction of the Karlsruhe model is necessary, reasonable and possible in the researched region.

The *tertiary goal* of the thesis is – on the basis of the processed data of the empirical studies already done – to make exact recommendations for interventions into the system, in order to improve the efficiency of community transportation and decrease the use of private transport tools.

With regard to the border location of the county, during the analyses the dissertation gives an outlook to the possibility if introducing the Karlsruhe model in the joint transportation catchment area of Debrecen and Oradea.

The research is done along the following hypotheses, in line with the objectives:

- H1: As regards the – applicability in the research region of the – success factors of the Karlsruhe transport organisation model, the regionalisation of the community public transportation service, the creation of an effective decision-making and financing meso-level is the most important prerequisite.
- H2: In Debrecen and its region, to satisfy with track-based solutions the suburban and regional transport demands induced by suburbanisation, it is indispensable to have a support for the regulation of the development of track-based transport like in Karlsruhe.
- H3: Without the development of the quantitative and qualitative parameters of public transportation, there is a risk that the share of users of private transportation will grow in the respective area and among the target groups.
- H4: In cross-border community transportation, the development of the cross-border transport relations following the Karlsruhe model between the neighbouring and cooperating regions of two eastern EU member states is blocked by several specific factors.

2. RESEACRH METHODOLOGY, DATA SOURCES

The *sample area of the research* is the *city of Karlsruhe and its transportation catchment area* in Germany, which coincides with the development and planning region called Mittlerer Oberrhein, consisting of two urban and two rural administrative units – Stadt- and Landkreis (hereinafter: the Karlsruhe region). The *target area* is *Hajdú-Bihar county*, in addition to the detailed survey of the *peri-urban catchment area of Debrecen*.

With regard to the type of topic, the objectives defined and the hypothesis set, the analyses of the dissertation concerning the sample and the target area are based on both *primary and secondary sources*. The secondary sources include to a large extent the academic and professional documents listed in the research preliminaries chapter, and also on German language literature. For the comparative analysis of transport systems it was necessary to do a detailed analysis of the *legal and financing background* at national and European Union level, through the analysis of *concrete legal documents and contracts*. In order to get to know the topical development ideas, the detailed studying of relevant strategic and programming documents was also carried out at various (European, national, cross-border, regional, county and municipal) planning levels.

On the other hand, the introduction of the Karlsruhe community transportation model from the aspect of the technical and technological, organisational and operational, and regulation and financing framework conditions is primarily built on the focused *content analysis* of background documents provided by the Karlsruhe Transport Association (KVV), and by the City of Karlsruhe.

The regional social and economic processes, competitiveness impacts prior to and following the introduction of the model are demonstrated by the *processing and analysis of a broad time series of statistical data*. The overview of the changes typical of suburbanisation and desurbanisation by the indices of social geography (population, density of population, migration) and mobility (number of cars, commuting, distribution of workplaces) in Hajdú-Bihar county and the *selected target area* of the dissertation – the suburban area of Debrecen – is also done with this method.

As regards the sources of social geography, demography and mobility data related to the sample area and the target area, sources of special importance include the database of the Hungarian Central Statistical Office called T-STAR, the Hungarian Regional Development and Spatial Planning Information System (TeIR), regional databases managed by the Municipality of the City of Karlsruhe, the Land of Baden-Württemberg and the statistical offices of the Federal Republic of Germany (SISKA, GENESISonline), and the information provided by the Institutul National de Statistica in Romania. Also, the documents, reports and structured databases provided by the City of Debrecen and the City of Karlsruhe are definitely worth mentioning. Among the sources on community transportation, the timetables of the Hungarian and German transportation service providers and their specific professional and accounting reports are to be mentioned.

During *empirical surveys* it was an important goal that they should provide information on the broadest possible circle of stakeholders in community transportation. In order to

meet this goal, data collection was done at three levels: it included *passengers* using the service, *institutions defined as the targets of travels*, and *decision-makers who order or influence* community transportation services (Figure 1).

The extension of *empirical research related to passengers and transport habits* to the total of Hajdú-Bihar county is not allowed either by the size of the thesis or the planned depth of the research, so before empirical researches were started, the research area and the target group had to be designated. The *passenger counting* part of the research, done at the bus station of Debrecen, the Grand Railway Station and partly aboard the vehicles covered all suburban railway and bus lines from the city, within the framework of an official passenger counting of the service. The collection of cross-border passenger traffic was allowed by the counting of passengers crossing the border at the crossing stations of Ártánd and Nyírábrány in December 2012.

Figure 1

Gantt diagram of the empirical surveys

	09/12	10/12	11/12	12/12	01/13	02/13	03/13	04/13	05/13	06/13	07/13
I. Survey of employers and higher education											
I.1. database creation		■									
I.2. request for data			■								
I.3. data input and analysis				■							
II. Passenger counting and traffic survey											
II.1. Nyírábrány/Érmihályfalva border crossing stations				■							
II.2. Ártánd/Bors border crossing stations					■						
II.3. railway						■					
II.4. bus							■				
II.5. data input and analysis								■			
III. Questionnaire survey											
III.1. definition of sample											
III.2. implementation of questionnaire survey (railway)							■				
III.3. implementation of questionnaire survey (bus)								■			
III.4. data input and analysis									■		
IV. Survey with prominent persons											
IV.1. implementation of interviews										■	
IV.2. content and data analysis											■

Source: By the author.

