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PROPOSAL AND APPLICATION OF METHODOLOGY OF REVITALISATION OF REGIONAL RAILWAY TRACK IN SLOVAKIA AND SERBIA. PART 1: THEORETICAL APPROACH AND PROPOSAL OF METHODOLOGY FOR REVITALISATION OF REGIONAL RAILWAYS

Summary. The paper presents a proposal of methodology for revitalisation of regional railway tracks and regional railway traffic, liberalization and competition in railway transport, quality requirements in regional traffic, principles of the contract on transport services in the public interest and with the current state of regional passenger transport in Slovakia and Serbia. First part of the paper deals with a theoretical approach of transport policy, transport regulation, suburban transport and introduces a methodology for revitalisation of regional railway tracks.

VORSCHLAG UND ANWENDUNG DER METHODE REVITALISIERUNG REGIONALE BAHNSTRECKE IN DER SLOWAKEI UND SERBIEN. TEIL 1: THEORETISCHER ANSATZ UND VORSCHLAGS DER METHODE ZUR REVITALISIERUNG REGIONALBAHNEN

Zusammenfassung. Arbeit beschäftigt sich mit Vorschlag der Methodik der Wiederbelebung der regionalen Eisenbahnlinien und regionalen Bahnverkehr, Liberalisierung und Wettbewerb im Eisenbahnverkehr, Qualitätsanforderungen im Regionalverkehr, Grundsätze des Vertrags auf Verkehrsleistungen im öffentlichen Interesse und mit dem aktuellen Stand der regionalen Personenverkehr in der Slowakei und Serbien. Ersten Teil der Arbeit beschäftigt sich mit theoretischen Ansatz der Verkehrspolitik, Verkehrsregelung, Vorortverkehr und die Vorbereitung Methodik der Wiederbelebung der regionalen Eisenbahnlinien.

1. INTRODUCTION

Previous century was the century with rapid development of industry, the growth of living standards and the related needs for increased mobility of the population. As this development continues in the next years and decades, the topic of mobility and passenger transport will definitely be on the agenda.

The population mobility is seen in every day's need to travel to school, to work, for shopping, for leisure etc. by every available transport mode that enables movement.

1.1. Importance of public transport

Individual road passenger transport also plays important role in this problem. Road transport has been growing incredibly fast in recent decades. Expanding individual road passenger transport has positive effects, like convenience and speed of travel, but also produces a lot of negative effects, for example significant increase in emissions, increase of noise, vibration, accidents, congestion, large occupation of land for transport infrastructure (e.g. high demands for parking areas) etc. This problem can be solved only by very good functional public passenger transport which will satisfy the largest possible number of the population and ensure adequate transport services operating in regions and between regions [1].

Area covered by transport services can be evaluated by the transport opportunity in terms of time (time position of connections), area (keeping the lines and location of stops), transport capacity (number of connections and capacity of the vehicles), financial costs (tariffs) and added value (comfort, additional services).

Public transport in terms of the size of the area it serves, can be divided into urban, suburban, regional and long distance transport. The most of the passengers has the beginning and the end of its transport routes in areas that are served by urban, suburban or regional services. Therefore, the importance of all three transport modes should not underestimated.

The main operating area of urban and suburban transport are large agglomerations with high density of the settlement, with large populations and with big transport demand. For the transport outside the suburban area, services are provided by regional transport. Regional transport has different function, as it operates in high density settled suburban and less populated areas away from the big cities.

Today, Regional transport in our countries in such state that is not able to obtain a higher share of transport performance at best case or at least maintain the current stake in worse case. The reason is the big disordering of connections inside urban, suburban and regional transport system and the competition between the operators of public passenger transport [2].

European Union's approach to urban, suburban and regional transport is clear - to support the role of local and regional transport, because its benefits should be seen in economic development and employment, reduction in congestion, lower energy consumption, less environmental problems in terms of emissions and noise reducing, reducing social barriers and increasing the quality of life. Achieving these goals helps in making the better use of environmentally friendly kinds of transport, such as green and more efficient public transport, cycling and walking. This requires an integrated approach.

