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PARAMETERS OF PASSENGER FACILITIES ACCORDING TO RAILWAY STATION CHARACTERISTICS

Summary. The article presents ways and goals of categorization of railway stations and stops in the Czech railway network. The aim of this categorization is to classify railway stations (or stops) in the railway network according to a suite of entrance parameters (e.g. municipality population, transfer links, job opportunities, tourist attractiveness). On the basis of these parameters, railway stations and stops will be classified into several categories, which will be used to specify the conclusions for station equipment concerning ticket offices, commercial services, waiting rooms and other accessories. Research results can be used as a support for infrastructure managers and railway operators to optimise the scale of their services.

PARAMETER DER BAHNHOFSAUSSTATTUNG FÜR FAHRGÄSTE IN HINSICHT AUF DIE CHARAKTERISTIK DES BAHNHOFS

Zusammenfassung. Der Aufsatz stellt die Weisen und Ziele der Haltepunkts- und Stationskategorisierung auf dem Tschechischen Eisenbahnstreckennetz vor. Seine Absicht ist die Stationen (bzw. Haltepunkte) auf dem Streckennetz nach einem Set der Eingabeparametern (z. B. die Größe der anliegenden Gemeinde, Umsteigeverbindungen, Arbeitsgelegenheiten, touristische Attraktivität) zu kategorisieren. Aufgrund dieser Eingabeparametern werden die Stationen und Haltepunkte in einige Kategorien einsortiert, mithilfe deren werden nachfolgend Folgerungen abgeleitet, wie der Bahnhof in Bezug auf Abfertigung, Kommerzräume, Warteflächen und andere Ausstattung eingerichtet sein sollte. Die Forschungsergebnisse können den Eisenbahnbetreibern im Gebiet des Umfangs der Fahrgastdienstleistungen wie eine Anleitung dienen.

1. INTRODUCTION

Equipment for passengers in railway stations and stops is one of the key parameters for both effective railway transport operation and passengers´ comfort. The range of needed accessory depends on many types of outer influence that may be stable or can be variable in time. By the station facilities we understand e.g. ticket offices, separate waiting areas, areas for short-time waiting, refreshment points, stores and shops and other supplementary commercial activities. The aim of this article is to introduce the methodology for a railway station categorization – the output then should be a recommendation for an optimal railway station or stop equipment, depending on demographical, economical, transport and other relevant influence. This methodology will be verified on certain examples that represent railway station of various parameters (traffic range and characteristics, parameters of the closest settlement etc.) – this will also serve for the calibration of the chosen parameters of the methodology. Later the importance of the single methodology parameters will be set by the authors.

2. FOREIGN EXAMPLES (DEUTSCHE BAHN AG)

Railway stations in the German railway network (or respectively under the administration of Deutsche Bahn AG) has been divided into seven categories since 2011 (a total number of about 5 400 stations), being slightly modified in 2013. These categories are also a part of a price rating methodology named "SPS 11 – Stationspreissystem", which is used for setting the fee level for an external use of the railway stations. Using seven categories and twenty-eight geographical areas a total of 196 fee levels were set for a railway station's external use.

The categorization of the DB Station&Service AG personal transport railway stations includes an evaluation according to various criteria with a different importance to the final score, which can reach a maximum value of 100 (relevant in 04/2013):

- number of platform edges; 1-15, 6 groups, importance 20%
- length of platforms; up to 90 – over 280, 6 groups, importance 20%
- number of passengers per day; up to 49 – over 50 000, 5 groups, importance 20%
- number of stopping trains per day; up to 10 – over 1 000, 6 groups, importance 20%
- personnel is present; 0 or 1, importance 15%
- barrier-free platform access; 0 or 1, importance 5%

Then the stations are divided into seven categories according to their total score:

- Category 1: 100,00 – 90,01 21 stations (eg. Berlin Hbf, Dresden Hbf)
- Category 2: 90,00 – 80,01 83 stations (eg. Berlin ZoologischerGarten, Cottbus)
- Category 3: 80,00 – 60,01 220 stations (eg. Bad Schandau, Görlitz)
- Category 4: 60,00 – 50,01 app. 600 stations (eg. Pirna, Zittau)
- Category 5: 50,00 – 40,01 app. 1000 stations (eg. Furth im Wald, Ebersbach)
- Category 6: 40,00 – 25,01 app. 2500 stations (eg. Eibau)
- Category 7: < 25,00 app. 880 stations (eg. Frankfurt/Oder-Neuberesinchen)

The importance and general equipment of the station corresponds with the reached category. Starting with the highest categories, which include the most important change nodes with all desirable services (both transport and supplementary commercial), followed by middle categories in smaller towns or city suburbs and ending at the lowest categories for stations equipped only by the basic accessories to provide safety or, possibly, a shelter in case of unfavourable weather. The categorization does not reflect the actual size of the railway station buildings, as their importance could have grown or dropped since the time of their construction.

