

## LENGTH OF TRANSFER TIME BETWEEN CONNECTING TRAINS – IS THERE AN IDEAL VALUE?

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**ABSTRACT.** Quality public transport is an essential part of global mobility. In general, there is an effort to ensure that as many transport users as possible use public transport. The public transport subsystems also include rail transport. Nowadays, traveling by train is not only a matter of overcoming longer distances in national and international transport, but also a matter of daily commuting to work, school or service. Suburban rail transport is usually part of integrated transport systems, the principle of which is the possibility to use several types of means of transport in one journey per ticket. An indicator of the proper functioning of these systems is the existence of quality and convenient transfer dates times and reliable transfer links that minimize waiting times and total time spent on transportation. Within these systems, there is no network-specific maximum transfer time, which usually depends on the technical solution of the transfer point, the distance that passengers have to cover between vehicles or check-in technology (for example, front door boarding, turnstiles, etc.). the ideal value of the transfer time in terms of the probability that the passenger will not miss the connection and at the same time represents different aspects of the view of this issue. This is on the specific route Ostrava – Prague, which is the busiest in the Czech Republic. Within it, two reference links will be selected (one for each direction), the mean value of the delay in the stations with connections and other statistical indicators will be determined. Furthermore, a simulation of train delays is created using the Monte Carlo method, from which the probability of a connection is determined and subsequently the degree of dissatisfaction with the route is determined while maintaining the current connections. From which a transfer time is subsequently identified in which the probability of passing is as low as possible, but at the same time in normal situations passengers do not have to wait too long.

**KEYWORDS:** Public transport, transfer time, train delay, connecting trains, stability of timetable.

### 1. LITERATURE REVIEW

According to Higgins et al. [1], waiting time is a critical aspect for passengers in deciding on the use of public transport and their perception of the quality of the service. During train journeys, there may be delays for certain reasons, which have a significant effect on the quality of public transport, with missing a connection at the planned transfer point being the worst possible option. The study by Vanstenwegen et al. [2] solves the railway timetable in Belgium and, with the help of linear programming, measures its performance by determining the value of the costs associated with waiting for a connecting link at a transfer station. On the selected railway network, the researchers used this method to find a significant reduction in the costs associated with waiting, with a 30 % reduction in transfer time and the resulting overall delay. However, reducing these costs will increase the number of times a trailer misses (by up to 12 %). According to Goverde [3], the term waiting time in rail transport has several meanings, namely the time after the passenger boarding the train before the train starts, the time the train stays at the railway station where the passenger does not leave, the transfer time at the passenger transfer station the train does not

miss/miss and then again the time before the start of the train to which the passenger transferred. The total transport time then consists of these individual components of waiting times and have an impact on the quality and competitiveness of public transport.

### 2. SOLUTION IN THE CZECH REPUBLIC

Within this issue, the authors of the article determine three model situations that are very easily applicable to the environment of suburban and regional railway transport in the Czech Republic. In principle, there are 3 basic intervals between connections for this form of rail transport. A 30-minute interval in the case of suburban transport to a large agglomeration, a 60-minute interval in the case of railway lines connecting to the main suburban lines and an interval of 120 minutes on normal regional lines. This value is crucial for the calculation, as it is the basis for how many minutes the passenger will have to wait if he misses the connection due to the delay. Due to the independence of local conditions, no specific route was selected, but a transport time of 60 minutes was set. Subsequently, the values for the transfer are determined, namely 5, 10 and 20 minutes, which increase the transport time accordingly. According to the available statistical

