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SPECIFICS OF THE RAIL AND ROAD TRANSPORT IN TERMS OF POSITIVE EXTERNALITIES AND THEIR VALUATION METHODS

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INTRODUCTION

This work is focused on the issue of external transport effects focusing on the positive externalities of transport and their complex analysis in context of economic evaluation of transport projects. Based on the analysis of the economic evaluation of negative externalities in transport and methods that are used to their evaluation, selected methods are used to evaluate the positive externalities in transport using case studies. Based on case studies, the road and rail specifics are interpreted and suitability of the selected methods for the evaluation of positive externalities in transport is assessed.

The first case study deals with the area of time savings valuation based on traffic-economic behavior of the population combined with the methods of willingness to pay and willingness to accept. Next case study examines the impact of the proximity of the transport infrastructure on the cost of apartments, where the hedonic price method is applied. This method most often determines how environmental factors are reflected in the market price of real estate. Next case study evaluates the benefits of the construction of transport infrastructure and its impact on changes in the business environment considering passenger road and rail transport. The latest case study looks at the benefits of improving the quality of public transport using Level-of-service rating method.

1 ANALYSIS OF THE CONTEMPORARY STATE IN THE FIELD OF THE THEME DISSERTATION

The term positive externality refers to a situation where one entity's business benefits another entity and does not have to bear the costs associated with it. From the economic point of view, positive externalities are market failures and allocation inefficiencies resulting from inaccurate ownership rights. State authorities can respond to these externalities by explicitly defining ownership rights or promoting internalization of externalities, as described by Hořejší et al. (2012).

As with rail transport, the development of road transport is linked to historical trend and development of the transport policy. At present, the greatest benefits of the road sector can generally be seen at these points (Zelený, 2007):

- door-to-door transport system,
- dense network of road infrastructure,
- high variability of means of transport,
- speed, operability and almost unlimited accessibility,
- adaptability to changes in demand,

- public transport systems in combination with rail transport,
- an irreplaceable role in multimodal transport for shorter distances.

On the other hand, the increase in popular road transport brings a number of problems to users, which are reflected in the negative cost-benefit analysis in the negative externalities. Geographically a demographically dense network of road infrastructure is often a criticized for its poor quality and neglected maintenance. In terms of positive externalities, the benefits of this mode of transport can be considered in the assessment of transport projects compared to the considered alternative modes, eg different travel speeds, availability of infrastructure and level and quality of service.

The specificities of rail transport come largely from the historical context of transport development. Tracks could lose importance over a decade, change purpose (eg, transformation of industry, strategic military requirements), or completely disappear from the point of view of economic inefficiency. Therefore, the dense railway network can be perceived by one as positive and others as dearly maintained inefficient luxury. Zelený (2007) sees the largest benefits of the railway sector in the following points:

- very low accident rates and a rare incidence of emergencies,
- elevation profile of railway track is more energy-efficient than the elevation of roads,
- high transport capacity of trains, high load capacity of trucks,
- lower susceptibility of transport infrastructure to damage due to frequent inspections,
- less dependence on weather conditions,
- traffic safety through dispatcher control,
- fast forwarding (corridor lines),
- comfort of traveling high-end trains is comparable to air travel,
- lower environmental impact (electrical traction, converted to performance),
- an important role in multimodal transport in long-distance transport.

Prentice and Mazurek (2010) divide the hierarchical framework to classify the benefits of transport to direct benefits, conditional (or mitigating) benefits, incidental benefits and tertiary benefits. These benefits are presented with a verbal evaluation or subjectively ranked according to a particular criterion. The economic assessment of intangible benefits is usually based on the best estimate or the evaluator's experience, when the so called shadow price principle is applied. Rodrigue (2017) classifies the benefits of direct, indirect, and derived.

Valuation can be divided into a pricing approach according to Blum (2008), where the value of externality is defined by the corresponding price in the private market, which in most cases is related to the costs of repair or damage, a substitution approach where the external value is defined

by the possibility of replacing the source, technology or farm, while preserving its original quality and attributes, a risk approach where the value of externality is defined by a discounted expected monetary value based on risk assessment and a utility approach where the value of externality is defined by willingness to pay to reduce negative effects.

Špalek (2005) sets out two basic ways of regulating externalities, namely public solutions that focus on bringing private costs associated with the production or consumption of a farm that negatively or positively externalize the cost of social private solutions that are related to the operation and functioning of the market.

Analysis of the issue of evaluation of positive externalities in the Czech Republic

In the Czech Republic Ing. Mgr. Hana Brůhová-Foltýnová, Ph.D deals with issues of externalities and their influence on the environment. She focuses mainly on the environmental issues of negative externalities and their internalization, both in their own publications and in publications projects of the Ministry of Transport. The problem of positive externalities is briefly discussed in "Transport and Society" by Brůhová-Foltýnová (2009). The field of external transport effects and their quantification is also discussed by Mgr. Vojtěch Máca, Ph.D. (2013) and Ing. Jan Melichar, Ph.D. (2005, 2013), both currently working for Center for Environmental Issues of Charles University.

In 2016, the Central Committee of the Ministry of Transport approved the material "Prováděcí pokyny k Metodice pro hodnocení ekonomické efektivnosti a ex-post posuzování nákladů a výnosů projektů železniční infrastruktury, pozemních komunikací a dopravně významných vodních cest", which is a binding document for assessing the economic efficiency of projects that are co - financed by OPD funds in the 2014-2020 programming period, and projects exclusively financed by SFDI fund and projects by private non-state investors co-financed from their own resources. On 15 November 2017, the "Prováděcí pokyny pro hodnocení efektivnosti projektů dopravní infrastruktury" came into force, the integral part of which is the "Rezortní metodika pro hodnocení ekonomické efektivnosti projektů dopravních staveb".

The evaluation of the economic efficiency of projects in the Czech Republic is based on the HDM-4, which has been developed since 1993 by the University of Birmingham, and its support and funding, including the World Bank, the British Ministry for Foreign Cooperation and other institutions. HDM-4 compares different investment options.