For the *questionnaire survey* – with regard to the choice of topic – track-based community transportation axes had to be identified within the county which, in addition to managing peri-urban traffic, provide the connection of peripheral areas to the county centre and also play a part in the cross-border macro-regional space. For the designation of the target area I received guidance from the essays by my topic leader on the peripheral areas in the Hungarian–Romanian border region (Baranyi, 2001; 2007). On the basis of all these, the *target area* of the survey included settlements served by the *Railway Line No. 106 Debrecen–Sáránd–Nagykereki* and *Railway Line No. 105 Debrecen–Nyírábrány(–Érmihályfalva)*, whereas the target group is those

who commute to the county centre from the respective settlements for non-leisure purposes.

During the questionnaire survey done aboard trains and buses in March and April 2013, approximately half of the average number of daily users of the lines was questioned, with non-repetitive random selection. The total size of the sample was n=631, including 411 railway passengers and 220 bus passengers, respectively. During the questionnaire survey a total of 29 questions were asked of the respondents, including general demographic data, travel habits and the respective service parameters.

The information gained was complemented by a database of commuters registered by my employer, Passenger Transport Directorate of KTI Non-for-profit Ltd. in October 2012, with my participation, concerning *employers with more than 50 employees registered by statistics and higher education institutions* in the county.

Table 2

Participants in the deep interview sessions

Function	Organisation	Position
<i>Representative of customer</i> (peri-urban/regional/national)	<i>KTI Institute of Transportation Studies</i> Northeast Hungarian Transport Organisation Office	<i>expert of railway transportation,</i> <i>expert of bus transportation</i>
<i>Customer</i> (local)	<i>Mayor's Office of Debrecen City</i> Department of Urban Development	<i>head of department</i>
<i>Service provider</i> (peri-urban/regional/national)	<i>MÁV-START Inc.</i> Timetable Planning Organisation, Centre of Regional Passenger Transport	<i>regional coordinator,</i> <i>head of regional passenger transport centre</i>
<i>Service provider</i> (regional/national)	<i>HAJDÚ VOLÁN Inc.</i>	<i>deputy director general of economic affairs, director of passenger transport services</i>
<i>Service provider</i> (local)	<i>DKV Debrecen Transportation Inc.</i>	<i>director general</i>

Source: By the author.

One of the goals of the *deep interviews* made with stakeholders at service provider companies and regional actors using or influencing community transportation services was the comparison of the findings of the questionnaire survey made with the passengers to the opinions of the experts interviewed (*Table 2*). The qualitative part of the deep interviews was conducted in order to assess the adaptation possibilities of the

Karlsruhe model to Hungary – after the drafting of the model to the interviewees – and to explore the situation of the community transportation at regional level in Hungary.

The processing of primary and secondary data was done with MS Office 2007 software and IBM SPSS 19.0 statistical programme package, while figures were made using the CorelDRAW X4 programme. The studying of references, available literature, legal documents and development documents was completed by December 2013. The processing of changes after this date will be done within the frameworks of my future academic career planned.

3. MAIN FINDINGS OF THE DISSERTATION

A prerequisite of the transport organisation model applied in Karlsruhe was the *railway reform* launched in Germany in the early 1990s. The Act on the Reorganisation of the Railway approved in 1993 (ENeuOG) allowed the enactment of the Act on Regionalisation in the same year (RegG), according to which the task of the organisation of short distance community transportation (ÖPNV) was transferred from the federal state to the Länder.

The organs responsible for the implementation of the ÖPNV in the Land of Baden-Württemberg, including Karlsruhe, are now the big cities and the administrative units around them, consisting of several municipalities (Stadt- und Landkreis). The railway reform did not only *delegate the responsibility of service provision to regional level* but also *settled the financing of the services* (BVBW, 1999). The financing of regional community transportation was done from the tax revenues of the Federal Government from mineral oil, which it transferred to the federal Land through the Regionalisation Fund. The resources from this fund could be spent, by the decisions made by the Länder themselves, on financing the procurement of transportation services and the development of the infrastructure of track-based networks. In addition to these, Baden-Württemberg also covered the loss of revenues of the transport association coming from the creation and operation of transport associations.