No. of occurrences of delays of train IC 548 between 23.3.-26.7.2022	to	6'-	11'-	16'-	21'-	31'-	over	Train
	5'	10'	15'	20'	30'	60'	60'	
Návisi (Nawisie)	5:02	101	4	0	0	0	0	21
Třinec centrum	5:08	97	8	0	0	0	0	21
Třinec (Trzyniec)	5:12	98	7	0	0	0	0	21
Český Těšín	5:18	94	10	1	0	0	0	21
Karviná hl.n.	5:33	87	12	5	1	0	0	21
Bohumín	5:44	68	25	11	0	1	0	21
Ostrava hl.n.	5:57	82	27	13	2	2	0	0
Ostrava-Svinov	6:05	70	34	16	3	3	0	0
Studénka	6:17	76	20	19	8	2	1	0
Suchdol nad O.	6:25	72	24	17	9	2	2	0
Hranice na Moravě	6:40	76	18	19	9	2	2	0
Olomouc hl.n.	7:12	58	29	19	13	5	2	0
Zábřeh na Moravě	7:36	54	24	24	14	6	1	2
Česká Třebová	7:58	53	20	20	23	6	1	2
Ústí n.Orlicí město	8:06	40	28	19	21	14	1	2
Choceň	8:24	49	25	12	13	19	5	2
Pardubice hl.n.	8:43	42	26	13	12	23	7	2
Kolín	9:05	42	21	17	10	25	8	2
Praha-Libeň	9:45	27	17	17	16	19	27	2
Praha hl.n.	9:52	26	14	19	16	22	26	2

No. of occurrences of delays of train IC 549 between 23.3.-26.7.2022	to	6'-	11'-	16'-	21'-	31'-	over	Train	
	5'	10'	15'	20'	30'	60'	60'		
Praha hl.n.	18:02	54	29	13	3	11	10	0	6
Praha-Libeň	18:08	60	25	13	4	12	8	0	4
Kolín	18:47	7	16	31	19	33	14	2	4
Pardubice hl.n.	19:11	12	24	25	16	28	16	1	4
Choceň	19:33	22	24	16	15	27	16	2	4
Ústí n.Orlicí město	19:51	10	24	20	13	32	19	4	4
Česká Třebová	20:00	17	19	17	16	30	19	4	4
Zábřeh na Moravě	20:21	12	20	14	14	29	28	5	4
Olomouc hl.n.	20:43	17	15	13	12	29	29	7	4
Hranice na Moravě	21:12	3	13	11	15	27	44	9	4
Suchdol nad O.	21:27	9	11	10	12	26	45	9	4
Studénka	21:34	10	10	9	12	25	47	9	4
Ostrava-Svinov	21:45	10	14	6	13	22	45	12	4
Ostrava hl.n.	21:53	12	12	9	9	25	43	12	4
Bohumín	22:02	12	12	8	9	25	44	12	4
Karviná hl.n.	22:20	1	5	7	6	20	45	17	25
Český Těšín	22:36	2	5	9	4	19	45	17	25
Třinec (Trzyniec)	22:42	2	5	10	4	17	44	19	25
Třinec centrum	22:45	2	5	9	3	19	44	19	25
Návisi (Nawisie)	22:54	3	5	8	5	19	44	17	25

FIGURE 1. Numbers of delayed trains according to individual time intervals.

yearbook of the infrastructure manager in the Czech Republic [4], specifically the Správa železnic, s.o. it is stated that 90.81 % of passenger trains in 2020 were run on time or with a maximum delay of 5 minutes.

Due to the ease of interpretation, the train connected to the connecting train will be marked first, the connecting train itself will be marked second. The authors assume that the second train at the transfer point will always wait for the arrival of the first train, which is not more than 5 minutes late. This means that the transfer time of 5 minutes will be increased by the time necessary for the transfer of passengers with regard to the amount of delay of the first train. It follows from the above that 9.19 % of trains were operated with a delay of more than 5 minutes in that year. However, this does not mean that in all cases of such a delay the second train will run on time.

The authors assume that in the case of a transfer time of 5 minutes the second train will always run if the first train is delayed by more than 5 minutes, in the case of a transfer time of 10 minutes the second train will run if the first train is delayed more than 10 minutes. The connection is not maintained if the first train is delayed for more than 20 minutes. Data on individual minute percentages of delays are not available, so it is necessary to determine for the purposes of the calculation what percentage of delayed trains was over 10 minutes and how many over 20 minutes. The percentages of likelihood of delay of trains and likelihood of loss connection you can find in Tables 1 and 2.

### 3. CASE STUDY

In this case study, two connections (IC 548 and IC 549) were observed on the busiest route in the Czech Republic (Prague – Ostrava) in the period from 23 March

	Likelihood of Delay			
	5–10 min	10–20 min	20–30 min	>30 min
<5 min	90.81 %	3.68 %	2.76 %	1.84 %
				0.92 %

TABLE 1. Likelihood of Delay (according to minute intervals).