Concerning the aim of this article – the station classification for railway station transport and commercial equipment range – the above presented categorization is insufficient, because it partly calculates with values, which are induced by the transport needs, and not with the needs themselves. The number of passengers and the number of stopping trains can serve as examples – without regarding the type of the station (en-route, junction, terminus etc.) and the operation characteristics (long-distance, suburban) it is not possible to estimate the use of the railway station accessories as it depends directly on these factors. This categorization is therefore interesting for its calculation of the final score of the station, but for further research we have to create a different classification, that would take more inputs into account.

3. ASSUMPTIONS AND CATEGORIZATION PRINCIPLES

The target of this research is to create a methodology that could be used with no extra technical knowledge or expert assessment, based only on one-time parameter definition. Therefore all the parameters have specific values and if not, they have to allow to be set based only on a general judgement. All inputs can be represented by either definite numbers (population, number of trains etc.) or easily distinguishable groups (local, regional, international). The result should be represented by a methodology that can be used for railway station buildings adaptations and dimensioning, mainly by their administrators.

In the categorization described in this article a set of input criteria is divided into a 100 point scale, what is also a maximum value a station can reach. The more points the station reaches, the higher is its importance concerning passenger services.

Although it seems that methodology inputs overlap with its outputs it is not so. The aim of the methodology is not to determine the overall importance of the station (part of which is used as one of the inputs), but only to set a recommended level of provided service.

Based on the total score the final category of the station is chosen and it corresponds with a certain range of services. The categorization is designed as an open system, i.e. its parameters are based on the expert knowledge of the authors verified in real example application. All input values can be recalibrated in case of need, as well as for the output categories different conclusions can be set. Therefore the main target of the methodology is not to assign certain services to a railway station strictly, but to provide a guideline for railway station buildings administrators in the station importance classification, which would be based on unified and exactly set inputs.

The whole categorization is designed as a two-step process. The first step divides the maximum sum of 100 points into four basic general groups, which are further divided among concrete subsidiary segments. Each criterion has a certain share in the final score and also has a given range of its values. Criteria are set mainly exactly to prevent a subjective judgement of a user during the evaluation process. In real the categorization is represented by three charts. The first one is used for a general criteria calibration, the second allows the calibration of the subsidiary segments. As a result the third chart will compute the total score based on the input values for the chosen station. The total score is then used for the station categorization into one of the predefined categories.

4. INPUT PARAMETERS

4.1. General parameters

General criteria in the categorization define the importance of four main groups of input parameters. A share of these criteria influences the further importance division of the subsidiary segments, where the maximum score of the subsidiary segments of a one group can reach only the share of the group within the general criteria. The general criteria are:

- position of the station within the network
- position of the station as a public transport change node
- settlement and a position of the station relatively to this settlement
- attractiveness of the station surrounds

Using these criteria we see, how importance is being divided among the position of the station within the railway network, its public transport inter-change operability (especially concerning integrated systems), position of the station respectively to the closest town or city together with its demography and also the presence of other transport sources and/or targets (job opportunities, sights, shopping etc.). More exactly the groups are explained below and their importance calibration example is shown in Fig. 1.