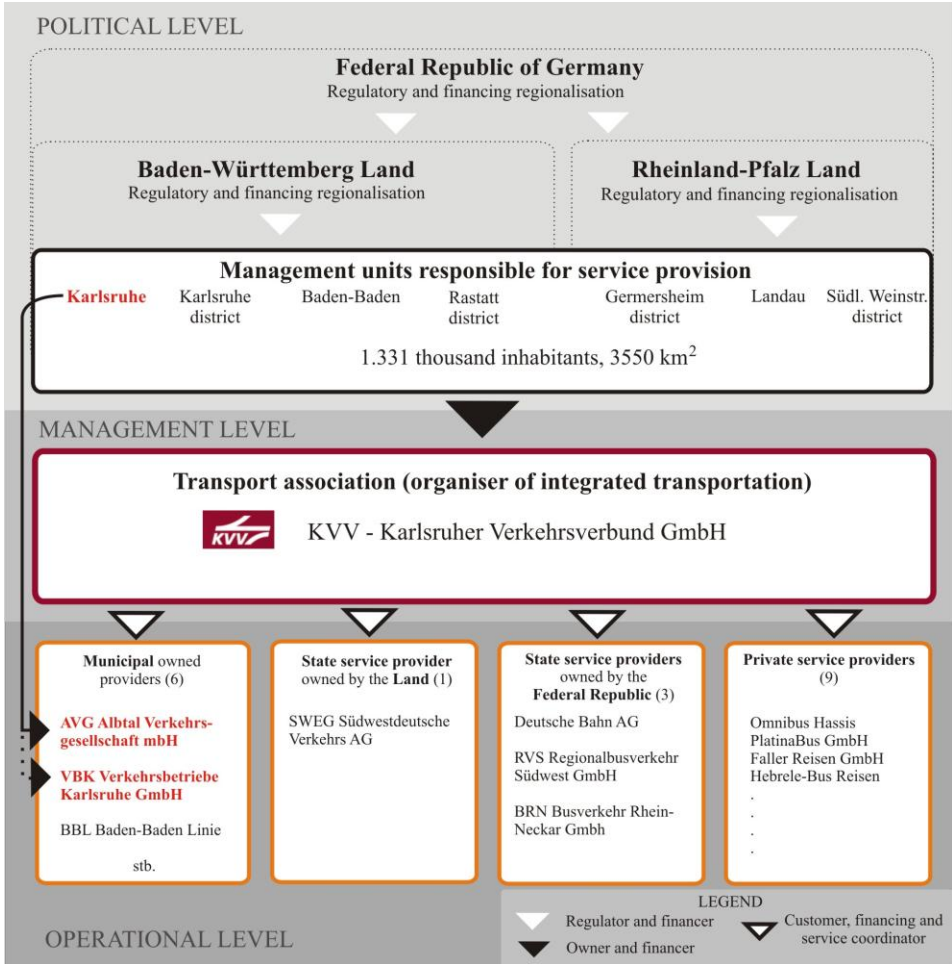
Within these new regulatory and financing framework conditions was the Karlsruhe Transport Association (KVV) founded in 1993, which was also a tariff community. The association works as a *three-level model* consisting of political, management and operator elements (*Figure 2*).

The organisational form and the adequate financing conditions allowed community transportation to satisfy mobility demands induced by suburbanisation in the Karlsruhe area at a much *higher quantitative and qualitative level* than before. The foundation of the service model was the *connection of the large-scale national and the local urban*

railway networks, the integration of community transportation services, the increase of the density of stops, the integrated periodic timetable and the tariff system using a wide range of preferential prices on business policy grounds.

Figure 2

Structure of the Karlsruhe community transportation model



Source: By the author, by the Report of 2011 of the KVV and other contracts of the company

The results and impacts of the new service supply model were positive, according to the pieces of literature processed. As a consequence of the passenger friendly tariff system and service level, both the number of passengers using the services of the KVV and the revenues from the travel fares continuously increased from 1996 to 2011, and the fare per one passenger has also risen since 2001. Although the scale of motorisation also showed a tendency of continuous growth in the years mentioned above, the proportion of community transportation in the division of labour in transportation slightly grew, parallel to some decrease in the level of motorised individual transportation.

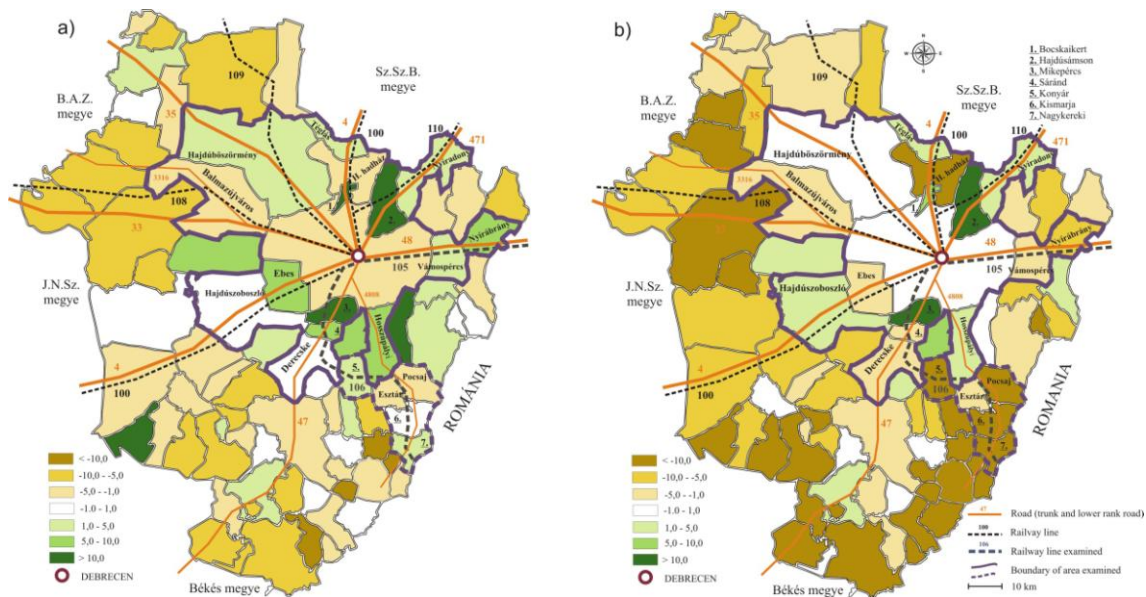
The improving transport accessibility also impacted the competitiveness of the respective region. In the case of the settlements served by the thoroughly analysed