Efficiency assessment of road and motorway constructions is carried out on the basis of CBA analysis, using net present value (NPV), internal rate of return (IRR) and return on investment costs (BCR).

Current status analysis in abroad

Goodwin and Persson (2001) summarize the most appropriate approaches in the evaluation of positive externalities in “Assessing the Benefits of Transport”, but it is only a certain methodological guide, which also contains suggestions for expert discussion.

The issue of transport benefits is one of the main field area of the founder of the independent Canadian organization Victoria Transport Policy Institute, Mr Todd Litman, who is often quoted in thematic studies. For example Litman (2001) is the author of the publication "Evaluating Public Transit Benefits and Costs , Best Practices Guide".

An interesting publication is also the "Guidebook for Assessing the Social and Economic Effects of Transportation Projects" by Forskenbrock and Weisbrode (2001), which provides a handbook for US authorities dealing with the social and economic impacts of transport projects on surrounding communities.

The assessment of impacts on land prices depends on the point of view. This is demonstrated, for example, by the studies of Iacon and Levinson (2011) or Cao and Hough (2007), who present different findings and results in this field area.

In terms of use Cost- Benefit Analysis, according to OECD / ITF (2008) the Cost- Benefit Analysis - in terms of a comprehensive economic evaluation of public benefit projects – is not used so much to evaluate infrastructure-investment infrastructure projects. And if CBA assessment methods are used, they are used to evaluate smaller projects in road transport and mostly in rural areas. In these cases, the benefits of, for example, increased traffic safety are higher than travel time savings. And since funding is dependent on the nature of the project (laying new surfaces, increasing capacity, increasing safety), the focus is mainly on the cost effectiveness. The OECD / ITF publication (2008) further notes that Cost- Benefit Analysis is systematically applied in northern European countries, although they are mostly the only input of the decision-making process. In the UK, the CBA is used systematically, which together with the document the environmental impact of the project and the multi-criteria analysis presented to those who ultimately decide on the future of the project. At the same time, however, factors that are difficult to evaluate, are taken into account.

Some experts also point to the diversity of short-term and long-term objectives, underlining that policy decisions are often motivated only by short-term goals. According to Hallsworth et al. (1998) or Seidenglanz (2006) it is just a typical example of a sector in which attempts at political regulation to create unintended consequences are very vulnerable.

The dissertation thesis presents several case studies from abroad dealing with the appreciation of benefits, respectively positive externalities in transport.

Model Example 1 - Transit Improvement Economic Evaluation Model

Study *"Benefit / Cost Analysis Of Converting A Lane For Bus Rapid Transit "* from the National Academy of Sciences , Engineering , and Medicine (2009) outlines the costs and benefits of valuing transport projects in the USA, which addresses the allocation of one lane for public transport. This study provides relatively complete an idea of what benefits costs can generate transport projects focused primarily on road transport.

Model Example 2 - Benefits of Public Transport in Montreal

Study *"Public Transit: A Powerful Engine For The Economic Development Of The Metropolitan Montreal Area "* by Board of Trade of Metropolitan Montreal (2004) sought to quantify the benefits of public transport in Montreal, Canada. This study investigated the links between public transport, economic development and quality of life. The study also mentions a relatively strong relationship between rising urban public transport and increasing competitiveness and urban metropolitan agglomerations, as well as factors influencing the growing popularity of public transport.

Model example 3 - New railway line in the region

This study addresses the new railway line project, which would cost US $ 250 million, annual operating costs would be US $ 5 million, daily would attract 10 thousand new passengers, or equivalent would be 2.2 million rail journeys per year, half of which would was a substitute for automotive transport. Contrary to the rules used to assessing rail projects in the Czech Republic, the study also calculates a series of direct and indirect positive benefits that have the character of so-called wider economic benefits for the micro-region or larger territorial unit. Study of the high-speed rail project in Great Britain by The Department for Transport (2011) also includes wider economic benefits.

Model example 4 - CrossRail high-capacity rail

Crossrail is a high-capacity railroad project within the London agglomeration, characterized by a high frequency of connections. Materials by DfT (2011) and GVA (2017) report as the main benefits of the rail network decrease of congestions in London, creating reliable backbone connections, better access to investment opportunities and the generation of job opportunities.

Interesting is the interpretation of benefits that do not fall under the conventional assessment of Transport Infrastructure Projects (CBA). According to estimates, Crossrail should also raise the total cost of residential and commercial real estate near the Crossrail network. Residential object

values should increase in central London by 25% and in suburban areas by 20%, as reported by the British Ministry of Transport (DfT , 2005).

The issue of positive externalities, or the benefits of transport, has not been widely resolved in EU legislation. Greater attention is therefore still being given to negative externalities, as harmonized conditions and a methodical procedure for the internalisation of external costs in EU (HEATCO) were published. The world's most widely used HDM-4 methodology in the world basically takes into account time valuation (passenger or cargo), savings from accident, noise and noise reduction emissions as benefit considerations.

The disadvantage of CBA is that it gives space to interest groups to manipulate inputs and outputs. Often, the relevance of inputs or the exclusion of important cost aspects is also questioned. Conversely, well-thought-out, meaningful and sustainable transport projects may come up with incomplete or incorrectly-designed analysis of the benefits of projects that might otherwise have a positive influence on the decision-making process.

2 AIMS OF THE DOCTORAL THESIS

There are a number of studies dealing with negative transport externality, but only a few studies available that deal with the economic evaluation of positive externalities in conditions of the Czech Republic. The question is how methods for evaluating negative externalities in transport can be used for valuation of positive externalities and what the areas of practical application of these methods are. The following objectives were set for the dissertation:

- Synthesize knowledge related to the evaluation of negative external effects associated with transport and assess the possibilities of using these methods to evaluate positive externalities.
- Create suggestions for using selected methods of evaluating negative externalities to evaluate positive externalities using case studies.