1.2. Transport policy and passenger transport regulation

Mobility of people cannot be implemented efficiently on market principles. The need for regulation arises from the economic substance of transport and from objective factors that induce market failure. An important factor in ensuring the people mobility is financing passenger transport. Public finances are involved not only in investing in infrastructure for passenger services, but also as investing in vehicles for passenger transport and reimbursement for services in the public interest for public transport companies.

Regulation of passenger transport is affected by three main factors. These are:

- Objective causes of market failure;
- Enforcement of subjective goals of governments (states) in other areas of social life through the transportation;
- Guarantee of the basic civil rights by the Government.

EU transport policy is one of the starting points of realizing the passenger traffic regulation on the national level towards ensuring the adequate, a sustainable, safe mobility and quality of life. These are implemented on the basis of law [7]. The EU Member States apply duality rights in transport. Figure 1 shows a scheme of the legal framework for the transport regulation in EU Member States.

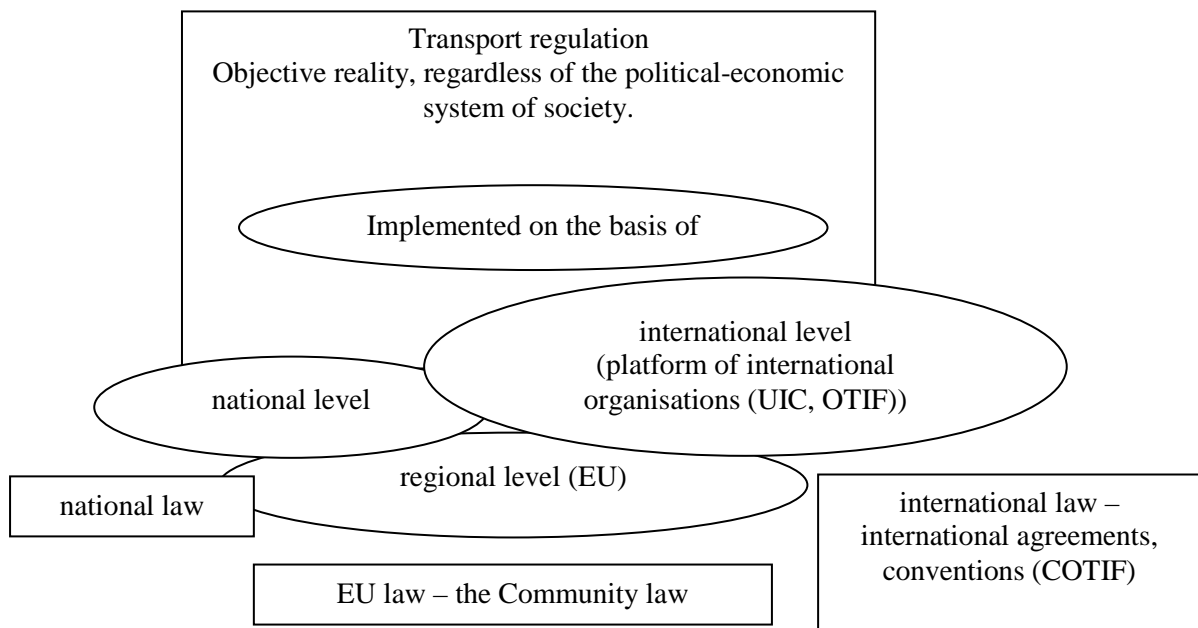


Fig. 1. Scheme of the legal framework for the regulation transportation in EU Member States
Abb. 1. Schema des Rechtsrahmens für die Regulierung Transport in EU-Mitgliedstaaten

The subject of transport policy is to modify conditions and relations in transport with tools that would ensure sustainable economic, environmental and social sustainability of transportation. Transport policy, as any public policy is not a one-time act. It should be a process with certain phases with formulation, implementation, evaluation of feedback for each of its stages and introduction of new decisions and actions [8].

The main objectives of the transport policy of the EU are:

- Economic sustainability:
 - The contribution to economic growth;
 - Contribute to increase the availability of employment by transportation and job creation;
 - In the future to reduce and eliminate congestion.
- Environmental sustainability:
 - Contribute to the reduction of greenhouse gases, local emissions and traffic noise;
 - The protection of sensitive areas before transport negatives.
- Social sustainability:
 - Decreasing of accidents;
 - To ensure availability of services;
 - Social cohesion, including the removal of social and regional disparities;
 - To ensure passengers' rights to high quality services;
 - Establish and maintain good conditions for employees in the transport sector.