suburban line S4 for example, the difference between the shares of those commuting out from and commuting into the settlements continuously decreased in 1998–2010, parallel to an increase in the number of daily commuters. In the town of Bretten along this line, the number of in-commuters has surpassed the number of those commuting out since 2001, the difference was approximately 20% in 2011. This suggests that a large number of new jobs have been created in all respective settlements, which is an important indicator of the competitiveness of the whole region as a business location.

The examination of the time series of indicators in *Hajdú-Bihar county* related to demography (number of population, external and internal migration), living conditions (housing constructions, housing density, motorisation) and economic activities (incomes, unemployment) proved that *changes of mobility* generated by out-migrations *related to suburbanisation are present* in the area too.

Figure 3

Changes in the migration balance of settlements in Hajdú-Bihar county, 1994–2002 (a) and 2002–2010 (b) (inhabitants /1000 population)



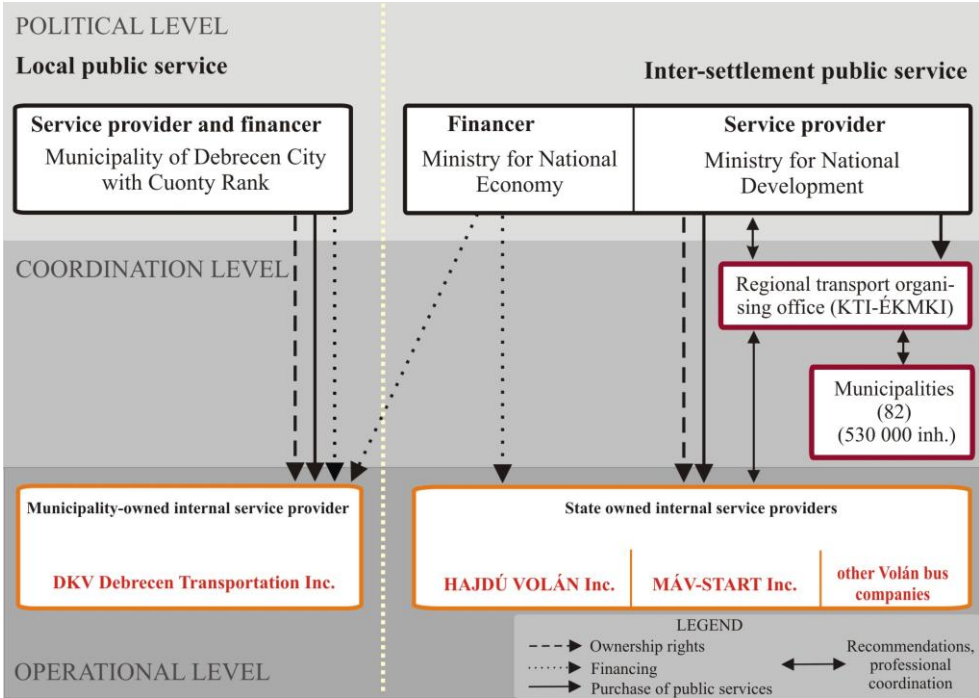
Source: calculated and edited by the author, based on data published by the HCSO in TeIR

The data of Debrecen and another 15 settlements in its direct peri-urban hinterland suggest that the formerly rural areas of the peri-urban area – classified as part of the “rural” settlement category in the dissertation – showed a dynamic growth of population, especially in the first part of the research period (Figure 3). The migration surplus of some settlements around Debrecen (e.g. Hajdúsámson and Bocskaikert) per one thousand inhabitants exceeded several times in the middle of the 1990s the values seen in settlements around Karlsruhe. The income, labour force and housing market data proved

that the majority of those moving from Debrecen into these settlements was active earners whose workplaces and training places were still in the county centre, so they probably commute daily between the satellite settlement and their former place of residence.

The analysis of the community transportation service structure of Hajdú-Bihar county, on the other hand, showed *hardly any change in the actors or impact mechanisms of regional transport organisation* in the research period (Figure 4). This means that neither an institution managing the urban and peri-urban mobility relations nor a financing system was born.

Figure 4
Structure of the Hajdú-Bihar county model of the organisation of community transportation



Source: By the author, based on legal regulations concerning the sector and public service contracts

The analysis of transport timetables of community transportation over an almost 20-year period and the passenger counting sessions all pointed out, however, the fact that *urban and peri-urban mobility demands* showing up in public passenger transportation were primarily *satisfied by road transportation* that is more flexibly manageable and has a better network. Public transportation by bus followed the change in travel needs all the time in the research period, the indices of the supply in the settlements concerned by out-migration improved in accordance with or even above the level of the population increase, and the capacity utilisation of the lines also improved. While in the case of settlements

most favoured by out-migrants the number of bus lines per 1000 inhabitants increased by 50%, there was hardly any change in the figures of railway transportation.

