M Ű E G Y E T E M 1 7 8 2

BUDAPESTI MŰSZAKI ÉS GAZDASÁGTUDOMÁNYI EGYETEM
KÖZLEKEDÉSMÉRNÖKI KAR

ISTVÁN PÁLYI

ECONOMIC MODELLING OF RECONSTRUCTION OF NETWORK OF RAILWAY PASSENGER TRAFFIC BUILDINGS, WITH SPECIAL REGARD TO PROTECTION OF HISTORIC BUILDINGS

Summary of Theses

Consultant:

Professor dr. habil. Péter Várlaki

Holder of Doctor of Technical Sciences Degree

of Hungarian Academy of Sciences

Budapest 2008

1. Introduction

The aim of the research: This dissertation investigates the infrastructure of Hungarian railway passenger traffic buildings representing considerable values in technical, economical, industry-historical and culture-historical fields. With this end in view comprehensive investigations will be carried out in the following fields:

- Structural analysis
- Economical analysis
- Analysis of a complex database, and
- Mathematical analysis.

The actuality of the issue is justified by the necessity of renovation of railway passenger traffic buildings that are in bad state of repair. On the other hand, since these buildings can also yield certain services and are re-utilizable, this issue has several economical aspects.

The subject-matter needs an interdisciplinary approach, several special fields are involved in the investigations, so the research is important also from the point of view of national economy. I used 130 literary sources during my investigations. Some of them are especially important. On the field of history of architecture of old Hungarian railway stations, railways and on forming railway and construction standard planning, work of fundamental importance was done by M. Kubinszky [1, 2, 3], railway buildings, their moral and physical outdating were investigated by T. Erdélyi [4]. Investments, properties and the corresponding qualitative data were investigated by K. Tánczos [5, 6, 7], and J. Pálfalvi [8, 9]. I relied on works of P. Havas [10, 11] concerning restoration processes. Effects ensuing from modernisation of safety appliances were investigated by F. Parádi and his colleagues [12, 13]. Up-to-date transportation-mathematical counting methods were given by Kövesné É. Gilicze and her colleagues [14, 15]. One of the most efficient tool for finding the optimum of objective functions in economical phenomena is attached to R. Bellman's name [16, 17, 18, 19]. A great number of important results were found in the field of approaching optimizations by combinatorial, matrix theoretical and game theoretical methods, and a considerable part of these results belong to Hungarian mathematicians: J.C. Kemény and J.L. Snell [20], D. König [21], J. von Neumann and O. Morgenstern [22], G. Pólya [23], P. Várlaki and I. Magyar [24]. I gained a new view of modelling large-scale nonlinear transportation networks by studying works of T. Péter and J. Bokor [25, 26]. In the (Hungarian) title I considered the (somewhat obsolete) word "indóház" suitable to make historical aspects perceptible. I regard the proper collection of features characterizing this topic as an important piece of work. With the aid of the necessary database the systematization of the main elements can also be done.

This research attempts at the same time to resolve a contradiction in the present Hungarian situation that concerns essentially the following three domains:

a) In so far as the investigations are based exclusively on traditions (e.g. on the maintenance of buildings) and are trying to mediate value in such a way, the fundamental changes of economical environment in the era of globalization will be left unanswered.

b) The fact must also be taken into consideration that railway passenger traffic buildings are in key position, fulfil a basic function in persons' change of place, but these buildings are not in every instance protected as listed historic buildings.

In such cases the imperfection of renovations will affect economical efficiency through the poor quality of service.

c) Finally, a third case ought to be considered as well, namely that of reusing these buildings, which can be partial or full reutilization.

This research also surveys international results, and considering these cases wants to cast light on a broad-scale possibility of practical exploitations. International examples can show how to

make good use of the available resources in a properly working environment – even if these resources are limited.
The nonlinear optimal cost sharing model discussed in the dissertation is applicable for all the three cases above (with the appropriate definition of profit). The objective function prescribes always the maximization of profit. The limiting condition stipulates that the limited nature of resources should be taken into account. Finally, the mathematical method ensures the achievement of the goal set by the optimal sharing of costs. With this approach the solution of the economical task can get into an up-to-date financing environment. With the financing solutions also new duties can be brought into the system, in cooperation with private capital (so-called PPP solutions).

2. The actuality of the research topic

Railway passenger traffic buildings represented in the industrial development of historical Hungary considerable technical and architectural historic monument value. Their reconstruction, preservation and re-utilization is a culture-historical task of vital importance. This task is accompanied by the necessity of improving the image of Hungary and of continuously developing and increasing the attractive force of tourism. Last century brought about adverse circumstances for these nice industrial architectural works. Many of them were destroyed in vicissitudes of the war, others were though rebuilt, but lacking expert reconstruction. The rest, railway station buildings – passenger traffic buildings – that can be reconstructed make up, however, an important part of the treasury in Hungary's history of architecture.
Railways are continuously functioning special institutions, they cannot even temporarily be suspended. The results of this special situation can well be observed in the state of repair of buildings: the signs of moral and physical ageing appear depending on the period of construction.
Ancient structures, though, are more lasting, durable, and observing newer buildings we might ascertain that the closer the edifice to our days is the less durable it is in comparison to buildings of old times, and that means that no matter exactly how old the buildings in question are, **they by all means need action.** Reconstructions of damaged buildings made in the post-war post-haste work provisionally repaired the stock of edifices, but the level and proper finish of these repairs – understandably – did not meet the requirements that could have been expected. Realization of this situation led to a widely desired and accepted attitude: PROTECTION OF HISTORIC MONUMENTS. This meant a new quality level, and having successfully been applied on other fields of life, care of historic buildings became indispensably necessary also within MÁV Co. (Hungarian State Railways Private Company by Shares).