3 LIST OF USED METHODS

Here are the most common methods used for assessing transport externality. These methods mainly relate to measurement of negative transport externalities. There are a number of studies and materials dealing with the assessment of the negative impacts of transport such as CE DELFT (2008), INFRAS / IWW (2004), including later updates, ExternE (2005) or HEATCO (2006); on the contrary, only a limited number of studies or expert articles dealing with positive externalities.

Hedonic price model

This is one of the oldest approaches to determining the demand for non-market commodities. This method determines how much of the difference in property prices is due to a certain difference in the environmental properties of properties and how many people are willing to pay for improving environmental performance, Garrod and Willis (2000). In the case study presented in chapter 4.2., a hedonic pricing model is applied using correlation and regression analysis, such as Forrest et al. (1992), who in his study examined the influence of city railways on the property price in Manchester. Forrest et al. (1992) found the mildly negative influence of urban railways on the price of properties near them, which explains above all the increased noise burden, increased movement of the users around the station and frequent traffic congestion around the traffic junction. Haripriya (2014) states that the hedonic price method is very demanding in terms of input data. In order to estimate the hedonic price function for a particular market, it is necessary to have a large number of observations describing both sales prices and numerous property characteristics in a given market. The biggest advantage of this model is that it is based on real market observation. At the same time, however, it is assumed that respondents are fully aware not only of the actual noise burden, but also possible negative impacts in exposure to this noise load. This can often lead to distorted and unrealistic conclusions that differ from professional literature as well.

The travel cost method

This method is based on an expanded theory of consumer demand and is based on quantification of the environmental benefits of public goods or damages associated with the loss of these benefits, which are derived from travel costs. Just as the hedonic price method belongs to the methods of revealed preferences, as reported by Melichar (2005). The main idea is to determine the financial and time-consuming nature of the visit to the recreational area. Analyzing how people respond to travel costs can be determined by awarding natural assets.

Random utility / discrete choice model

Špalek (2005) states that, unlike the travel cost method, random utility / discrete choice model to evaluate the properties of the sites under consideration. The principle consists in explaining the choice between two or more goods with variable levels of an attribute. This model can be applied as a superstructure in the case study presented in Chapter 4.1, which deals with time appraisal (WTP and WTA) depending on the mode of transport chosen for the given session based on the population's traffic-economic behavior.

Contingent valuation method (stated preference method)

According to Šauer (2007), it is a method of out-of-market valuation and valuation of natural goods, which by means of a questionnaire survey finds a hypothetical willingness to pay for an environmental item, a hypothetical willingness to accept compensation for damage. For a more detailed description of the application of the conditional assessment method, see Boyle (2003) or Melichar et al. (2008).

Willingness to pay (willingness-to-pay - WTP)

According to Kršková (2011) this method represents the maximum amount a subject is willing to pay to gain some benefit or, on the contrary, to avoid negative consequences. Blomquist (2003) criticizes the WTP model for being too much burdened by the budget options or limitations of the subject involved, ie it is directly dependent on the distribution of wealth in society. This leads to a relatively different WTP in countries that are relatively similar from other angles (for example, culturally or historically), as Kršková (2011) mentions.

Willingness to accept compensation (willingness To Accept - WTA)

The opposite of willingness to pay is the willingness to accept that Kršková (2011) defines as the minimum amount that the body is willing to accept to accept some unwanted or negative consequences. Kršková (2011) mentions the shortcomings of the WTA model in that when the subject decides only on the basis of how much he would accept, his valuation is too exaggerated, ie he will usually say more than the perceived value (benefit) of the farm. Both methods (WTP and WTA) are in the dissertation work was used in calculating the estimations of positive externalities of transport, especially in combination with method of preference.

Level-Of-Service

Level-of-service rating is a method used to assess the quality of transport and, unlike the above methods, Litman (2008) currently focuses on the evaluation of positive externalities, due to improved transport planning and decision-making based on a comprehensive quality assessment of the survey of the transport system. It was created to solve traffic flows, congestions and related traffic planning. Within the LOS ratings, the A (best) to F (worst) assesses travel conditions (use of the transport system) to identify problem areas and generally evaluate the quality of the examined transport system. The method of assessing the quality of the transport system using LOS ratings is applied in a case study to assess the change in the quality of urban transport in Pardubice city, presented in chapter 4.4.

Market price method

Špalek (2005) defines market price as a price that balances supply and demand in conditions of perfect competition. Distortions in the form of imperfect competition, incomplete use of resources, taxes, subsidies or externalities can be eliminated through adjustments to so-called shadow prices. This method is used in the case study presented in Chapter 4.2. to investigate the impacts of the proximity of the transport infrastructure on property prices.

Scientific methods

The following scientific methods are used during the dissertation:

- analysis and synthesis ,
- deduction and induction ,
- case studies, system approach,
- multi-criteria analysis , Saaty's method,
- regression analysis and correlation,
- analysis of statistical data,
- questionnaire survey.

The description of the individual methods and the possibilities of their application can be found in relevant chapter of the dissertation.

4 PROBLEMS SOLVING

Four studies are presented in this chapter, which includes the application of selected valuation methods used for valuation of externalities.

Case study - Time savings valuation based on WTP and WTA

This chapter deals with application of the WTP and WTA methods. Application of both methods is presented on conditions of the Czech Republic. At the same time, data from questionnaire survey where a WTP method with dichotomical choice format was used for the purposes of this case study when respondents were asked whether they were willing to pay the price for the surveyed entity or not. It has always been a choice between road and rail transport, more precisely between the use of car and train on the submitted cases of four selected sessions.

Input data to technical-economic analysis of this case study are tariff conditions available for both road and rail transport, the current price of petrol and diesel, technical data about the consumption model car and valid timetables. Questionnaire survey was attended by 398 respondents from all 14 regions of the Czech Republic.

In the expert part of the questionnaire survey, certain questions were asked, of which the relevant ones are further analyzed in relevant chapter of the dissertation. To quantify the willingness to accept or willingness to pay, derived equations for the calculation of WTP and WTA are used for selected scenarios.