1.3. Suburban railway transport

The basic function of suburban rail transport is to provide the transport services for persons from the adjacent suburban areas to the city centre and back at any time and as quickly as possible with a reasonable quality of service.

Suburban transport serving the operational area of an urban agglomeration, has in our countries radius of 40-60 km and 100-130 km in major world capitals. Generally accepted principle is that rail transport is used for strong traffic flows of passengers and other modes of transport provide suitable overlapping, creating a complementary network.

Rail transport is mainly used in large cities and industrial sites, where the public transportation to work, schools and recreational areas by railway transport seems to be the only viable solution, especially in the countries with the largest developing of individual automobile transport [3]. The capacity of road network has reached its limits and congestion slows the movement of vehicles below the acceptable level. Railway transport is capable to manage a large passenger flows. Railways have advantages especially in suburban transport, which is fast, with the technical design allowing easy entry and exit for a lot of passengers and providing high comfortable transport.

Railway weakness in this field is the profitability of operation. There are big groups of passengers using discounted fare (students, retired ...), demand for transportation is changing during the day and the frequency of connections in specific parts of the day is one of the main quality factor of satisfying the passenger's needs. With that related a need for reserves and significantly small the total usage of vehicles [4].

High frequency of passenger train connections in specific hours of the day practical eliminates the possibility of using railway for other categories of trains (freight, long distance transport...). In case of stronger passenger flows, rail suburban transport can provide quality services only when using its own railway infrastructure. This solution, which requires better equipment of the central passenger stations and railway infrastructure, demands more investments and operational planning.

In our railways, suburban transport is not organized on separate railroad. Mixed operation – using the same railway lines by all categories of trains, including the suburban, regional, long distance and freight trains, is less suitable for the organization of the suburban trains. Quality of the suburban transport is often lower at the cost of the higher requirements for the organization and management of railway transport.

1.4. Requirements for the organization of suburban transport

Regardless of significantly different conditions on different lines, suburban transport should satisfy the following conditions:

- The number of suburban trains should provide full satisfaction of transport needs of the population and not just in terms of total traffic for 24 hours, but particularly in the various periods of day (peak hours) and day of the week;
- Effective allocation of trains so as to guarantee the daily transportation to work and school, as well as in the opposite direction;
- Sufficient density of trains, in which the passengers are losing a minimum time of journey in the train and waiting for the train. Higher speed of suburban trains has major significance for passengers who travel daily and their journey often takes a large part of their free time;
- Stopping the trains organized at each train stop with regard to temporal and local needs (i.e. some stations opened only seasonally);
- These conditions, designed according to passengers needs should be coordinated with the often conflicting interests of the operator (capacity utilization of the facilities).

Organization of the suburban transport should consider many forms of temporal and regional passenger flow irregularities. Flow of passengers on suburb area in direction from urban centres to suburban gradually decreases by zones. Therefore, the whole lines should be divided into zones that are limited by section stations and some suburban trains should begin or end the journey in section station [9]. Section stations should be equipped not only for exit, entry or transfer of the passengers, but also for waiting, turning, cleaning and refilling trains and making inspections and minor repairs and maintenance of vehicles.

Suburban transport should ensure:

- Good connections to other (public urban) means of transport;
- Speed;
- Frequency of connections;
- Regularity;
- Comfort;
- Security;
- Reliability;
- Appropriate fare;
- Good location of stations and other necessary objects;
- Polite and willing to behaviour of employees.

2. METHODOLOGY OF REVITALISATION REGIONAL RAILWAY TRACKS

Proposed methodology of revitalisation of regional railway track and regional railway transport consist of five steps (Figure 2):

1. Analysis of the transport potential in the region;
2. Analysis of the requirements of potential customers;
3. Proposal the technical and technological parameters of the transport system;
4. Implementation of the proposal;
5. Feedback.

2.1. Analysis of the transport potential in the region

In transport, infrastructure and vehicle fleets are planned and used in operation for a long period (10-30 years), so it is necessary to perform the analysis of the transport potential and qualified forecast of the development in all analysed fields in the long term. Factors (Figure 3) that influence the demand for transport (potential) are:

- Demographics of the population (number and distribution of the population in the region, age structure, employment rate, disposable income);
- Economy, industry and employment (number of jobs, location and structure);
- Social and cultural aspect and lifestyles (health, shops, active recreation, education);
- Regulations made by state and local governments.