3. Methodology of the research

<u>3.1. Structural aspects of my investigations</u>
My dissertation investigates *the special process of creating the one-time railway passenger traffic buildings in order to form the optimal reconstruction strategy of these.*
It also sums up the peculiarities and characteristics of the structure of Hungarian railway passenger traffic buildings touching also upon industry-historical, railway, and legal aspects.
In my treatise *I investigate the question of preservation of buildings, the maintenance of function and of cultural heritage, and also the problem of switching over to a new function, respectively. I will investigate the module-type standard design applied at establishing the*

one-time railway stations and the possibility of taking this module-type standard planning into consideration when forming the optimal reconstruction strategy.

3.2. Database relations of the research

In my work *I investigated the possibility and the possible system of creating a dynamic database necessary for the optimal renovation strategy of railway passenger traffic buildings. My goal is to enable this database to handle large quantities of complex information materials (figures, texts and numerical data), furthermore it should serve as a base for the ARCHICAD program and for optimal planning strategies.*

3.3. Optimization aspects of the research

In the dissertation *I worked out a nonlinear optimal cost sharing model for the optimal reconstruction strategy of railway passenger traffic buildings. The method takes into account the limited nature of the available resources. I set the aim that my method should yield a very quick optimal cost sharing solution for the reconstruction strategy even in the case of a great number of railway station buildings, because it is important that the investigation of a great number of strategic variants, respectively substrategic analysis be feasible before making a decision.*

3.4 The more important questions examined in my investigations, which are indispensable for the complex analysis

1. *How many old railway passenger traffic buildings wanting renovation or reconstruction are there really in Hungary? What is the average value of such a railway station building?*

2. *What should a reconstruction consist of? (Edifice, technical appliances? Full or partial exchange of front-elevation to preserve characteristics? How to solve problems of interior design?)*

3. *How large cost does the renovation of one railway passenger traffic building carry and what items do the total expenses consist of?*

4. *What sort of national assets would go wasted if the renovation failed to come about, and what will the nation gain if the renovation occurs?*

5. *How does the reconstruction affect tourist trade, nostalgia journeys and other technical and industrial relations?*

6. *What kind of reconstruction strategies can be reckoned with? (Scope of buildings to be renovated? Which of them should reasonably be the first one to start with? Which one should be the next suitably fit to continue with? The expenses and necessities are decisive, respectively, also the question, what profit do the individual renovations bring, carried out partly or fully, respectively, which are to be taken into account in the strategy, too.)*

7. *What sort of mathematical models can be relied on for planning an optimal reconstruction?*

4. Scientific results of the treatise

<u>1. Thesis:</u> For shaping the strategy for optimal renovation of railway passenger traffic buildings I examined the special process of forming and creating these buildings.

I ascertained the peculiarities of the structure of railway passenger traffic buildings in Hungary, the qualitative and quantitative characteristics of this structure, touching also upon industry-historical, railway, and legal aspects, as well as upon network and economical characteristics [3. P.I.], [5. P.I.], [10. P.I.].

<u>T.1.1. The process of development and establishing of railway station buildings</u>

From the start of railway construction in Hungary (1846) till the Compromise of 1867, during 21 years, a railway network of 2,341 kilometre length was built. During the following half a century this length grew to almost the tenfold, i.e. to 22,870 kilometres by 1918. Taking the statistical average, the distance between stations was defined to be cc. 15 kilometres, which means that on the territory of Hungary at that time about 1500 railway stations were built until the First World War. By the help of statistics again, we can estimate the built-in volume as being about 3 million cubic metres. The architectural task of constructing the buildings of the above measurement is equivalent to the task of bringing about a medium-size town of 50,000 inhabitants during half a century. It is easily seen that these buildings (railway passenger traffic buildings) even by their order of magnitude were of special importance within the cc. 35,000 piece stock of buildings of MÁV.

After the end of Word War I, instead of the earlier mentioned 22,870 kilometres, according to statistical data published in 2001, there is a 7,784.8 km long line of rails in the possession of MÁV Co., about 150 kilometres in the possession of GYSEV in Hungary today [27]. As compared to this, the length of railway line tracks (of standard, wide, narrow gauge) is 9,077.2 kilometres, in connection with this the length of tracks is altogether 12,866.7 kilometres. A whole-range survey and summation on the number of railway station (passenger traffic) buildings is not available at present, but they can be estimated with great preciseness to be 900, and that means that they are at an average distance of 8.66 kilometres from each other. This average length is almost the half of the 15 km index number before the First World war! This might be due to the fact that certain settlements along the railway, where the train earlier did not stop, nowadays have railway station buildings. But the estimated number does not mean that the train stops only at 900 places, since there are even now such railway stops, where there is no railway station building (railway passenger traffic building).

<u>T.1.2. The qualitative characteristics of the structure</u>

The features and individual characteristics of a railway station building as an edifice: Owing to the peculiarities of the railway, the edifices – railway station buildings, railway passenger traffic buildings and railway yards in general – were usually not built in the middle of the cities, on the contrary, they were built on the tangential parts of the settlements.

They had to be established in such a way that the life of the settlement be disturbed in the slightest possible degree. Namely, train transportation used to be not only noisy, but earlier also especially environment polluting as a consequence of the large amount of soot, smoke and carbon dioxide emitted by steam engines. A train cannot take part in urban traffic as it is a vehicle unable to make any defensive movement and unable to overtake as well, quite the contrary, it everywhere needs advantage, so it can run only on a protected railway line specially supplied by barriers. (The only exceptions of this rule are the main railway stations of the largest cities, as e.g. the Eastern, the Western and the Southern Railway Stations in

Budapest, which were built in the central, inner parts of the city.) This localization was not explicitly disadvantageous, because it ensured the establishment of location of industrial investment based on railway transport. All these brought about also the drawbacks, since these industrial surroundings often showed the sad signs of a city district turning into slums.
No wonder that in this situation prejudices were formed, in consequence of which it is difficult to explain and protect the historical significance and visual value of this kind of edifice. In contrast to these, railway station buildings standing alone in an impressive landscape are in a better position. The majority of both types, however, are equally worth protecting.
Passenger traffic building: The railway passenger traffic building plays an important role in departures and arrivals. Passenger transport, arrangement of passenger traffic is the most sensitive process of transport activities of the railway. A passenger turns up exclusively in the passenger traffic building and its rooms, so their adventures and experiences are attached to this building. Hereby the opinion of a passenger is formed by his/her experiences in the passenger traffic building – apart from the experiences during the time spent in the train.
For this reason are these buildings – unlike all the rest of railway buildings – outstandingly important establishments:

- The only type of edifice which is in connection with the travelling public.
- Its system is complicated, its functioning is complex, it cannot be classed exclusively among the buildings of a single special service.
- It stands on the separating or connecting line, resp., between the settlement and the railway, owing to its wall-composing role it is an important public building of both the settlement and of the railway.
- The railway station (passenger traffic) building is the crucial element of the connection between the settlement and the railway and that function points beyond the building.
- According to the building-site plan the railway station building adjusts itself to the requirements of railway line network from the railway side of the building, while regarding from the settlement side it constitutes the proper closing of the foreground of the railway station.

As a consequence of their importance these railway station passenger traffic buildings must be highly evaluated knowing the relationships (connection of passenger traffic, of railway track network and of settlement), and with respect to protection of historic buildings the preservation of their value must continuously be carried out.

The emergence of railway station building as a specific edifice: The formation of a railway station's look took place along with the establishment of railway architecture. The railway is a "hazardous industry", therefore the railway sums up the regulations in trade instructions. The construction of buildings must be guided by the instructions even when these regulations would hinder the best architectural solution. In the course of construction, however, the railway's appearance is shaped in practice so that each separable building complex has a main building, beside or around which the further buildings are settled (as e.g. on a passenger railway station the admission building is the main railway station building, on hauling (traction) premises it is the locomotive shed. The group of buildings of passenger railway station excels from the building complexes. Its ruling element is the admission building – the railway passenger traffic building – which is the most important building of the station foreground regarding its measurements and architectural shaping. A considerable part of railway buildings satisfies such special requirements which do not occur in generally known buildings. Their construction, however, can be carried out exclusively complying with the strict instructions and special regulations.

Regulations and architectural instructions: The construction must comply with the force of double regulation. General stipulations were contained in the so-called all-Hungarian building acts in the earlier decades. In our days National Settlement and Building Requirements (OTÉK)'s system of regulations enforces the general stipulations (Government Order No. 253/1997 (XII. 20.)), also on nationwide level, but under other name. The specific regulations, on the other hand, are formed by the railway itself, and these requirements and instructions are published in a system set into a unified structure.

This double procedural order assures at the same time that the general regulations and the special authorities' regulations be enforced simultaneously. All these made it possible that those buildings of special character, by their remarkable quantity well deserving the distinguished attention of generations of the public and of experts, could be completed.

T.1.3. Quantitative characteristics of the structure

The order of magnitude of Hungarian railway passenger traffic buildings is determined by the number of passengers, and the significance of regional and of railway situation of the station.

These differences, however, are perceivable also within our railway yards accommodating the largest rate of passengers. These railway yards form two groups. The three *largest main railway yards in Budapest*: Eastern Railway Station, Western Railway Station, Southern Railway Station are of special importance. These railway stations are so-called railway terminals, and this quality in itself makes a difference. An additional characteristic of these stations is that each of them has underground connection.

Succeeding in the order of railway stations are the *focal point railway stations* of national importance, then come the *county seats' railway stations* (e.g. Zalaegerszeg, Kecskemét), and then *certain railway focal points* (e.g. Dombóvár, Mátészalka). The most important railway stations are joined by the network of lots of minor intermediate passenger traffic buildings, which altogether constitute the complex of buildings consisting of about 900 buildings from MÁV's part and of 20 independent units from GYSEV's part.

The special importance: The special importance is justified by the background of passenger traffic of Budapest's two million inhabitants – as potential passengers. Herewith the satisfaction of demands of passenger traffic derived from the number of inhabitants is more important than the railway significance of passenger traffic buildings. Resulting from this, the data of magnitude were worked out accordingly. The two largest of them (Budapest Eastern and Budapest Western Railway Stations) e.g. amount to more than two million cubic meters (together with the glass-roofed train receiving areas) in volume [4]. Passengers turn up in any of these railway stations daily in so large numbers that would correspond to the number of total inhabitants of a large country town, and this traffic is even amplified by the international passenger traffic.

The architectonic appearance, facade patterns of these railway stations have wholly and completely become part of the visual unit representing the texture of the city by now.

Railway stations with large traffic: The railway stations with the largest traffic are all stations with transit character, being main line junctions and terminals at the same time. From among these two used to be in Budapest:

- Józsefváros Railway Station (ceased to exist in the meantime),
- Kelenföld railway station.

Average passenger traffic, admission building: railway passenger traffic building, whose size is 20–40,000 cubic meters of air, showing a striking difference compared to the measurements of the three Budapest main railway stations [4].

Their passenger traffic is characterized by the following statements:

a) They typically show local-central importance, which predominates in the attraction zone of a radius of 20–30 kms of the town.
b) Destination traffic, which is characteristic of towns of county rank, county seats, regional centres.
c) The focal point railway situation means – in addition to occupational traffic – also a transit passenger traffic, i.e. passengers changing trains towards stations along the side lines branching off or towards stations along continuing main lines.

The importance of focal point stations is verified by the regrettable fact that the railway passenger traffic buildings destroyed by bombs during the war destructions had to be rebuilt after the end of the war. In the course of rebuilding new edifices of a volume of about 200,000 cubic meters of air came into existence. Among them products of soc-real, traditional and modernist architectural endeavours can equally be found [4].