At sessions 1 (Trutnov - Pardubice), the narrow majority of respondents chooses the train transfer option over car. There is a saving of 110 CZK, but also increase the travel time by 40 minutes. The Preference Coefficient (Preference Weight) is 0.52.

Scenario: I'll pay less, I'll be there later.

WTA_{R1} = 1,43 CZK/min – the cost of higher travel time

Positive value is the financial cost of a freely chosen transport mode selection higher travel time for that session.

At session 2 (Prague - Pardubice), a clear majority chooses train. There is a saving of CZK 160 and also less travel time by 25 minutes. The cost paid for a motorway usage can hardly be recognized for selected session, so it has not been counted in. The preference coefficient is 0.82.

Scenario: I'll pay less, I'll be there earlier.

WTP_{R2} = -5.25 CZK / min - savings for less travel time

A negative value indicates cost saving while saving travel time at the session.

At session 3 (Liberec - Pardubice), three quarters of the respondents choose a passenger car option over train. There is time saving of 67 minutes, but also a cost increase of 100 CZK. The preference coefficient is 0.77.

Scenario: I'll pay more, I'll be there earlier.

WTP $_{R3}$ = 1.15 CZK / min - cost saving time

On the considered session, the rail link is similar to that of the rail link from session 1, a monorail line of regional character with speed limitation a large number of railway stations and stops.

At session 4 (Pardubice - Ostrava) the clear majority of respondents choose the option of transport by train. There is a saving of 15 minutes and saving of 270 CZK. The preference coefficient is 0.82.

Scenario: I'll pay less, I'll be there earlier.

WTP $_{R4}$ = -14.76 CZK / min - savings for less travel time

A negative value indicates cost savings while saving travel time for the session.

Since September 2018 discounts on fares were introduced, involving passengers from 6 to 18 years, students 18 to 26 years and passengers older than 65 years. This would, in a new questionnaire survey, influence the transport and economic behavior of passengers, in particular the age groups of public transport users concerned.

The resulting complete case study data, including the limiting conditions and the evaluation of the results, are presented in relevant chapter of the dissertation.

Case study - Influence of the proximity of transport infrastructure on property prices

Pardubice city study was selected for a case study investigating the impact of the proximity of the transport infrastructure (public transport stops) on the property price. Data source is real estate portal Reality.cz. The aim of the correlation analysis is to find out which of the of these variables affects the price of the property. The focus is on the proximity of public transport stops, namely three modes: urban public transport, rail and bus services. Software Statistica 12 was used for statistical analysis. Within this analysis, it is necessary to define a set of factors and the conditions under which the given method is applied to the model case of Pardubice city.

The subject of statistical analysis is to determine the strength and type of observed variables. Force and dependence (correlation) is expressed through various degrees of statistical dependence including correlation coefficients. The absolute value of the degree of statistical dependence should be in closed interval from zero to one.

After the first calculation step, the case of the undesirable multicollinearity between the train stop distance and the bus station occured. After the elimination of the variable "Distance to Bus" multi-collinearity does no longer occur.

As expected, a very strong dependence between the apartment's price and the size (living area) of the flat has been demonstrated. At the same time, the weak and negative dependence of the apartment price on the given sample was proved in relation to proximity to nearest urban transport stop and to the main railway station.

Regression model can be used to determine the equation, including the individual factors that affect the price of the apartment near to the transport infrastructure. The regression is thus::

$$cena\ bytu = 629547{,}4 + 17060{,}9 * vel.bytu - 53{,}3 * vzd.MHD - 27{,}1 * vzd.žel. \quad (1)$$

where: *vel.bytu* surface area of the flat [m^2]

vzd.MHD is the distance from flat to nearest urban transport stop [m]

vzd.žel is the distance from flat to the main railway station [m]

Pozn.: absolute value of the regression model [CZK]

Based on verification calculations made in the dissertation thesis , the resulting regression equation can be interpreted in such a way that the apartment price increases with the growing residential area of the flat, decreasing with increasing distance to the nearest public transport stop and the decreasing distance to the railway station. The resulting complete data of the case study, including the conditions and the evaluation of the results, are presented in the relevant chapter of the dissertation.

Case study - Benefits from the construction of transport infrastructure

This case study explores the benefits of the construction of transport infrastructure and its impact on changes in the business environment in the field of passenger road (bus) and rail transport. The benefits of commercially operating traffic on the section under consideration or through a transparent tender for the transport serviceability of a particular session is to save government subsidies for ordered transport services in sessions that are currently private carriers willing to operate without subsidies or with lower subsidies than is the case with national carrier. However, this concept is not applicable to the entire railway network but only to commercially interesting sessions.

The aim is to estimate the potential of the completed D11 motorway for bus carriers, which can be expressed by the aggregate coefficient using Saaty's method. For evaluating the potential for bus carriers following procedure shall apply using Saaty method (Olivková, 2011; Friebelová 2008).

The first step is to establish the evaluation criteria and their description. Criteria determination was carried out by the research team together with the supervisor and supervisor by a specialist based on the Delphic method, a prognostic method of group finding a solution. For clarity, the criteria and their description are given in the relevant chapter of the dissertation.

Using the pairwise comparison method, you need to verify the consistency of pairing each criterion with a consistency test (Saaty , 1987). The consistency test calculation according to Hasse and Meixner (2009) follows in five steps. The calculated consistency rate is:

$$CR = \frac{0{,}1103}{1{,}24} = 0{,}089 \quad (2)$$

The CR consistency rate is considered acceptable at 0.10 (10 %). Consistency is therefore acceptable. Next steps of the calculation can follow. For the needs of the model, it is necessary to define the various scenario scenarios and the verbal description of the criteria in the next step. On the basis of expert estimates, an optimistic variant, a pessimistic variant and a realistic variant are set.

The last step of the calculated model of calculation is the evaluation of the potential of the considered relationship for the bus carrier itself. A comparison of the individual data of both scenarios is given in Table 23 of the respective chapter in the dissertation.