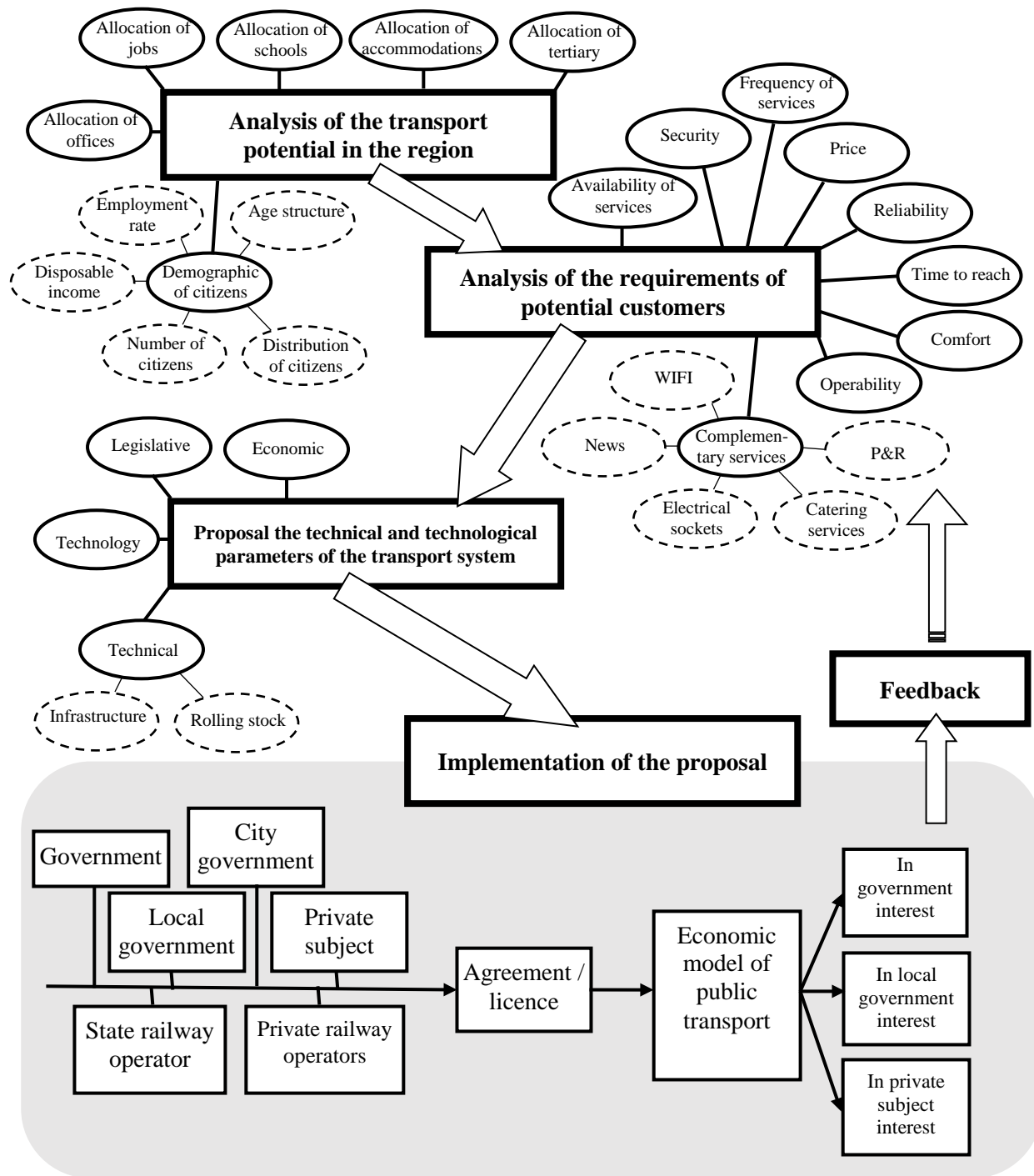


Fig. 2. Scheme of proposed methodology with affecting factors
 Abb. 2. Schema der vorgeschlagenen Methodik mit Einflussfaktoren