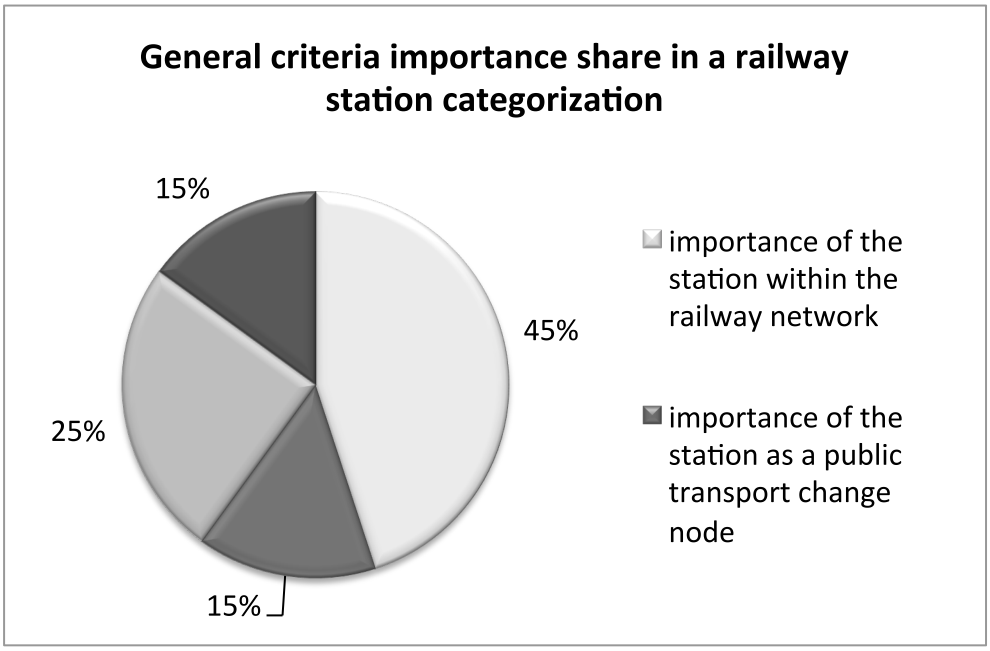

Fig. 1. General criteria share on the total score of the station/stop
Abb. 1. Der Anteil der allgemeinen Kriterien an der Gesamtbewertung der Station/des Haltepunktes

4.2. Subsidiary criteria

The Importance of the station within the railway network criterion consists of segments defining transport characteristics of the station, given by a position of the station within the network as well as the structure and the intensity of the railway traffic. Due to the fact, that the range and structure of the traffic strongly influence passengers´ requirements on the station accessories, the biggest importance share belongs to this criterion within the decision model.

The Railway traffic structure segment represents the quality category of the trains, which stop in the station. It acquires four values rising with a category of the train – suburban trains with a peak interval shorter than 30 minutes, regional trains with a peak interval over 30 minutes, lower quality fast trains and higher quality fast trains (Ex, IC, EC). The highest stopping category is determining. This criterion assumes, that passengers travelling longer distances and those using higher quality trains require a higher level of services within the station buildings. On the other hand daily passengers of suburban trains with short intervals usually require only minimum or even no facilities, as they are coming to the station only a short time before a train departure. If the interval is shorter than 15 minutes a part of the passengers even come to the station regardless of the timetable, as they consider the longest waiting time still appropriate. That can be seen from the development of suburban stations (e.g. Praha-Běchovice or Zeleneč), where shortening the interval has not brought expansion of station services. Moreover, at some stations a reduction in services can be found as a result of more regular use of prepaid tickets instead of single tickets.

The Number of incorporated directions segment considers the fact that in a station, where more railway routes meet, a certain (hardly definable) part of the passengers only changes and does not use the station facilities at all. Therefore with the growing number of incorporated directions the segment score decreases. However, this effect depends on hardly describable parameters, such as platform configuration or timetable (waiting times for connections), therefore only a small importance share is assigned to this segment. During the methodology functionality verification the authors found out, that in some cases this segment can skew the total score of the station. The first countermeasure is the lowered importance share, the next could be a separate coefficient, that would consider the ratio between transit and source/target passengers. From real observations we see, that inverse proportion can be reasonably used only if a perfectly planned timetable allows the passengers to transfer so quickly, that they have no need (or even no chance) to use the station services.

The Number of stopping trains in a peak hour segment evaluates the intensity of railway traffic in the station. It is a total sum of stopping trains not distinguishing among the train categories, as this quality has its own segment. The segment score rises with the number of stopping/ending trains. The peak hour is the hour between two: 00 in which the highest number of trains stop in the station, usually in the morning or the afternoon rush hour.