> *2. Thesis: I determined specifically the economic aspects of an optimal reconstruction strategy for railway passenger traffic buildings. I analysed the problem of maintenance, preservation of function, care of cultural heritage, and also the possibility of adapting these buildings for a new function, with regard to industry, commerce and tourism.*
> *I pointed out that considering module type planning applied at the construction of one-time railway passenger traffic buildings involves even today special advantages when forming the optimal reconstruction strategy ([7. P.I.], [11. P.I.], [12. P.I.]).*

T.2.1. The standpoints of the reconstruction strategy

The Hungarian State Railway Co. (MÁV) made its first own monument conservation regulations in 1987 [28]. This book of rules takes the (earlier completed) monument conservation decree covering the whole country as its starting point, and adds the peculiarities following from the characteristics of the railway. With this far-reaching procedure MÁV accomplished a exemplary task, since apart from the above mentioned nation-wide regulation there is no system of requirements of similar character.

The protected buildings of the railway:

1. Listed historic buildings (all-Hungarian)
2. Buildings enjoying local protection
3. Historic buildings enjoying railway protection

Types of buildings	**Degree of protection**					
	Nation-wide listed historic building			**Local protection**		**Railway protection**
	M I.	**M II.**	**M III.**	**FM**	**HV**	**VM**
Admission buildings	3	7	2	4	9	64
Other operative buildings		2		1	1	15
Non-operative buildings	1	2		1	1	1
Residential buildings						3
Altogether	4	11	2	6	11	83

Abbreviations used: FM – capital city protection, HV – other local protection, VM – railway protection

Table 1: *MÁV Co.'s buildings divided according to their function and type of protection (source:* Sínek Világa, *vol. LXIV, no. 179, special issue of 2001, p. 6)*

According to the "Act on Protection of Cultural Heritage" (no. LXIV, coming into force on 8th October 2001) are the buildings classified in the first (M I) group into the nation-wide list of monuments:

1. Budapest Eastern Railway Station admission building (railway passenger traffic building)
2. Budapest Western Railway Station admission building (railway passenger traffic building)
3. Gödöllő Railway Station former royal waiting hall (railway passenger traffic building)
4. Former Károlyi palace at no. 11 Múzeum street, Budapest, 8th district.

11 buildings belong to category M II, 2 buildings belong to category M III, among them there are 9 railway passenger traffic buildings. Buildings under local protection were placed into this category by the FVM decree no. 66 declared on 13th August, 1999. This category contains 17 railway buildings, among which 6 enjoys the protection of the capital city, and the number of admission buildings – railway passenger traffic buildings – is 13. Finally, there are 83 buildings in the third group. This is a large number, these buildings were qualified into this group by MÁV Co.'s monument conservation regulations coming into force under no. 109.199/1987. According to the corresponding special literature this number was originally 91, but in the meantime one of them was destroyed, 2 were sold, while 6 were deleted from the list. (Source: MÁV Co.'s protected admission buildings, *Sínek Világa,* vol. LXIV, no. 179, special issue of 2001, p. 7.)

The influence of processes after the change of regime (1990) on the protection of railway's architectural assets (privatization – transformation of organization – technical development): The impact of technical development on the railway brings about indisputably major changes within MÁV Co. as well. *As a result of modernization several buildings became superfluous in Hungary, too. Large railway stations in towns built around the turn of the 19th and 20th century (Szombathely, Kaposvár, Pécs), the office block on the Pécs Regional Directorate, and large workshops, as for instance the Eiffel workshop of Northern Vehicle Repair Workshop, respectively, could be taken into the nation-wide list of historic monuments [29].*

T.2.2. Aspects of the renovation strategy and the functionality

The fate of railway buildings: The fate of railway buildings is well-defined, but we can also say that their lot is by no means identical. Admission buildings, passenger traffic buildings – where the railway is still functioning – have to stand on the alert waiting for the train, while the fate of certain, by now not absolutely necessary buildings (as e.g. well house, watchman's shelter, interlocking tower etc.) can be predicted, as soon as they lose their functions.

The liquidation of the world of old-fashioned scattered, isolated farms had proceeded at a great pace, so the small railway stations which once had served also as regional centres for detached farms lost the greater part of their – otherwise not too big – passenger traffic. Saving values and abolishing junk is not only a cultural interest but also national economy's best interest. Experiences acquired until now show that only a complex reconstruction based on suitably comprehensive plan established with the help of creative powers and resources can lead to the desired result.

The MÁV Co.'s building maintenance and restoration strategy: After taking stock of MÁV's building assets the tasks of maintaining these properties were determined within the framework of the organizational modernization already in 1977. The divisions had to solve basically two groups of jobs [4].

1.) Within the frame of planned maintenance the restoration, renovation, and capital repair of buildings – railway passenger traffic buildings – have to be carried out. At the same time the state of repair of buildings must be preserved, deterioration has to be prevented, moreover the level of the buildings' condition has to be increased.

2.) In order to ensure satisfactory operation and operational safety, the necessary jobs have to be done out of turn.

For carrying out the arising jobs, however, it is absolutely necessary to know the basic dimensional and qualitative data concerning the possessions. According to approximately precise surveys, the proprietor (by former name: PHMSZ, Special Directorate for Railway Tracks, Bridges and High Structures) was in possession of nearly 13 million edifice cubic metres of air of building stock. In addition to this, a further 6.0 million cubic metres of air volume of buildings are maintained by the maintainers themselves.
The whole stock of edifices of MÁV Co. includes 33,000 buildings and structures, which means cc. 400 cubic metres of air for an average structure.
The qualitative index – determined mainly by the age of a building – may be even more important, and on the basis of this index the following classification can be elaborated [4]:

1st age group -	built before 1900	**26%**
2nd age group -	built between 1900-1914	**13%**
3rd age group -	built between 1914-1945	**19%**
4th age group -	built between 1945-1965	**23%**
5th age group -	built after 1965	**19%**

Table 2: *Railway building assets classified by age (dr. Tibor Erdélyi: Vasúti épületek (Railway buildings), Műszaki Könyvkiadó, Budapest,1983, pp. 88.)*

The major part of the restoration job is made up by the third age group (these buildings quantitatively represent a significant proportion, what is more, their state of repair is remarkably poor), while in case of buildings older than those the most important task is keeping the level of state of repair and warding off danger.
The systematic maintenance-restoration system of the railway company can be either
- linear or focal point maintenance-restoration system (non-typical method), or
- maintenance-restoration recurring in cycles (typical method) [4].