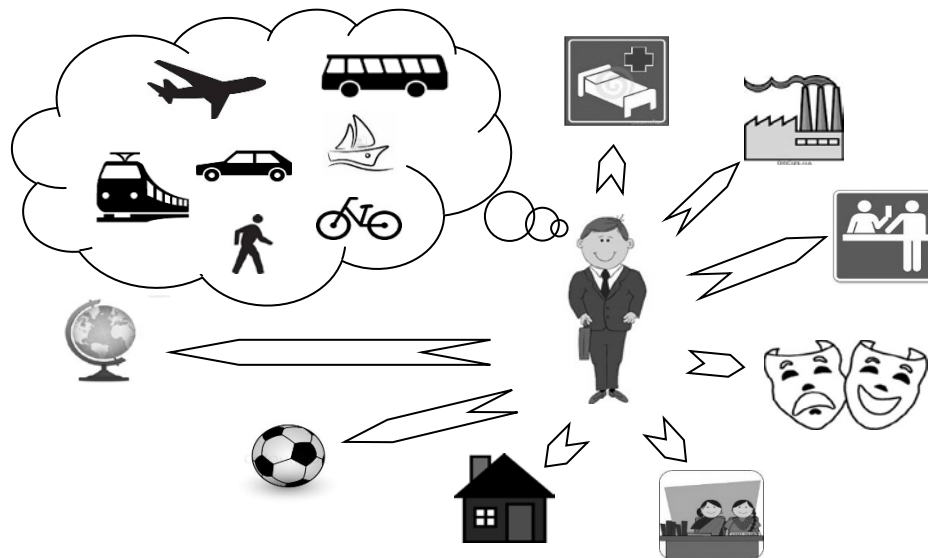


Fig. 3. Confrontation between demand and offering of transport services

Abb. 3. Konfrontation zwischen Nachfrage und Angebot von Verkehrsdienstleistungen

2.2. Analysis of the requirements of potential customers

Similarly as Maslow's pyramid of human needs attributed to various human needs different priorities, and if they are not at least partially met the needs of higher priority (lower situated in the pyramid), there is no need for people with lower priority, also we can organize the transport requirements of potential passengers on transport to some pyramids, and apply similar principles to that of Maslow's pyramid [6]. Depending on local demographic and economic conditions, the order of priorities of the transport system requirements could be various (Table 1 and 2).

Factors affecting the choice of transport are:

- The availability (temporal, distance);
- Security (active, passive, internal);
- The frequency of services (number, frequency);
- The price (basic fare, social and commercial discounts);
- The reliability (independent of weather conditions);
- The time to reach (time of travel);
- Comfort;
- Operability;
- Complementary services (Wi-Fi, newspapers, electrical socket, catering services, Park & Ride):
 - Before the transportation;
 - During the transportation;
 - After the transportation.

2.3. Proposed technical and technological parameters of the transport system

The proposed technical and technological parameters of the transport system must be based on a qualified long term forecasts. If we fail today to design and implement a transport system that would fulfil the requirements of long-term projections, then we should focus on designing a technical and technological solution that will be easily adapted in the future to the level of the requirements of the next generation.

Factors influencing the transport supply:

- The technical:

- Transport infrastructure (number of line tracks, max. track speed, type of traction, safety devices, interlocking system, intervals);
- Rolling stock (design speed, accessibility, microclimate, information system, sanitary facilities);
- The technology (the train timetable type, frequency of connections, continuity of connections, P & R, separated or mixed operation);
- The legislative (law-making in the field of passenger transport);
- The economic (performance in the public interest, the commercial risk).

Table 1

Interaction between factors affecting the choice of transport and factors influencing the transport supply

Factors affecting the choice of transport mode	Factors influencing the transport supply (numeric mark)
Temporal availability	1.1.6, 2.1, 2.2,
Distance availability	1.1.6, 1.2.2, 2.4,
Security	1.1.4, 1.2.2, 2.5,
Price	3, 4
Reliability	1.1.1, 1.1.3, 1.1.6, 1.2.4, 2.1, 2.2, 2.3, 2.5,
Time to reach	1.1.1, 1.1.2, 1.1.3, 1.1.5, 1.1.6, 1.2.1, 1.2.2, 2.1, 2.2, 2.3, 2.4, 2.5,
Comfort	1.1.6, 1.2.2, 1.2.3, 1.2.4, 1.2.5, 2.3, 2.4,
Operability	1.1.1, 1.1.3, 1.1.4, 1.1.6, 1.2.4, 2.1, 2.2, 2.3, 2.4, 2.5, 4
Complementary services	1.2.2, 1.2.4, 1.2.5, 2.4,
Environmental aspects	1.1.3, 1.1.6, 1.2.5, 2.4, 3,