The resulting coefficient of 0.73 for the expected option means that the completion of the remaining section of the D11 motorway opens up a considerable potential for bus carriers in this session. At the same time, there would be a greater competitive potential against rail transport, and this session would become more attractive to car users, as travel time would be shortened.

The resulting complete case study data, including the specification of factors affecting road and rail transport, are set out in the relevant chapter of the dissertation. .

Case study - benefits from improving the quality of public transport

According to Litman (2008), it is generally the tendency to value qualitative factors such as comfort, comfort, safety and prestige with higher values. However, practice often focuses on quantitative factors and impacts in transport planning and economic assessment and underestimates qualitative factors and impacts. This chapter of the dissertation thesis aims to estimate the economic quality factors in public transport, which have the positive benefits of transport, by applying the method of the so-called Level-of-Service rating. For the conditions of the Czech Republic, author applies a method of determining suitable factors divided into the following five phases, according to Litman (2008):

1. Defining quantifiable factors
2. Determination of appropriate methods of quantification of selected factors

3. Data collection
4. Integrating calculations into aggregate index
5. Include results in the planning process

For the needs of the method, it is necessary in the first step to determine the factors and the way of their evaluation, on the basis of which a table of intervals of individual LOS ratings expressing the level of public transport quality is constructed. On the basis of the theoretical knowledge, a questionnaire was drawn up, which included selected factors and their score: The author chose a model example of the urban transport in Pardubice city. The selected cases are being solved in follow-up chapters in dissertation, expert assessments were carried out in cooperation with supervisors.

The first step is to calculate the sum of the best variants (a), where the best options are summed, ie. the ideal scenario. This gives the upper limit of the entire evaluation interval. The sum of the worst variants (c) is summed up by the worst options, ie. worst case scenario. The sum of the middle variants (b) summed up the mean values of the options, with the calculated fare factor being taken as the mean value between 1 and 0. The calculated values a, b, c are further used to calculate the evaluation intervals between the individual LOS stages. Then, the entire evaluation interval is divided into LOS A-C and LOS D-F, the split value being *b*. The final distribution of LOS ratings according to the model questionnaire is entered in Table 26 in the relevant chapter of the dissertation.

In this chapter a calculation methodology of Litman (2008) is used. It calculates the savings through LOS ratings. For the model example of application of the LOS rating method for Czech conditions, the author chose Pardubice city. In the case study there is considered change in the quality of public transport rating LOS E to LOS C. This change is by Litman (2008) interpreted as a change from poor quality of the space waiting to good one, such as a covered waiting area, possibly with benches, increase perceived quality of the vehicle, such as new interior upholstery, elimination of unwanted noise, deploying vehicles of the newer production year or with more seats, minor adjustments to the platforms, adjustment of the stopping environment or new ways of paying the fare, installing additional ticket machines, etc. For the case study, the following two sessions were selected.

Session 1: Session with transfer: Dubina, center - Airport

In the first step input data need to be defined. For the urban transportation it is considered walking for 5 minutes, waiting is 10 minutes. The driving time is 9 minutes. In the transit hub there is a waiting time of 5 minutes. Then travel to the finish stop is 13 minutes. Walking time from the destination stop to the destination is 5 minutes. For individual car transport, the distance from

Dubina to the Airport is approximately 7.2 km and the passenger car will overcome this distance under normal city traffic conditions in 13 minutes. Walking time to vehicle and from vehicle is always considered for 2 minutes.

The next step is to calculate the partial travel costs of time for individual time factors, such as walking, waiting, time spent in the vehicle or time to switch. The calculations are presented in Table 29 in the respective chapter of the dissertation, which also sums up the cost reduction resulting from the increased comfort of waiting and increasing the comfort and comfort of public transport from LOS E rating to LOS C. Driving time, the timetable has also remained unchanged. This is the upper limit of cost savings when there is an improvement in the perception of the quality of public transport by its users.

Session 2: Session without transfer : Dukla, carriage - Globus

For the urban transportation it is considered walking to the stop for 5 minutes. Then waiting is 10 minutes. Travel time to the finish stop is 20 minutes. Walking time to the destination is 5 minutes. For car there is the shortest distance from Dukla (carriage) to Globus about 5 km. If a driver travels the same route as a bus, it will take 10 minutes considering usual city traffic. Walking time to vehicle and from vehicle is always considered for 2 minutes.

Even though Litman (2008) calculates savings only for public transport users who have to transfer, there are experimentally calculated savings for a user who uses a direct link without transfer. Comparison is carried out again with alternative individual car traffic. From Table 30 in the relevant chapter of the dissertation is seen that due to the increased comfort of waiting and increasing the convenience and comfort of traveling by public transport (from rating LOS E at LOS C) decreased travel expenses in proportion to the IAD from 123% to 84%.

This case study describes a practical approach how the LOS ratings can economically evaluate a qualitative level and change the perceived quality of services within the considered public transport system. The result is the transformation of qualitative factors into the monetary value of time.

5 RESULTS AND DISCUSSION

Practical part of the thesis dealt with four areas of appreciation of positive externalities in transport. The selected methods of evaluating predominantly negative externalities were applied to case studies and the results obtained are summarized and interpreted in the following paragraphs.

Time savings valuation based on WTP and WTA

On the basis of the processed data and the results of the computation of the willingness to pay and the willingness to accept, using the dichotomical choice format in the questionnaire survey on the WTP application, a case study was prepared in the Czech Republic. By applying the WTP method, the advantages over conventional valuation can be seen in the following points:

- compared to conventional methodology it is not an estimate of macroeconomic indicators,
- this method is based on current tariff and fuel prices, takes into account direct competition between IAD and rail passenger interregional transport,
- this method takes into account the so-called European approach, ie the WTP approach in foreign studies on this topic, eg Eboli and Mazzolla (2008).