It is the cyclic method that is worthwhile to deal with, since cyclic restoration occurs at about 33 year intervals and its main characteristic is the maintenance-restoration with capital repair. 3% (breaking down to years) of the building stock belong here, and for a building, when it comes to its turn, such a restoration may even mean complete reconstruction.

Cases of cyclic renovation:
- Sorting out without substitution:
  The building became morally and technically (physically) completely obsolete, its function ceased, replacement is not necessary.
- The function of the building ceased to exist:
  The building's state of repair is still adequate, its utilization can be considered in another manner, with a capital repair.
- The function of the building remains the same.

Economical aspects: The determining factors of economic aspects are moral and physical obsolescence [4]. The decisive factor can, however, be generally deduced from establishing the fact of physical deterioration. *In a peculiar way, after throwing light on physical outdating also the requirements connected with moral outdating come to the surface.* This happens because the judgement of the situation is greatly influenced by individual opinions and by circumstances.
The railway company is in an unusual situation, since the buildings set up by it have to be maintained by the railway company itself, while it is not possible to make manoeuvres with

them on the real estate market. So problems of economic efficiency are raised – unlike in the average cases – in a much wider connection.

Aspects of economic character during establishing and life cycle of buildings arise in relation of:

- railway operation,
- construction and
- maintenance [4].

Operational impact consequences of railway operation can be wide, and can influence e.g. the theory of proportional development, too. The economic efficiency index of the construction depends, however, greatly on the measures of the building, on the mechanisms of the building, and on the quality of materials used. Although erecting a building is an activity happening once, but the imperfections of it will show up permanently in later times.

Building – renovation – maintenance: *Accomplishing railway buildings and their subsequent maintenance, renovation, restoration and reconstruction with special regard to monument protection requirements imply entirely purpose-made jobs.*

The effect of cultural heritage and protection of historic buildings on renovation and reconstruction jobs: In conformity with processes of the European Union the developing of railway and evolving a passenger transport of high standard have come again into the foreground also in Hungary. *New services have come out as well: along MÁV Co.'s and pan-European traffic corridors and along trunk network lines the network restoration has started.*

In the ready program there were originally 25 railway passenger traffic buildings included. 5 among them are nation-widely listed historic buildings, 2 enjoy local protection, 5 are recorded as railway historic buildings. Three years later, in 2001, this program was completed by 8 buildings, among them 2 listed historic building, 2 are railway passenger traffic building protected by the railway company. *This renovation program of railway passenger traffic buildings is unprecedented in MÁV's history, and it necessitates a thorough monument-protection preparation. In the course of the preparation it is indispensable that erudite documentation regarding each protected building be made.*

The 2001–2010 restoration program of the most important railway passenger traffic buildings awaiting renovation: *Certain aspects had to be kept in mind: What is the expectation of the society? What does the society consider a success? The Company's ability of shaping the social* **"***general state of mind" had to be improved, too.* Accordingly, the restoration program of railway passenger traffic buildings was worked out in several versions.

The preservation – renovation – restoration of historic monuments, among them also listed railway buildings, railway passenger traffic buildings have been going on for decades and the success is a general interest of the society, pointing beyond the interest of the railway company.

<u>T.2.3. Tourist trade aspects of the renovation strategy</u>

MÁV nostalgia train routes and tourism: Hungarian State Railways can look back upon a 150 year long history. Based on this conception MÁV called its own railway historic park in Budapest into being. Railway relics in their old state were collected and systematized here, placed into an environment true to one-time nature. Without these museum pieces there would not have been Hungarian railway.

MÁV Co. – recognizing *the old railway's importance from the point of view of domestic and foreign tourist traffic – keeps nostalgia train routes in operation within Hungary's borders and a bit even beyond the borders.*

The four important nostalgia routes at present are:

- Budapest–Vác–Szob (beginning of May, beginning of July, beginning of September)

- Gödöllő–Bécs and Budapest
- Budapest–Esztergom (from the beginning of June till the beginning of August)
- Around Lake Balaton (from the end of June till the end of August)

T.2.4. Taking module type standard designing into consideration when shaping renovation strategy

The order of magnitude of buildings and the development of standard design: The area (ground space) and volume of the buildings express basically the measure. This parameter is indicating at the same time how much the building costs will come to. As a result of typifying, a four-class order were worked out regarding admission buildings. The general public thinks that railway edifices built in the heroic age of 19^{th} century railway construction are all identical or at least they are very similar to each other [3]. If there is a similarity, then it is the consequence of identical functional requirements. This identity of requirements and the great number of railway buildings, the repetition of tasks led on a world scale to creating and utilizing a new type of planning process, the standard design.

This can be considered as an important factor in the history of architecture related to railway construction [3]. The decisive era lasted from the beginning of railway construction to the end of World War I. The so confined subject matter will hopefully trace out this – often neglected or disregarded – form of our architectural traditions. On the other hand, this subject matter concerns also the important range of problems of *protection.*

On the buildings classified into categories from I to IV we can study witty examples of easily available development and extension. (A perspective view of admission buildings of MÁV's routes of local interest. M. Kubinszky: Régi magyar vasútállomások, Old railway stations in Hungary, Corvina Kiadó 1983, p. 52.)

As to the development of the designs, it is more and more noticeable that the designers endeavoured to make a picturesque impression. This trend results in quite eye-catching, unique appearances in case of the first class versions (as e.g. the railway passenger traffic building in Veszprém, built in 1896). *Taking standard design into account offers special advantages even nowadays, when we form our optimal renovation strategy.*

The "great ones" above categories: First ones in the row are the three main railway stations in the capital city, indicated by the points of the compass. Around the turn of the 19th and 20th centuries Hungarian State Railways built its new railway passenger traffic buildings and representative admission buildings on major settlements and railway junctions in place of old railway station buildings already with a more modern attitude. *Not only in Budapest, but also in the country all the important railway stations not destroyed by the war are even now able to fulfil remarkable role in shaping the view of a town. This role, however, needs further enhancing by the effective tools of monument protection.*

> 3. Thesis: *I worked out the system of a dynamic database for optimal renovation strategy of railway passenger traffic buildings. This is suitable for and able to handle the great amount of (figures, textual and numerical) complex information material which is needed for strategic calculations, furthermore, it serves as a base for ARCHICAD and for the optimal planning programs [1. P.I.], [2. P.I.].*

It must be taken into account that the planning of architectural reconstruction in the fields of industry and transport has developed with a stormy speed compared to earlier ages in the past decade. This makes the application of modern information technological methods indispensable.