Table 2

Numeric marks for the factors influencing the transport supply

Factors influencing the transport supply		Numeric mark	
Technical factors	Transport infrastructure	Number of line tracks	1.1.1
		Max. track speed	1.1.2
		Type of traction	1.1.3
		Safety device	1.1.4
		Operation intervals	1.1.5
		Density of infrastructure net	1.1.6
Technical factors	Rolling stock	Design speed	1.2.1
		Accessibility	1.2.2
		Microclimate	1.2.3
		Information systems	1.2.4
		Sanitary facilities	1.2.5
Technology factors	Train timetable type	2.1	
	Frequency of connections	2.2	
	Continuity of connections	2.3	
	P&R	2.4	
	operation (separated/mixed)	2.5	
Legislative factors		3	
Economic factors		4	

Today we mostly use public transport means and transport routes that were proposed 10 years ago for bus transport, 20 years for railway rolling stock and more than 30 years ago for transport infrastructure. After 10 to 30 years people will use transport means and transport infrastructure that is designed and built today, so today's solution will be used by next generation.

When designing the transport system, the integration of all transport modes (see White Paper - a network of citizen) must be a priority, so that we can take advantage of the different modes of transport (bus, rail, water, air, individual - walking, cycling, car).

2.4. Implementation of the proposal

Railways have a long tradition in many European countries. It was a mode of transport that helped in starting an industrial revolution by transporting a large quantities of raw material and emergent. Today, railways also has an important part in everyday transport of passengers in large cities and regions. But, the growing competition in transport market has led to a situation that railways are in much inferior position then in 20 or 30 years ago. As we can see from the current practice, only good quality railway service can compete to other modes of transport. This means that some parts of the railway infrastructure and system must be revitalised and modernised. Revitalisation of railways is aimed at improving the speed of trains, and punctuality and reliability of service. These parameters are presented as a priority in railway transport service defined by passenger surveys [5]. Local, urban and regional passenger railway transport in European countries that are in the process of the railway restructuring must be verified for the new requirements before the start of the competition on the transport market.

Methodology for revitalisation of regional (and suburban, local) railways must be defined to enable easy application on various case studies, and considering all previously defined factors and parameters. Results of a long term predictions and forecast of transport, traffic and passenger volumes must be used in the process of establishing the feasibility of regional railways revitalisation. This imply that the revitalisation should be observed in socio-economic environment by a dynamic approach in period of at least 20 years. We propose the use of well-known method of Internal Rate of Return (IRR) as a measure of feasibility of proposed regional railway revitalisation. It is also called the discounted cash flow rate of return. In this approach, the inputs must be defined in three categories: Incomes or savings obtained by new railway service, Costs or additional costs, and Investments required for revitalisation. Additionally, Residuals of investments can be used in final calculation of IRR. Internal rate of return can be defined as the discount rate at which the present value of all future cash flow is equal to the initial investment or in other words the rate at which an investment breaks even. IRR calculations are commonly used to evaluate the desirability of investments or projects. The higher a project's IRR, the more desirable it is to undertake the project.

Assuming all projects require the same amount of up-front investment, the project with the highest IRR would be considered the best and undertaken first. To apply this method it is required to prepare and calculate forecasted incomes based on the estimation of future number of passengers. Also, future costs and investments will depend on the passenger numbers as a function of number of trains and train units and proposed timetables. The model has a high sensitivity and is very reliant on the quality of forecast models results.

2.5. Feedback

Each system, no matter how perfect set-up, needs feedback to be able to reflect on the changing needs of customers. This could be secured by regular survey of passengers, as well as of the potential customers who are still using another mode of transport.

Transport coordinator or the carrier can make the actual measurement of transport quality in the form of an objective measurement that takes into account:

- Distance availability of services;
- Time availability of services;
- The degree of the required level of service.