The faster adaptation of road transportation was also promoted by the more direct touch of HAJDÚ VOLÁN Inc. (the bus company) with the users of the services, coming from its county level organisation and service area – as opposed to the MÁV-START Inc. (the railway company) with national level organisation and service area. Another factor greatly contributing to the decrease in the number of railway passengers was the deterioration of the service quality because of the neglected maintenance and developments of the tracks and rolling stock.

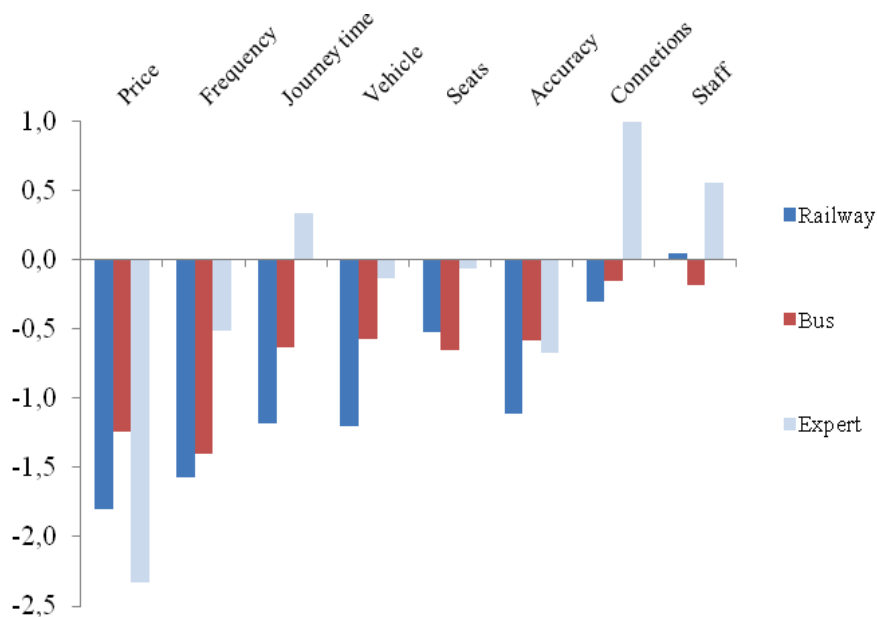
The dissertation – due to the border location of Hajdú-Bihar county – also looked at the *interregional dimensions of the Karlsruhe model*. The analysis of the case study done in Saarbrücken at the French–German border, following the Karlsruhe sample, proved that the maintenance of cross-border community transportation relations is problematic even in the case of cooperating regions of two old EU member states. The biggest *transport barrier* at the Hungarian–Romanian border is the *lack of infrastructure connections*, and also the low number of lines crossing the borders, as the lines in the timetable primarily serve the long-term international mobility demands and not the regional ones. Also, a number of further institutional, tariff and information factors set back cross-border railway traffic, the most significant of which is the different status of the two countries in the Schengen Agreement.

Although the surveys of passenger traffic indicate low number of cross-border travels, other processes *suggest that the demand will increase*. Among these processes there are labour market tendencies: while unemployment rate is 9–16% in the Hungarian counties, in the neighbouring areas in Romania it does not exceed 4–6%. Gross average wages, on the other hand, lag by 20–41% in the Romanian counties behind the values registered on the Hungarian side of the border. This means that for the inhabitants on the Romanian side it is Hungarian wages, for the citizens on the Hungarian side it is job opportunities in Romania and incomes – above the social benefits in Hungary – that may be attractive.

The *empirical parts* of the research made several contributions to the findings of the analyses of statistical data. The respondents in the *deep interviews* said that the adaptation of the Karlsruhe model in the region first necessitates the reconsideration of the financing system, then the adequate transformation of the organisational structures and the consistent obedience of the legal regulations (by all parties). This can only be achieved along a quality focused county level community transportation strategy based on the relatively advanced transport endowments of the county and capable of financing the system.

Figure 5

Disparities between the satisfaction level with the services and their importance as seen by passengers and experts questioned



Source: By the author, on the basis of the findings of the questionnaire survey

The findings of *passenger interviews* also underlined the assumption that systematic interventions are needed already in the short run in order to create the balance between the quality parameters and the prices of the services – as perceived by the respondents (*Figure 5*).

The negligence of these and the giving up of the use of community transportation by passengers project the risk of the increase in motorised individual transportation and the related growth of the socio-economic costs in the region.

4. CONCLUSIONS AND RECOMMENDATIONS

The examinations of the dissertation highlighted several aspects of the Karlsruhe model which together allowed the flexible adaptation of the supply of regional community transportation to the mobility demands induced by suburbanisation. The identified success factors served as the basis for the complex comparative analysis of the situation of peri-urban community transportation in Debrecen, the conclusions of which – grouped around the four preliminary hypotheses of the dissertation – are as follows:

According to **hypothesis 1** *the most important prerequisites for the adaptation of the success factors of the Karlsruhe model of transport organisation to the target area are*

regionalisation of community transportation services, and the creation of an effective decision-making and financing meso-level.