I created quickly manageable and improvable databases for storing masses of data of railway passenger traffic buildings. These are suitable for working out optimal renovation strategies, and are also able to supply such world renowned programs as the planning program ARCHICAD with data. This program can excellently be used in architectural reconstruction planning on the basis of available architectural designs. Owing to the large size of the task and the dynamic change of the data, static variables are unfortunately not able to carry out the method, application of these would involve the following disadvantages:

- The size of static variables will be decided at the translation of the program.
- The size cannot be modified during the run.

Therefore, in order to use the memory effectively, it is necessary that the program itself should dynamically manage a certain area of the memory. The essence of this:

- When we need area of memory for any of our variables, then we reserve the memory-area and use it.
- When we do not need the reserved area any more, then we free the memory-area.

In this way we can realize the dynamic use of memory. The size of this area well surpasses the sizes of other data area of the program. *I set up a modern database relying on the object-oriented program language,* which through its file-managing works highly flexibly. *I made use of the ability of this language (being close to the language of mathematics) that – due to its dynamic data storing capacities – it is suitable to manage large databases.* When bringing about the code I went by the modern attitude, which is based on the application of objects:

1. Combination of date and code (field + method).
2. It has succession property.
3. It has polymorphism property.
4. It possesses closedness property.

This attitude offers furthermore very flexible and wide potential in further development of the database.

The system of the database: *The model postulates n railway passenger traffic buildings, and is able to store one by one the renovation costs, the expectable time factor of the renovation, the direct and indirect profit resulting from the renovation, the technical drawing data and physical parameters necessary for the planning, furthermore the workable textual information, each belonging to the respective building. The database is a dynamic chain, into which a further element of the chain can at any time be inserted.* The dynamic data areas can be managed optimally with the aid of the list structure. A record type can be used for object-oriented language realization. <u>*The list so generated is a record chain.*</u> The list consists of list elements, these contain data and a pointer pointing to the next list element.

The aim of the applied method is to ensure a very quick availability on the records created from the data of railway passenger traffic buildings. Records contain figure data, physical parameters, workable textual information etc. Data can be searched, valuated in the dynamic chain established on the heap area, moreover the chain can continuously enlarged by further elements. *The aim of the method – in addition to quick availability of data – was to establish a database necessary for optimal renovation strategy of railway passenger traffic buildings.*

<u>*4. Thesis:*</u> *I worked out a mathematical method for a nonlinear optimal cost sharing model for the optimal renovation strategy of railway passenger traffic buildings. The method applies nonlinear partial benefit functions and it takes the limited nature of resources with the Lagrange multiplicator method into account. Its application gives immediate direct optimal cost sharing solution for the renovation strategy of practically unlimited great number n of railway passenger traffic buildings. Its speed ensures that a great number of strategic variants, resp. substrategic analyses can be carried out before making a decision [4.P.I.], [5. P.I.], [6. P.I.], [7. P.I.], [9. P.I.]*

I investigated in this range of subjects the possibility of application of the elegant Bellman theorem. I found that the combinatorial method applied for the optimal distribution of the projects – although it employs the sequential solution and the Bellman theorem quite ingeniously – did not yield a breakthrough in our problem.
The number of railway passenger traffic buildings selected for renovation is denoted by n, the renovation costs determined by technical surveys in the single individual cases are denoted by $K_1, K_2, K_3, \ldots, K_n$. The allocation in the budget at our disposal for the renovation is A, where *the actual available funds are less than all the demands:*

$$A < K_1 + K_2 + K_3 + \ldots + K_n .$$

We are looking for the optimal distribution policy. Variables $x_1, x_2, x_3 \ldots x_n$ denote the unknown optimal expense values, which will denote the costs of the renovations actually carried out.
All the benefit issuing from the renovation is denoted by the benefit function $f(x_1, x_2, x_3, \ldots x_n)$ which is at the same time the objective function to be optimized (maximized). Since the benefit presents itself in each case of renovation separately:

$$\mathrm{f}(x_1, x_2, x_n) := \sum_{i=1}^{n} f_i(x_i)$$

The accurate and fair definition of partial benefit functions $f_i(x_i)$ is a fundamental question at each renovation. The partial benefit functions are monotone increasing functions bounded from above, since it is unnecessary to go above the actual renovation expenditure K_i .
We suppose moreover that $f_i(x_i)$ is a function differentiable by x_i.
The function $g(x)$ denotes the bounded nature of resources:

$$\mathrm{g}(x) := \left(\sum_{i=1}^{n} x_i \right) - A$$

For formulating the conditional boundary value problem I applied the Lagrange multiplicator method:

$$\mathrm{h}(x, \lambda) := \left(\sum_{i=1}^{n} f_i(x_i) \right) - \lambda \left(\left(\sum_{i=1}^{n} x_i \right) - A \right)$$

For describing the nonlinear partial benefit functions the following exponential function meeting the above requirements is well applicable. The coefficient $0 \le \beta_i$ occuring in the function is a parameter characteristic of the extent of usefulness x_i.

$$f_i(x_i) := \beta_i K_i \left(1 - \mathrm{e}^{(-c_i x_i)}\right)$$

Hereby I obtained a direct formula for each optimal x_i $(i=1,2,\ldots,n)$:

$$x_i := \frac{-\left(\sum_{i=1}^{n} \frac{\ln(\beta_i K_i c_i)}{c_i} \right) + A + \ln(\beta_i K_i c_i) \left(\sum_{i=1}^{n} \frac{1}{c_i} \right)}{c_i \left(\sum_{i=1}^{n} \frac{1}{c_i} \right)}$$