The application of the WTP method to a case study shows how to obtain the bases for calculating user time savings in the economic evaluation of traffic projects in a given session (especially the assessment of positive externalities of the project) as well as the preference coefficient that determines preferential user choice in relation to travel costs and driving time based on WTA and WTP methods. If the total time of transport was considered, it is necessary to add to the train the time needed to transport from the starting point to the railway station, the waiting time and the time to move from the destination railway station to the destination. Due to the individual differences of the individual times and times transport costs are therefore considered only for the net travel times of the given means of transport for selected sessions.

UNITE (2003) uses value 21 EUR per hour for work time and 4 EUR per hour (private and leisure time) for road traffic value. Other studies, such as INFRAS / IWW (2004), use higher values that also take into account possible indirect costs from the risk of congestion affecting employees, customers and other transport users.

HEATCO study (2006) recommends using time values based on vehicle-kilometer instead of person-kilometer. Differences are, for example, when assessing commuting time (8,48-10,89 EUR / car) and private journeys (7,11 - 9,13 EUR / car), for example used to estimate delays or

congestion in congestions. For congestion in private passenger transport, it is recommended to multiply the standard time value by 1.5, in freight 1.9 and in passenger transport by 2.5. Values of time savings estimates, as recommended by the HEATCO and the differentiated by country, mode of transport, purpose of journey and length of journey, are based on WTP based surveys.

Alternatively, the application of the method may be combined or supplemented by the above-mentioned coefficients, depending on the processors of the economic study, as to which other variables may lead to more accurate results, to extend this basic model accordingly..

The hedonic price and the impact of the proximity of the transport infrastructure on the property price

A case study was prepared on the chosen example of Pardubice city and its aim was to express the influence of the proximity of the transport infrastructure on the prices of apartments in Pardubice city using the application of the hedonic price method. There is dependence between the price of apartments and distances of the transport infrastructure in Pardubice city. The case study shows that the proximity factor of the public transport stops at an average of 0.46% at the price of apartments in Pardubice, and the factor near to the main railway station accounts for an average of 2.92% for the price of apartments in Pardubice city. Negative correlation in both cases means that the greater the distance of the transport infrastructure is, the lower the flat rate is. Proven dependence is mild.

The principle of evaluating positive externalities by the hedonic pricing method can thus be one of the imaginary counterparts to the negative externalities assessed in the studies of transport projects. Based on the results of a case study, for example, price maps in the given locations can be revised. The results generated by this case study may vary depending on the quality of the data being processed or the property parameters under consideration, to which Haripriya (2008) or Forrest (1992) also draws attention.

However, the possible extension of the study with transport at rest on the price of real estate is subject to several restrictive conditions. It is necessary to carry out a thorough analysis of the transport at rest in the city, to consider only real estate with comparable parking conditions, as distorted results can be made clear and cluttered by often confusing the assignment of particular parking spaces and their number to apartment buildings and other properties, attendance distance from parking spaces and last but not least, it is necessary to take into account other individual factors that affect the transport at rest in connection with the price attractiveness of residential locations.

For the above reasons, due to the complexity of the data collection and analysis of the parking areas in Pardubice city, the transport at rest was not included in the model case, but if the above mentioned conditions are fulfilled, this factor can be put into the evaluation method appropriately, as transport at rest has a significant impact on the real estate price.

At the same time, it should be mentioned that this method is not used so much in the Czech Republic because, using the hedonic method, it is assumed that the real estate market represents a market of perfect competition, as Melichar and Honigová (2005) say . Similarly, different conclusions are reached with the application of this method, as evidenced, for example, by Forrest et al. (1992) who found the city's rail transport negative impact on the property price in Manchester, and Bajic (1983), which found the positive effect of a metro proximity on the property price in Toronto. Not only from these cases can be deduced that the results of the hedonic price model differ from case to case, it is always necessary to describe the input data, the specifics of the given location, including the historical and urban development, the specifics of the transport behavior of the population and, last but not least, the restrictive conditions of the case study, which also influence the interpretation of the results and conclusion of the study.

By using correlation and regression analysis combined with real estate data, the dependence between property prices and distance to traffic junctions can be determined. When applying this analysis, there may be a multicollinearity problem that has arisen in this practical study so the variable needs to be eliminated. When assessing the environmental characteristics of Haripriya (2008), a frequent example of multi-collinearity is, for example, an increased concentration of harmful emissions and an increased noise level in the property near the road infrastructure. It also points out that the input data in the hedonic analysis should only come from one real estate market.

From a certain distance, it is also necessary to take into account negative externalities such as noise and vibrations that can be valued by the WTP method based on the hedonic valuation or expressed noise reduction preferences or the so-called Impact Pathway Approach in relation to the impacts of these negative externalities on human health.

Also technological and technical level of rail transport in the area needs to be taken under consideration and also the general level of these transport systems. Reference can be made to Chapter 4.4., where the impact of changing the quality of the transport system in the case of urban public transport in Pardubice city was examined in the case study. The perceived quality of bus and rail transport, expressed through LOS ratings, can thus help to improve transport planning while reducing the time travel cost, and secondly to increase the competitiveness of bus and rail transport towards individual car traffic, thereby increasing the interest in these modes of transport in the intended location, increasing real estate prices near transport hubs.

Benefits from the construction of transport infrastructure – motorway D11 case

This case study is aimed at evaluating the benefits of building a new transport infrastructure. Criteria were defined by Saaty's method of quantitative pair comparison, their description and weight, and the outcome of scenario 1, which foresees the completion of D11 motorway. The result is the attractiveness coefficient for initiating or expanding business in bus traffic on a model session.

When pairing occurs, there is always a certain inconsistency of the pairwise comparisons, the goal being not to exceed the stated consistency level. Otherwise, the study would lose its predictive value and the results would be distorted.

The resulting coefficient of 0.73 for the expected variation "Model Case - D11" means that the completion of the remaining new section of the D11 motorway presents a relatively high potential for bus carriers in this session.

Completion of D11 motorway would increase the competitive potential for rail transport and at the same time make this session more attractive to IAD users, as travel time would be shortened. This deduction was confirmed in 2016 by the entry of the Student Agency (RegioJet) to this session where from May 2016 it started to operate one pair of connections a day, although the D11 motorway is currently completed to Hradec Králové only.