The moral of the relevant pieces of literature and legal and organisational documents is that the starting point of the creation of this model was the regionalisation of short-distance community transportation services in Germany. In addition to the creation of responsibility for regional service provision, the presence of financing resources promoting the cooperation of service users at regional level was the foundation and guarantee of the financial sustainability of the satisfaction of regional mobility demands related to suburbanisation. Without these measures, the interoperability services and technical improvement typical of the model could not have been implemented in Karlsruhe in the present form.

The social and economic indices relevant for transportation services tell us that the increased demand for mobility in Hajdú-Bihar county resulted in challenges for the organisation of transportation especially in the peri-urban areas of the county centre, Debrecen. No integrated transport organisational solutions matching the new characteristics of movements – and making community transportation an attractive alternative of private transportation – have been introduced in the Debrecen area so far, blocked by the framework conditions of regulation. The detailed analysis of the community transportation organisational mechanisms in Hajdú-Bihar county demonstrated that the integration of local and regional public services at peri-urban level is blocked by the lack of a decision-making level linked to the spatial level where mobility demands actually show up, from the side of transportation organisation; and by the lack of financing solutions necessary for a sustainable operation, from the side of the financial regulation. Another remark connected to this hypothesis is that another serious difficulty for the actual implementation of the model is the serious disparities visible in income and demographic indices of the two respective regions.

Hypothesis 2 suggests that *for Debrecen and its region the support of a regulation concerning track-based transportation solutions similar to that in Karlsruhe is indispensable so that this transport sector should satisfy peri-urban transport needs induced by suburbanisation.*

The analyses conducted identified as another cornerstone of the model the creation of the track-based transportation infrastructure network in Karlsruhe that was also allowed by regulatory tools. The transport development and financing regulations of the Land in question tell us that infrastructure development supports of community transportation could only be spent on track-based transport investments. The act on passenger transportation in effect only allowed the use of road transportation services

in areas where there was no railway network. This was well supplemented by the transport policy of the city of Karlsruhe that had a track-based transport orientation too.

In Hungary, on the other hand, the regulations in effect did not require the development of track-based networks and the preference of services managed by these transport means until the appearance of the act on passenger services and the related calls for timetables in 2012.

This is also reflected by the findings of the surveys of the network density and the density of stops in Hajdú-Bihar county. The research revealed that both in the county and in the suburbs of Debrecen it is road transportation now that offers a better network. This fact was not significantly changed by the European Union's regional development resources, either. The majority of supports awarded served the development of road and bicycle path network, leaving just over one-tenth of all invested sums of infrastructure developments for community transportation, besides a negligible share allocated for the support of railway developments.

As regards the level of regulation, the decisions made on the use of transportation services was not bound by sectoral priorities like in Germany, which is reflected by the findings of the analyses of timetable information covering twenty years. Most of the settlements surveyed were accessible both by rail and road transport services, but it was definitely road transportation services that better adapted with their timetables to the mobility demands incurred in peri-urban mobility. As a result of this, passenger counting sessions clearly show now a dominance of bus transportation services: the majority of commuters in the suburban areas of Debrecen use this kind of community transportation even where there is an adequate railway service.

Hypothesis 3 says that *without the quantitative and qualitative development of community transportation services there is a risk of growth in the proportion of the users of private transportation in the research areas and among the target groups of the research.*

The references processed demonstrate an improvement in the quantity and quality of community transportation services after the introduction of the Karlsruhe model, making public transportation competitive also for the users of individual transportation. The data of the questionnaire survey conducted with the passengers of selected railway and bus lines in the suburbs of Debrecen only reflect the opinions of the respondents in this respect, nevertheless they may serve as guidelines for the identification of the problems of the presently available services and the definition of the possible development directions in the region.

According to the findings of the processing of the questionnaires, the evaluation of the services by the passengers was positive on the whole. Of bus passengers, 65% considered accessibility offered by bus as good, and the same proportion of respondents felt an improvement in the supply of bus transportation services in the previous years. The same proportions at the users of railway services were 53% and 57%, respectively.

The findings of detailed analyses concerning further elements of the service raise many issues, however. On the whole, there were several major disparities between the values of the quality parameters expected and actually experienced by passengers questioned, especially in railway transportation where the frequency of lines, the quality of the carriages, the timetables and accuracy were especially often criticised. If we add that a significant part of the passengers responding found the price of the services too high, it is clear that already in the short run interventions may be needed which change the price/value ratio of the service for the better, in order to maintain a general satisfaction level.

If these developments are not made, the future decisions on the choice of transport tool may be influenced by that. According to the answers related to the choice of transport tool, the lack of developments will probably make the users of the respective railway lines change to bus, while approximately 60% of bus passengers would shift to the use of car. With regard to the high proportion of driving licence holders among the respondents, and the fact that most respondents possess at least one car in their households, in case of a parallel deterioration in the parameters of the two sectors the further growth in the proportion of users of individual motorised transportation is more than likely.

According to **hypothesis 4**, *in cross-border community transportation, the development of the cross-border transport relations following the Karlsruhe model between the neighbouring and cooperating regions of two eastern EU member states is blocked by several specific factors.*

As regards the city of Debrecen in the target area and the neighbouring Oradea in Romania, authors of the relevant pieces of literature expect the strengthening of the cross-border attraction of the two regional centres in the border area and the appearance of the concomitant demand for mobility in the middle run (Pénzes, 2013).