The similarity constant c_i occurring in the function is suitably chosen in such a way that in case of $x_i=K_i$ the function $f_i(x_i)$ should approach the value of K_i with an error of at most 1%, when $\beta_i=1$:

$$c_i := \frac{\ln(100)}{K_i}$$

The great advantage of my procedure is that it solves the complicated nonlinear dynamic programming task without numerical analysis – using a closed form – on the basis of a direct relation. Hereby it provides a result most quickly and makes the solution of unrestrictedly large problems of size n possible!
In case of

$$K_1 + K_2 + K_3 + \dots + K_n = A$$

the method trivially gives back the values

$$x_1 = K_1, x_2 = K_2, x_3 = K_3, \dots, x_n = K_n$$

but in case of an actual restriction

$$A < K_1 + K_2 + K_3 + \dots + K_n$$

already the weights β_i and expense factors K_i play a part in optimizing the benefit function.

5. The empirical utilization of the new scientific results

By the empirical utilization we should not lose sight of the fact that railway buildings are part of the railway operation, and that changes of railway architecture can also be observed from the developmental directions of the railway. This theory was maintained for a long time, until winds of changes began to blow from other directions. The changes of urbanisation raised the new interpretation of the usual connection between the railway station – the railway passenger traffic building – and the town.
First Paris served with an example that deserved attention. In the middle of the 1990-es, in the course of new theories concerning restoration of railway passenger traffic buildings, new tendencies began to spread. The essence of them was that railway passenger traffic buildings should again become liveable central territories of cities. As a matter of fact, after the end of the Second World War, during the reconstructions, generally gloomy railway stations without any characteristic feature were built. On the other hand, the existing railway stations with splendid architectural qualities were neglected in an unfriendly way, or were renovated inadequately, and so were not attractive for staying there.

- *For the renovation of railway passenger traffic buildings I ascertained the features of the structure of Hungarian railway passenger traffic buildings, the qualitative and quantitative characteristics of the structure and the economic aspects of the optimal renovation strategy.*

The data are searchable and can be evaluated in a dynamic chain, moreover the chain can continuously be enlarged by further elements.

- *The aim of the method worked out by me is to ensure a very quick availability in a large-sized database of records established from data of the railway passenger traffic buildings. The records contain data of picture, physical parameters, workable textual information etc.*

Apart from the fast availability of data, the goal of the method is to create a database necessary for the optimal renovation strategy of railway passenger traffic buildings.
I investigated in this subject matter the possibility of application of the elegant Bellman theorem. I found that the combinatorial method applied for the optimal distribution of the investments – although it employs the sequential solution and the Bellman theorem quite ingeniously – did not yield a breakthrough in our problem. It is only a smaller problem that it works with “whole” units, a more considerable drawback of it, however, is that due to the large number of railway passenger traffic buildings, it cannot give a satisfactorily fast procedure. A further insufficiency is that the actual budget at our disposal for the renovations is usually smaller in the empirical cases than all the demands, and this necessitates a conditional optimum calculation process.
I worked out the Lagrange multiplicator method, which applies exponential partial benefit functions. The main advantages of the procedure by empirical applications are:

- *It solves the complicated nonlinear dynamic programming task without numerical analysis, on the basis of direct relation, and hereby yields results extremely fast.*
- *It makes solutions of unrestrictedly large n-sized problems possible.*

I demonstrated the employment of the method through calculations concerning a factual restoration program of MÁV Co. I demonstrated the mathematical method on the distributional data of the first year of “Restoration program of MÁV’s railway admission buildings 2001–2010”. The application of the method yielded a benefit increase of 3%–33% compared to the actual cost spending.

Naturally, benefit is produced also by the reutilization, the renovation investment realizing new targets. In this case the benefit of entering new functions has to be ascertained through careful market analyses, whose outcomes can be taken into account also by the above statements when determining optimal investment costs. Hereby, new functions can be brought into the system – naturally in cooperation with private capital, by the so-called PPP solutions.

References

[1] Kubinszky Mihály: Régi magyar vasútállomások, Corvina Kiadó, Építészeti Hagyományok (1983)

[2] Kubinszky Mihály: Az 1876 és 1900 között megnyitott magyar vasutak építészetének története, Magyar Vasúttörténet 2nd vol., Közdok Kft., 1996.

[3] Kubinszky Mihály: A magyar vasút és az építési szabványtervezés kialakulása. Közlekedéstudományi szemle 6., June 1998, vol. XLVIII.

[4] Erdélyi Tibor: Vasúti épületek, Műszaki Könyvkiadó, Budapest, 1983.

[5] Tánczos Lászlóné.: Vasúti reformok és prioritások Közép- és Kelet-Európában. Közlekedéstudományi Szemle 1993, no. 9, pp. 331–334.

[6] Tánczos Lászlóné.:Versenyeztetési lehetőségek a vasúti közlekedésben - az Angol vasutak privatizációs terveinek értékelése. Közlekedéstudományi Szemle 1993, no. 10, pp. 361–367.

[7] Tánczos Lászlóné.: Az európai közlekedési miniszterek konferenciájának módszertani ajánlásai a közlekedési beruházások tervezésére és értékelésére. Közlekedéstudományi Szemle, vol. XLIV, 1994, no. 8, pp. 281–289.

[8] Pálfalvi József: A tartósan állami kézben maradó vagyon hatékony működtetésének tapasztalatai és feltételei a közlekedésben és a hírközlésben. Európai Tükör sorozat, no. 71. A Miniszterelnöki Hivatal Integrációs Stratégiai Munkacsoportjának kiadványa. Budapest, 2000, pp. 3–99.

[9] Pálfalvi József: Infrastrukturális beruházások - beruházások elemzése, kockázatkezelés, hatékonysági számítások. In: Útügyi szakmai továbbképzés: Az EU integráció közúti feladatai kiadványban. KHVM Budapest, 1999. N°7. pp. 103–119.