Thus, the case study can serve as one of the inputs in the preparatory phase of the project to process the economic analysis based on determining the attractiveness of the relationship for the carrier. Differential factors for evaluating the attractiveness of the projected session for carriers in the road and the railway transport are level of market liberalization, construction and modernization of road infrastructure, minimum attractive sessions for expansion existing private carriers, or even for the entry of new private railway carriers, high business risk in rail transport, different transport infrastructure charges, different tariff conditions, unless there is a uniform tariff of the integrated regional transport system (eg IREDO) and, last but not least, the limited capacity of rail transport.

Analogously, Saaty's method and the same procedure for assessing the commercial potential of a railway taking into account the current situation, which the processor must undergo a thorough technical-economic analysis in the preparatory phase. In case of rail transport there is an ideal condition if a case study can count on a fully open transport market for rail carriers. The resulting coefficient can thus be defined as the degree of attractiveness of a given session for initializing or expanding a business in the area of public passenger transport, in particular when comparing travel times and fares for variants without and with project.

The use of Saaty's method assumes the existence of a team of experts who determine the most appropriate criteria that have the greatest impact on the project scenario compared to the

current state, ie without a project. The research team also participates in the point evaluation of the individual pairs of criteria. This team is usually made up of experts who have to meet requirements such as education or length of practice in the field. The use of this method is sensitive to the subjective views and perspectives of the individual problem solver, which is reflected, for example, in defining the optimistic, pessimistic and realistic variant of the scenario. Each of the scenarios should be based on trends estimated based on available statistical data in context with the analysis of the current status. Similarly, the factors influencing the modes of transport to be compared must be taken into account, such as the commercial potential of the route in relation to the current and potential traffic flows of the passengers, the level of competitive environment, for example by the number of carriers operating regular connections to the sessions under consideration, the number of connections between the carriers, the financial background of the carriers, modes of transport on the session, economic and temporal terms railroad and individual automobile traffic on the session, administrative burden with respect to the comparison of transport modes, level of transport market liberalization, or barriers for entry, contractual obligations in the context of transport services and the last but not least, the potential for qualitative improvement of the provided transport services in the given relation, for example on the quality of the available transport infrastructure, the attractiveness of the region being assessed, etc. Analogous factors can be considered in the same way from the point of view of rail transport.

Assessing the benefits of improving the quality of public transport

The last case study in the practical part of the thesis deals with the evaluation of the benefits of improving the quality of public transport. The results show that, as a result of increased waiting comfort and increased comfort and comfort of public transport (from the LOS E rating to the LOS C), the travel cost in relation to the IAD was 123% to 84%. For the model case, two sessions were selected by the author in the public transport network in Pardubice city, with the first session being Dubina, Centrum - Letiště and the second session is Dubina, Centrum - Globus. Inputs are expert estimates.

Improving the quality of public transport services can be, by analogy, implemented into other influential aspects such as increased travel speeds, transit rates, reduced fares, or parking fees. When introducing programs for the qualitative improvement of transport systems, individual strategies should create a synergistic effect that results in an increase or even a multiplier effect on the overall benefits of transport for its users.

Similarly, the LOS rating method can be applied to rail passenger transport. Most transport operations in the Czech Republic are carried out by a state-owned carrier ČD as (MDČR, 2016),

while the owner of the infrastructure is the state, through the SŽDC. For programs to improve infrastructure for increased competitiveness and greater use of rail transport, owners can, in turn, request the infrastructure manager (eg SŽDC) to apply for subsidies. One of the supported activities is, for example, to increase the comfort and facilities of the station and stop infrastructure in the management of the railway infrastructure manager, or to modernize and reconstruct the lines and other infrastructure related to upgrading within the railway hubs.

Case study in Chapter 4.4. shows how comfort and comfort can substantially reduce the travel costs of time. Moreover, these benefits are virtually invisible for most current models for the economic evaluation of transport projects.

Conventional methods of economic evaluation tend to concentrate mainly on travel times (driving speed) and give little weight to comfort and comfort factors when traveling. Consequently, the results of conventional valuation are based on a planning process that does not take into account all the factors and thus they can not achieve full optimization of the transport system compared to what would maximize the efficiency of the transport system and social well-being. Litman (2008) also notes that conventional methods also often underestimate alternative modes of transport, as they are generally judged to be slower and as well as service options because they overlook the value offered by multiple levels of service and also the quality of service because quality improvements are often underestimated. If investment in improving the quality of public transport is neglected, public transport is less attractive than individual car traffic, resulting in higher travel time compared to travel costs of car travel. Motorists have the possibility to have comfort and comfort directly influenced by investments in a better car or guaranteed or better parking space. However, an individual user of public transport in the city does not have this option. If public transport does not meet the user's quality requirements, the user switches to alternative modes of transport.

Improving the quality of services in alternative modes should take into account the benefits for existing users, the benefits for new users of the improved transport system, the benefits for other road users by reducing the risk of accidents and the occurrence of congestions, benefits for society by optimizing existing infrastructure and transport capacities, cost savings (time), benefits in energy savings and reduction of pollutant emissions, or the benefits of higher sales of transport companies from increased passenger interest. The use of the LOS rating method is foreseen in case studies or preparatory phases of new projects focusing on improving transport standards in public transport. In USA, UK or Australia, this evaluation method is used to optimize the traffic planning process and the evaluation of transport projects.

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6 AUTHOR'S OWN CONTRIBUTION

The dissertation deals with issues of positive externalities in transport and methods of their valuation. In the practical part of the dissertation there were presented four case studies, using methods used primarily for the evaluation of negative externalities. Based on the results of studies, it is then possible to include this evaluation of positive externalities in the overall assessment of the economic efficiency of transport projects.