Table 1

Chart 1. – Dividing general criteria into segments and their importance (part 1)

Importance of the station within the network	total importance (maximum)	45	already divided	45	to divide	0

Railway traffic structure (the highest of the categories)	importance (maximum)	20	given maximum	20

type of railway traffic	rating
suburban trains with a peak interval shorter than 30 minutes	5
regional trains with a peak interval over 30 minutes	10
lower quality fast trains (R)	15
higher quality fast trains (EC, IC, Ex)	20

Number of incorporated directions	importance (maximum)	5	given maximum	5

number of incorporated directions	rating
2	5
3	4
4	3
5	2
6 and more	1

Number of stopping trains in a peak hour	importance (maximum)	20	given maximum	20

number of stopping trains in a peak hour	rating
1 or less	3
2-3	6
4-5	10
6-10	15
11-20	18
more than 20	20

Importance of the station as a public transport change node	total importance (maximum)	15	given maximum	15

importance of the station as a public transport change node	rating	explanation
no importance (is not a public transport change node)	0	-
local change node	5	only bus lines within the settlement
small regional change node	8	only regional bus lines/bus city transport
large regional change node	12	only regional bus lines/bus or tram city transport
inter-regional change node	15	regional and inter-regional bus lines/tram and bus city transport, metro

The second group of segments – Importance of the station as a public transport change node – represents the importance of the station regarding the other modes of a public transport assuming that in optimal case all modes of public transport share the facilities placed preferably within the railway station. The criterion can score four grades – a local change node, a small regional change node, a large regional change node and inter-regional change node. All these types have also their analogy in a city public transport system where a similar division can be made using the means of city public transport.

The Position of the station according to the settlement criterion represents the relationship between the station and the settlement, for simplification represented only by a directly corresponding settlement – usually the town or city of the same name. The input parameter of this criterion is the population of the whole settlement. The score rises linearly with the population number. A correction of this score is provided by many coefficients that correct the actual score depending on the position of the station according to the settlement and also on the existence of other public transport systems nearby. The correction is used in case the station is difficult to reach from the settlement and it is further specified by an existence of another (easily reachable) change node / station. In such cases we assume that the passengers´ demand will be divided among more change nodes / stations or will be attracted to the more accessible one. A special case is represented by a station with a disadvantageous position according to the settlement, whereas there exists another more advantageous public transport change node / station with a similar range of services and similar transport directions. In such case the coefficient affects the total score of the station, because almost all demand will be attracted to the more advantageous change node / station.

The last Attractiveness of the station surrounds criterion considers other influences that may induce transport demands of a permanent or random character. Mainly we are talking about concentration of job opportunities, shopping stores or tourist and recreational attractions, considering their range coverage (town, region, country).

Table 2

Chart 2. – Dividing general criteria into segments and their importance (part 2)

Position of the station according to the settlement	total importance (maximum)	25	
population			
for each	5 000	citizens	1 point
i.e. over	125 000	citizens the same score	
station position according to the settlement coefficient	maximum coefficient value given	1	

station position according to the settlement coefficient	coefficient value	examples	remark
station reachable by foot from the whole settlement area	1	Stratov, Všenory, Poděbrady	
station within the area, reachable by foot or city transport from the whole settlement area, no comparable station/stop	1	Pardubice hl.n.	
station within the area, reachable by foot or city transport from the whole settlement area, there is a more advantageous station/stop	0,25	Nová Paka	*reduces only "Position of the station according to the settlement"*
station within the area, reachable by foot or city transport from the whole settlement area, there is a comparable station/stop	0,5	Ostrava-Svinov, Ostrava hl.n.	
station outside the area, reachable by city transport, no comparable station/stop	0,5	Dvůr Králové, Hořice	
station outside the area, reachable by city transport, there is a more advantageous station/stop	0,1	Golčův Jeníkov	*reduces the total score of the station*

Attractivness of the station surrounds	total importance (maximum)	15	given maximum	15

attractivness of the station surrounds	rating	examples
no attractiveness	0	-
tourist or recreational target - local	5	Malá Skála, Hrusice, Zlenice
tourist or recreational target - regional	10	Máchovo jezero, Křivoklát
tourist or recreational target - coutry	15	Mariánské lázně, Kutná Hora, Karlštejn
concentrated job opportunities within a walk range	5	Jihlava - Bosh Diesel
shopping store within a walk range	5	-

5. OUTPUT PARAMETERS

The final 100-point scale is divided into 5 groups that set a general category of the station and its passengers´ facilities. Below one of the possibilities is presented – the group description as well as the point range can be altered.