The evaluation of the application of the Karlsruhe model in the French–German border region demonstrated that the financing of the international regional transport services is not exempt from problems even at the Western borders of the Union. The analysis of the situation of the Hungarian–Romanian community transportation

revealed a number of further obstacles for the organisation of international passenger transport in the region.

The biggest difficulty in relation with the quality of the services is the interruption of the continuity of the transport networks at the border and the concomitant lack of infrastructure connections. The quantity of services offered by the existing network elements in the region is low by international standards and serves the long-distance transport demands more than the regional ones. Looking at the issue from the side of tariffs, the fares in international transport, exceeding the domestic ones, do not make community transportation attractive for potential passengers, either. According to the surveys conducted, a number of further institutional and information factors set back cross-border community passenger transportation.

The biggest obstacle, however, was identified by the findings of the questionnaire survey. The majority of the settlements served by the transport lines are in the vicinity of the border, along Line No. 105 three pairs of trains run daily to Romania. Despite this, only approximately one-sixth of the respondents of the questionnaire survey travel to the neighbour country for whatever reason, two-thirds of them cross the border less frequently than once a week. The draft analysis of the economic and social processes in the border region, however, also revealed factors suggesting a growth in mobility demands in the future.

To summarise the thoughts above, the processing of international and Hungarian literature, the analysis of statistical data and the findings of the empirical surveys verified the preliminary hypotheses of the dissertation. On the basis of the statements concerning the hypotheses and the professional views stated by the prominent experts interviewed, the *following recommendations can be made* for the adaptation of the Karlsruhe model to the target area:

1. The *organisational frameworks* of the application of the Karlsruhe model in the peri-urban areas of Debrecen were *created* by Act No. XLI. of 2012 on passenger transport services, by the introduction of the institution of *transport organisers*. For the *actual cooperation* of the local and regional actors of community transportation, however, *financing conditions promoting the integration* of the urban and peri-urban community transport *services* must also be created, by making further *decisions on the regulation of transportation* at the state level.
2. During the *transformation of the frameworks of national financial regulation* related to developments and the use of services, the *definition of directives for*

sub-sectoral priorities is an absolute necessity, in order to allow a more effective use of public funds spent on public services. *On the basis of this it will be possible to create a service model to be applied in the peri-urban areas of Debrecen*, after the further detailed analysis of the networks and the arising demand for mobility, and also after making the feasibility calculations of the investment and operational costs of the different transport means.

3. In order to *achieve the improvement in the quality* of transportation services expected both by the users and the contractors of the services, the *reconsideration of the application of discount fares by social policy consideration* in the peri-urban segment seems to be an obvious solution, with the *re-grouping of the public funds saved this way to the area of services development*. This requires the reconsideration of the relevant state regulation and a preliminary survey on the social impacts.
4. For the *provision of the expenses* of track-based infrastructure developments and the procurement of the rolling stock related to the Karlsruhe model, *resources at the national level*, similar to those in Germany, are *not available in Hungary*. Financing of the investments related to peri-urban and regional transportation systems in the researched area may take place from the *European Union resources* planned for the 2014–2020 budgetary period. For Hajdú-Bihar county, in addition to the regional and cohesion supports, *resources for cross-border infrastructure developments of the Hungarian–Romanian border region* will also be available in the budgetary period concerned. On the basis of these facts, during the further analyses concerning the application of the Karlsruhe model in Debrecen a *selected focus* should be placed on *researches of the railway lines No. 105 and 106*, serving the border region – and analysed in-depth in the dissertation.

5. NEW ACADEMIC ACHIEVEMENTS OF THE DISSERTATION

1. A multidisciplinary processing of the Hungarian and international literature on infrastructure, the organisation of community transportation services and urban development.
2. The organisational, regulatory, financing and technological prerequisites of the Karlsruhe community transportation model were analysed; also, the impact of the realisation of the model on the factors of mobility and competitiveness were assessed.

3. Focusing on the success factors of the Karlsruhe model, an academic analysis of the peri-urban, regional and cross-border community transportation features of Debrecen and its catchment area was made, complemented with empirical studies.
4. On the basis of the comparative analyses of the thesis I demonstrated that sub-urbanisation-related demographic and economic processes characteristic of the Karlsruhe region are also present in the suburbs of Debrecen; however, the framework conditions of transport organisation necessary for the satisfaction of the extra transport demands generated by these processes are missing.
5. A database operating with new methodological aspects was created on the basis of empirical researches done for the mobility features of more than six hundred passengers using six peri-urban bus lines and two railway lines of Debrecen.
6. Using the experiences of the Karlsruhe model and the findings of the interviews made with prominent persons, new transport regulation and financing recommendation, never applied before, were made for Hungarian peri-urban transport organisation.

6. APPLICABILITY OF THE RESEARCH FINDINGS IN PRACTICE

1. The dissertation, in addition to providing researchers dealing with the topic discussed with relevant information, will be a guideline utilisable in practice for the professional and political decision-makers involved in the preparation and implementation of transport development projects planned in the peri-urban areas of Debrecen.
2. The methodology applied in the dissertation will be applicable in the exploration of the problems of peri-urban community transportation in other big Hungarian cities as well as in the elaboration of possible solutions.
3. The database gained by the processing of the information of the timetables and the questionnaire survey may serve as a starting point for those responsible for the contracting and provision of the services in the planning of peri-urban transport organisation and service development interventions.