[10] Havas, P.: A csomóponti rendszer kialakításának lehetőségei a MÁV hálózatán. KTE előadás Budapest, September 9, 1991.

[11] Havas Péter: A globalizációs hatások és a vasúti közlekedés, Magyar Tudomány Napja 2003. Az MTA Közlekedéstudományi Bizottság ülése kibővített tudományos ülésszaka. MTA, November 12, 2003.

[12] Parádi F., Jóvér B.: Vasúti hálózatok kapacitásvizsgálata mikroszimulációval. Vezetékek Világa. Budapest, 2003/1, pp. 27–30.

[13] Hall, W. – Parádi, F.: ESTW-Simulation zur Schulung von Fahrdienstleitern. Signal+Draht 7+8/1996, pp. 12–16.

[14] É. Köves-Gilicze: Integrated transportation planning, the current state of sience. Transport Modelling Conference and Training for an Enlarged Europa at TUB. June 22–24 2005, p. 8.

[15] Kövesné dr. Gilicze É. – dr. Korchmáros G.: Válogatott matematikai fejezetek. Tankönyvkiadó, Budapest 1974, p. 204.

[16] R. Bellman: Dynamic Programming, Princeton Univ, Press, N. J., 1957.

[17] R. Bellman: Combinatorial Processes and Dynamic Programming, Proc. Symp. in Applied Math. Combinatorial Analysis, p. 217, 1960.

[18] R. Bellman: The Theory of Dynamic Programming, Bull. Amer. Math. Soc, 60. p. 503—515, 1954.

[19] R. Bellman: Dynamic Programming and Lagrange Multipliers. Proc. Nat. Acad. Sci., Vol. 42, pp. 767—769, 1956.

[20] J. C. Kemény and J. L. Snell: Finite Morkov Chains, Van Nostrand, N. Y., 1960.

[21] D. König: Theorie der Endlichen and Unendlichen Graphen, Akad. Verl. M. B. H., Leipzig, 1936, Chelsea, N. Y., 1950.

[22] J. von Neumann and O. Morgenstern: Theory of Games and Economic Behavior, Princeton Univ. Press, 1953.

[23] G. Pólya: Sur le nombre des iseméres de certains composés chimiques, C. R. Acad. Sc., 202, p. 1554, 1936.
[24] Várlaki, P. és Magyar I.: Aszimmetriák és konfliktusok a közlekedési infrastruktúra fejlesztésében. MTA Nemzeti Stratégiai Kutatási Program, 1997, p. 40.
[25] Péter T. – Bokor J.: Járműforgalmi rendszerek modellezése és irányításának kutatása. A jövő járműve, 1–2. Bp. 2006. pp. 19–23.
[26] Péter T. – Bokor J.: Nagyméretű közúti közlekedési hálózatok nemlineáris modelljének kapcsolati hipermátrixa, A jövő járműve, 1-2. Bp., 2007. pp. 16–21.
[27] MÁV Zrt. Statisztikai zsebkönyv 1996–2000 (published: 2001).
[28] MÁV Műemlékvédelmi szabályzata; 1987.
[29] Sínek világa, vol. XLIV, no. 179, special issue of 2001.

Author's scientific publications connected with the dissertation

[1. P.I.] Pályi István: Dinamikus lánc létrehozása, vasúti indóházak optimális adatbázisának kialakítására, Közlekedéstudományi szemle 4, April 2000, vol. L, pp. 125–128.
[2. P.I.] István Pályi: CONSTRUCTION OF OPTIMAL DATABASES FOR RAILWAY-STATION RESTORATION KNOWLEDGE MANAGEMENT SYSTEMS, Periodica Polytechnica Ser. Transp. Eng. Vol. 31, No. 1-2, pp. 97–105 (2003).
[3. P.I.] Pályi István: PORTFÓLIÓ-REFERENCIÁK, Author's publication, pp. 1–15 (2005).
[4.P.I.] Pályi István: INDÓHÁZAK REKONSTRUÁLÁSÁNAK OPTIMÁLÁSI PROBLÉMÁJA. Közlekedéstudományi szemle 6, June 2007, vol. LVII, pp. 227–231.
[5. P.I.] Pályi István: Közlekedési infrastruktúra rekonstruálásának optimálási problémája. pp. 1–6. Research report, BME Közlekedésautomatikai Tsz.
[6. P.I.] Varlaki P.; Palyi I.; Toth, L.; Gombaszogi, I.: Reconstruction Decision Model for Trasportation Infrastructure Systems Computational Intelligence and Intelligent Informatics, 2007. ISCIII apos; 07. International Symposium, 28–30 March 2007, pp. 163–166, Digital Object Identifier 10.1109/ISCIII.2007.367382
[7. P.I.] Pályi István: Beruházási források optimális szétosztása indóházak felújításánál. Research report, BME Közlekedésautomatikai Tsz.
[8. P.I.] Pályi István: Optimal Distribution of Investment Sources by Renovation of Railway Buildings, Periodica Polytechnica Ser. Transp. Eng. 2008, to appear.
[9. P.I.] Dr. Nádai László – Pályi István – Dr. Várlaki Péter: Nemlineáris modell, kutatás-fejlesztési források optimális szétosztásának tervezésére, korlátos források mellett, A Jövő Járműve 2008.
[10. P.I.] Pályi István: A hazai vasúti indóház-struktúra sajátosságainak kvalitatív és kvantitatív jellemzőinek vizsgálata. Közlekedéstudományi szemle 2008, to appear.
[11. P.I.] Pályi István: A vasúti indóházak állagmegőrzésének, a kulturális örökség gondozásának és új funkciókra alkalmazásának kérdései. Közlekedéstudományi szemle 2008, to appear.
[12. P.I.] Nádai L. – Pályi I. – Várlaki P.: Strategic decision making for transportation infrastructure reconstruction. Acta Polytechnica Hun. 2008.