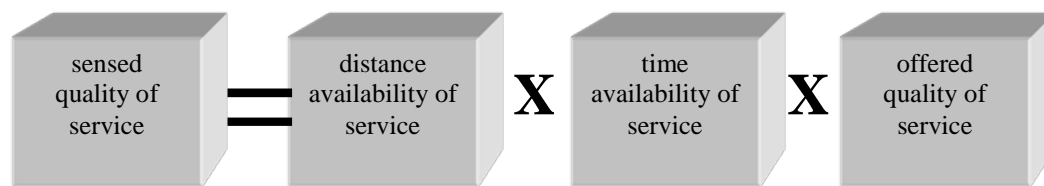


Fig. 4. Factors of service quality

Abb. 4. Faktoren der Servicequalität

3. CONCLUSION

- EU transport police supports the environment friendly modes of transport;
- EU member states have to implement EU regulations to their national law;
- it is necessary to develop operational railway transport system to *eliminate* negative impact of transport to environment;
- operational railway transport system has to be attractive for potential customers,
- attractiveness of transport system depends on good connections between different modes of public transport, speed, frequency of connections, regularity, comfort, security, reliability, appropriate fare, good location of stations and other necessary objects, polite and willing behavior of employees, added services at railway stations and in trains,
- revitalization of regional railway transport depends on transport potential, requirements of potential customers, technical and technological conditions in region.

State of regional transport in Slovakia and Serbia and possibility of application of the revitalisation methodology can be found in part 2 of this paper.

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References

1. Sekulová, J. & Nedeliak, I. & Nedeliaková, E. Utilization of dynamic model Stauss and Neuhaus in conditions of railway transport. *TRANS-MECH-ART-CHEM: X международная научно-практическая конференция студентов и молодых ученых*. 26.-27.5.2014. Москва: МИИТ. [In Russian: X International scientific-practical conference of students and young scientists Moscow: MIIT].

2. Vesković, S. & Belošević, I., & Milinković, S. & Ivić, M. Methodology for revitalization of regional and local railroads. *XV Scientific-Expert Conference of Railways - RAILCON'12*. Nis. 2012. Serbia.
3. Fischer, U. & Mirković, S. & Milinković, S. & Schöbel, A. Possibilities for Integrated Timetables within the Serbian Railway Network. *Facta universitatis-series: Mechanical Engineering*. 2012. P. 145-56.
4. Lalinská, J. & Čamaj, J. Ekonomické dopady meškaní vlakov v osobnej deprave. Strečno, Slovak Republic, September 18th and 19th, 2014. Žilina: Žilinská univerzita. 2014. P. 120-126. ISBN 978-80-554-0918-4. [In Slovak: Economics aspect of passenger's trains delays]
5. Pečený, L. & Gašparík, J. & Dolinayová, A. Quality criteria regional passenger rail services in Slovak republic. *Standards of public transport central strategy vs. regional priorities: sborník příspěvků ze semináře Telč 2014*. Brno: Masarykova univerzita. 2014. P. 39-50. ISBN 978-80-210-7287-9.
6. Nedeliaková, E. & Dolinayová, A. & Gašparík, J. Methodology of transport regulation in the Slovak Republic. *Periodica Polytechnica: Transportation Engineering*. 2010. Vol. 38. No. 1. P. 37-43.
7. Dolinayová, A. & Nedeliaková, E. National railway policy in the Slovak Republic and regulation of the transport. *TEN-T core network & European and national railway policies: proceedings of the 3rd SoNorA University Think Tank Conference (Potsdam)*. 11th of November 2009. Erfurt: Institut Verkehr und Raum der Fachhochschule Erfurt. P. 71-78.
8. Halás, M. & Gašparík, J. & Pečený, L. Possibilities of using suburban train units with tilting system in integrated transport systems. *LOGI 2013: 14th international scientific conference. Conference proceedings*. October 10th 2013, České Budějovice, Czech Republic. České Budějovice: Institute of Technology and Businesses. P. 131-140. ISBN 978-80-7468-059-5.
9. Halás, M. & Zitrický, V. & Blaho, P. Searching for the weaknesses of existing regional railway lines. *Logi: scientific journal on transport and logistics*. 2013. Vol. 4. No. 1. P. 53-62. ISSN 1804-3216.

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