Based on application of the methodology on dozens of stations the authors suggest the following categorization, which can be approximately described by model examples:

A (100 – 86pts.): may correspond to large railway nodes in cities with population over 100 000, with higher quality trains stopping

B (85 – 61 pts.): may correspond to important railway nodes with strong source/target traffic, partly with higher quality trains stopping

C (60 – 46 pts.): may correspond to middle-sized stations in larger towns and city suburbs

D (45 – 26 pts.): may correspond to stations and stops in smaller towns with regional traffic

E (25 and less pts.): may correspond to stations and stops with minimum service demand caused by low transport demand or short time spent within the station facilities

Table 3

Facility recommendation according to the category

	A	B	C	D	E
Area layout					
shelter					x
heated/tempered hall	x	x	x	x	
separate waiting area	x	x	x		
separate higher-quality waiting area	x	x			
Transport services					
ticket booth/window	x	x	x	x[1)]	
check-in centre	x	x			
Other services					
supplementary services basic	x		x		
supplementary services extended	x	x			
supplementary services centre	x				
bathroom	x	x	x	x	

x[1)] … depending on turnover, can be combined with commercial activities

6. CONCLUSION

The main target of the above described methodology is to provide a guideline for railway infrastructure administrators, carriers, public administration or integrated transport system coordinators. Its goal is not to present a strict definition how a chosen station should be equipped, but to provide an order or a categorization according to exact criteria. Based on this categorization a decision concerning the station facilities can be made, the recommendation by the authors according to the final score was given.

The main advantage of the methodology is the possibility of its recalibration. This was used mainly during the first calibration on a few dozens of existing stations within the Czech railway network. In the next phase the methodology was calibrated on a few suburban railroads in Prague suburbs and at majority of important railway traffic nodes. Subsequently the methodology was provided for evaluation and testing to chosen Integrated Transport System operators (e.g. in South-Moravian Region) and after minor changes it was found suitable for practical usage.

References

1. Jacura, M. & Havlena, O. & Javořík, T. & Pöschl, D. & Svetlík, M. & Týfa, L. & Vaněk, M. *Optimální podoba přestupních uzlů veřejné hromadné dopravy* [certifikovaná metodika]. Praha: ČVUT v Praze (zpracovala Fakulta dopravní, Ústav dopravních systémů). 2012. Available at:

http://vlaky-sgs.fd.cvut.cz/index.php?file=vystupy&action=show. [In Czech: Jacura, M. & Havlena, O. & Javořík, T. & Pöschl, D. & Svetlík, M. & Týfa, L. & Vaněk, M. *Optimum form interchanges public transport* [certified methodology]. Prague: Czech Technical University in Prague (prepared at Faculty of Transportation, Department of Transport Systems).]
2. Dietmar, L. *Das System Bahn. Handbuch.* Hamburg: DVV Media Group GmbH. 2008. [In German: Dietmar, L. *The railway system. Manual.* Hamburg: DVV Media Group GmbH.]
3. *Das Stationspreissystem SPS 11 - Gültig ab 01.01.2013.* Berlin: DB Station&Service AG. 2012. Available at: http://www.deutschebahn.com/file/3047500/data/stationspreissystem _2011_gueltig_ab_2013.pdf. [In German: *The station pricing system SPS 11 - Valid from 01.01.2013.* Berlin: DB Station & Service AG.]
4. *Die sieben Bahnhofskategorien.* Berlin: DB Station&Service AG. 2013.Available at: http://www.deutschebahn.com/de/geschaefte/infrastruktur/bahnhof/bahnhofs_kategorien.html. [In German: *The seven categories of railway station*. Berlin: DB Station & Service AG.]
5. *Bahnhofskategorieliste 2013* (gültig ab 01.01.2013). Berlin: DB Station&Service AG. 2013. Available at: http://www.deutschebahn.com/file/3216668/data/bahnhofskategorieliste __db__station__service__ag__2013.pdf. [In German: *Station Category List 2013* (actual from 01.01.2013). Berlin: DB Station & Service AG.]
6. Ross, J. *Railway stations: planning, design and management.* Oxford: Architectural Press. 2000.
7. Blow, C. *Transport Terminals and Modal Interchanges, Planning and Design.* Oxford: Architectural Press. 2005.

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