Main benefits of the dissertation:

- elaboration of the analysis of the present state of the issue of evaluation of positive externalities in transport,
- application of WTP and WTA methods for the evaluation of time, time savings,
- application of the hedonic price method to assess the impact of transport infrastructure proximity on property prices,
- application of Saaty's method for determining the aggregate coefficient for assessing the benefits of the construction of a new transport infrastructure, including the specification of the different aspects of road and rail transport,
- application of the LOS rating method for assessing the quality of public transport services, expressing time savings in improving the quality of the transport system,
- usability of case study methods and backgrounds for further research on the issue of assessing positive externalities in transport,
- applicability of the presented methods for expanding the basis of the transport projects economic evaluation in terms of both negative and positive externalities.

7 CONCLUSION

The importance of positive externalities in relation to transport policy is currently unquestionable, and in the coming years this trend will continue as a result of the need for more and more accurate and relevant economic evaluation of transport projects. From the analysis of the current state of the given issue it follows that the topic of dissertation is very topical, which results also from the analysis of domestic and foreign sources where the problem is solved by the most frequent case studies. Even so, less attention is paid to positive externalities than negative externalities, which are still ahead of transport policy, mainly due to programs to reduce emissions and generally mitigate the impact of negative externalities on the environment.

The analysis shows that the transport projects in road and rail transport are mostly assessed in terms of negative externalities and positive externalities are mentioned only in a qualitative and not quantitative way. Examples of unconventional economic assessments of selected transport projects from Great Britain, the USA, or Canada show that evaluating positive externalities can contribute to the positive economic balance of the evaluated project, its adoption by competent authorities and subsequent implementation.

For example, frequent arguments against the economic efficiency of high-speed rail projects in the Czech Republic appear to be odd in analyzing materials in the UK high-speed rail project where a group of experts defines so-called wider economic benefits that assess the positive impact of the project on the region and in terms of business activities, job opportunities, agglomeration benefits, foreign investments and their multiplier effects, etc. However, this assessment method is demanding for data collection and some statistical data required for the application of this model are not available in the Czech Republic.

For application of WTP and WTA, sessions with different road and rail transport segments were deliberately chosen, with two sessions having the advantage of rail transport in the form of a corridor with high travel speed for the user, with two sessions having the advantage of road transport in the form of motorways. The most logical option is when the user pays less and will be in the destination earlier. This is an example of the Prague - Pardubice session, when compared to car, it is a user's point of view to save less travel time. The opposite case is the Trutnov - Pardubice session, where users choose the option to pay less, but they will be in the destination later. Methods WTA and WTP can be used to economically assess the behavioral and economic behavior of the population in relation to the willingness to pay and to receive compensation for lower and / higher travel time.

When assessing the impact of the proximity of transport infrastructure on real estate prices, the findings of the above mentioned studies were already found in the research. The theory of the hedonic price method thus faces paradoxical situations and often contradictory conclusions that are influenced by many geographical, environmental, economic or psychological aspects where the property price positively affects the proximity of transport infrastructure or agglomerations with good transport accessibility and environmental aspects such as proximity to parks, forests or a no-noise environment. Some studies, on the other hand, found that in certain cases the negative externalities predominate in the assessment of the real estate price in the areas under consideration, for which there are also specifics, which are also an explanation of these negative trends. For a case study on the impact of the proximity of the transport infrastructure on property prices, a model example of Pardubice city was chosen, where it was determined how much the factor near the public transport stops and the factor near to the railway station is at the price of apartments in Pardubice. Negative correlation in both cases means that the greater the distance between the transport infrastructure and the home, the lower the apartment price, and vice versa, with the observed dependence being mild. Within limiting conditions and described specifics of the location under consideration, the link to transport at rest, which also affects the price of real estate, is mentioned. However, should a case study be extended to the effect of this aspect, several conditions would have to be considered, in which compliance could be included in the input data for correlation and regression analysis.

In a case study to measure the benefits of building a new transport infrastructure, the Saaty's method was used to determine the cumulative coefficient for the scenarios that is expected to complete the D11 motorway. This study works with the multi-criterion decision method and results in a coefficient of attractiveness for initializing or expanding a business in bus transport to a chosen session that takes into account the criteria that characterize the change in the transport market. The result of the case study can then be interpreted in such a way that the realization of the remaining section of the D11 motorway opens up a great potential for bus carriers in this session. At the same time, there would be greater competition potential for rail transport and at the same time, this session would become more attractive to car users, as travel time would be reduced in the case of bus traffic. This deduction was confirmed in 2016, among other things, by the entry of Student Agency (RegioJet) to this session, where from May it started to operate one pair of connections a day, although the D11 motorway is only completed to Hradec Králové. From the tariff point of view, the bus service is the most advantageous and, with the entry of another competitor, there is no prerequisite for rising fare prices, except for the usual price adjustments in relation to the macroeconomic indicators and the performance of the domestic economy. An analogous procedure

can be chosen for assessing commercial potential for rail carriers, in the case of rail transport, it is an ideal condition if the case study can count on a fully open transport market for rail carriers.

The latest case study analyzes the benefits associated with improving the level of public transport services. The method and so-called LOS ratings were applied to the conditions of the Czech Republic, namely the model case of public transport in Pardubice city. Sessions were selected from the Dubina, Centrum stop to Letiště stop and the non-transfer session from the Dukla, Centrum stop to Globus stop. Based on the results of both model sessions, it can be deduced how comfort and comfort can substantially reduce the travel costs of time. Moreover, these benefits are virtually invisible for most current models for the economic evaluation of transport projects. Conventional assessment methods often focus only on the cruising speed parameter and attach little weight to the comfort and comfort of traveling. The case study shows how qualitative factors can be translated into the quantitative expression of travel time value.

The author sees the potential of using the method of determining LOS ratings also in rail passenger transport, where the level of comfort and comfort is generally very variable and depends on the fleet renewal and scale, the level of information provided by the carrier and the quality of the infrastructure or the levels of modernization of the tracks and stops / stations on the side of the rail operator. The use of the LOS rating method is foreseen in case studies or preparatory phases of new projects focusing on improving transport standards in public transport and optimizing the decision-making process in line with the requirements of the users of the transport system.

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