7. SUMMARY

The Karlsruhe model is an adequate and efficient transport management solution in the transportation hinterland of the German city Karlsruhe, as a response to the changes in mobility induced by the spatial processes linked to urbanisation. An important prerequisite for the implementation of the model, however, was the regulatory, organisational and financing regionalisation of community public transportation service.

A basic goal of the thesis was to look at whether the same processes have taken place in the peri-urban area of the city of Debrecen and if so, how the Hungarian system of public transportation services has adapted to the mobility demands of those moving out from the county centre. In addition, the author wanted to find out whether the introduction of the Karlsruhe model was necessary and reasonable in the area in question, on the basis of the processes going on in Hungary.

In line with these goals, to supplement the multidisciplinary processing of the relevant Hungarian and international literature, the Karlsruhe model was also analysed beyond the technical-technological aspects. These analyses were greatly promoted by the economic reports, public service contracts and researches on mobility made available by the Karlsruhe Transport Association (KVV) and the City of Karlsruhe. The findings of the researches clearly supported that the success of the model is due to much more complex correlations than the mere integration of national and urban railway lines.

The economic and financing success of this solution would have been impossible without the simultaneous appearance of the need for extra mobility generated jointly by the spatial rearrangement of the population in the Karlsruhe region and the increase in the number of population, the regional financing resources compensating for the economic disadvantages of the cooperation of the service providers, and the introduction of a market determined tariff system built on business policy discounts. The basis of the predictable organisational functioning is provided by the three-level transport association model built on the regional level cooperation of users and service providers, allowed by the regulatory environment created by the federal state. The increase in the number of passengers was primarily due to the demand-driven timetable including quality focused, integrated single services.

On the basis of the examination of almost 20 years of statistics related to the demographic, economic and living conditions indices of the settlements in the peri-urban areas of Debrecen it became clear that changes in the mobility typical of suburbanisation are also present in the area in question, although with lower intensity

and spatial scale than in Karlsruhe. The analysis of the legal regulations of the sector, however, is a proof of the fact that the Hungarian framework system of transport management has adapted less to the new challenges and it shows significant differences compared to the background of the Karlsruhe model.

During the period in question, organisational and financing centralisation remained intact all the way in Hungary, as did the strict separation of urban and extra-urban services, the lack of consumers at regional level and the dominant role of state- and municipal owned service providers. The tariff system is based on regulated tariffs, supplemented with central support on social policy grounds for a considerable part of travels, and the management of the service providers is based on central state support.

The analysis of the changes in the supply offered by the transport sub-sectors of the area, also in a 20-year period, and the passenger counting sessions pointed out that the needs for peri-urban mobility coming from suburbanisation can be met primarily by road transport, given the centralised circumstances of transport management. As the more flexibly manageable bus transportation followed the changes in the transport demands all the way in the research period, the supply features of the settlements preferred by the out-migrants improved proportionately to or more than the increase in the number of population, also, the capacity utilisation of lines improved.

The quantitative expansion of railway traffic, on the other hand, primarily took place in the case of travels outside the growth poles of urban and peri-urban transport demands, in addition, the quality of the services has not improved tangibly, because of the neglected preservation and developments of the railway tracks and the rolling stock. This led to the under-utilisation of the capacities in some places. The faster adaptation of road transportation was also promoted by the fact that the road transportation company named HAJDÚ VOLÁN Inc., due to its county level organisation and service area, is in more direct touch with the users of transportation than the railway company, MÁV-START Inc. that has a national level organisation and range of services.

The results of the secondary data processing and content analyses were complemented by the empirical researches of the dissertation. The participants of the in-depth interview sessions reinforced the presence of the mobility impacts of suburbanisation in the area and also the assumption that the implementation of the Karlsruhe model, the progress of transport management at urban and peri-urban level is blocked in the first place by the financing and regulatory frameworks. Although the judgement of the Karlsruhe model by the interviewees is definitely positive, their main priority is not the adaptation of the exact transport organisational model but the

transformation of the system of financing in a way that creates the possibilities of a quality centred service development.

The importance of quality improvements is suggested by the conclusions of the questionnaire survey done with the users of the peri-urban public transport, too. Significant differences between the expected and the actual values of quantitative and qualitative parameters of services can be seen especially in railway transport, which, supplemented with the information related to the habits of car use, suggest that there is a risk of passengers shifting to individual motorised transport, if no development interventions are made.

On the basis of this, in order to prevent the social and economic costs of individual transportation, it seems necessary to make national level decisions on peri-urban transportation which give regional actors more freedom in strengthening local cooperations, the allocation of resources available for quality improvements and the definition of division of labour in public transportation. The issue of the applicability of the Karlsruhe model can only be raised afterwards, besides taking into consideration the existing transportation networks and the local circumstances of the services, after the detailed cost analyses looking at development and maintenance expenses of each respective sub-sector.

The application of the model in Hungarian-Romanian cross-border public transportation does not seem to be a realistic option even in the middle run, considering the blocking institutional factors identified in the dissertation and the low level of demand for the services. Taking the potential tenderable resources and the advantages coming from the economies of scale into consideration, however, the theoretical chance of the implementation of the model must be kept in mind in long term strategic planning.

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