Loss of Connection (per. of cases)	Transfer Time		
	5 min	10 min	20 min
	9.19 %	5.51 %	2.76 %

TABLE 2. Likelihood of losing connection during different transfer times.

to 26 July 2022, i.e. 126 connections in the direction of Prague and 126 connections in the direction of Ostrava. The connections IC 548 and IC 549 are part of the long-distance line Ex1 and serve stations (Návisi, Třinec-centrum, Třinec, Český Těšín, Karviná hl.n., Bohumín, Ostrava hl.n., Ostrava-Svinov, Studénka, Suchdol nad Odrou, Hranice na Moravě, Olomouc hl.n., Zábřeh na Moravě, Česká Třebová, Ústí nad Orlicí město, Choceň, Pardubice hl.n., Kolín, Praha-Libeň, Praha hl.n.). However, connection IC 548 does not serve the section Návisi – Bohumín on Sundays and connection IC 549 does not serve this section on Saturdays. Train arrival delays at individual stations are shown in the tables in Figure 1. For better clarity, individual delays are categorised. It should be noted that 21 connections of trains IC 548 and IC 549 are listed as cancelled in the Návisi – Bohumín section, but these are connections that do not run according to the valid timetable.

To illustrate the whole situation, the authors de-

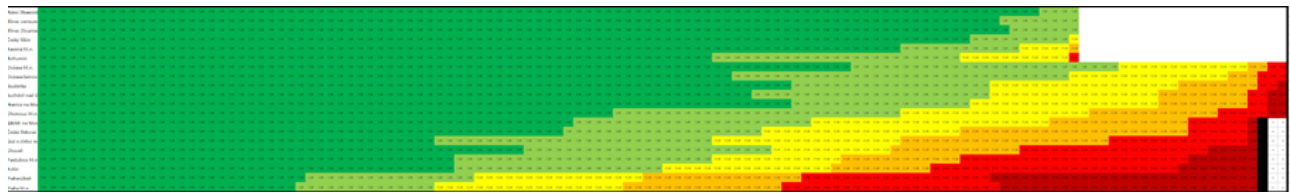


FIGURE 2. Distribution of train delays within individual stops.

Station	Arrival	$\lambda$	No. of occurrences of delayed train IC 548												$\Sigma n$	
			<0,5>	(5,10>	(10,15>	(15,20>	(20,25>	(25,30>	(30,35>	(35,40>	(40,45>	(45,50>	(50,55>	(55,60>		(60,inf)
Ostrava-Svinov	6:05	6,01	600 543	225 873	98 026	42 624	18 588	8 201	3 488	1 560	600	281	129	33	54	1 000 000
Hranice na Moravě	6:40	6,83	553 504	231 530	111 576	53 705	25 879	12 423	5 798	2 842	1 424	684	326	176	133	1 000 000
Olomouc hl.n.	7:12	8,27	485 051	233 842	127 252	69 793	38 239	20 919	11 418	6 120	3 266	1 812	1 036	580	672	1 000 000
Česká Třebová	7:58	11,59	377 999	218 015	141 521	92 026	59 754	38 590	25 118	16 585	10 680	6 964	4 493	2 917	5 338	1 000 000
Pardubice hl.n.	8:43	15,02	306 582	196 516	141 392	100 496	72 449	51 391	36 891	26 657	19 267	13 748	9 738	7 086	17 787	1 000 000
Kolín	9:05	15,60	297 344	192 697	139 331	101 589	73 499	53 634	38 924	28 120	20 521	15 036	10 735	7 770	20 800	1 000 000
Praha hl.n.	9:52	21,73	223 322	159 597	126 630	100 811	80 072	63 588	50 430	40 101	31 920	25 367	20 284	15 976	61 902	1 000 000

Station	Arrival	$\lambda$	No. of occurrences of delayed train IC 549												$\Sigma n$	
			<0,5>	(5,10>	(10,15>	(15,20>	(20,25>	(25,30>	(30,35>	(35,40>	(40,45>	(45,50>	(50,55>	(55,60>		(60,inf)
Kolín	18:47	19,78	242 744	169 126	131 213	101 869	79 403	61 718	47 908	36 925	28 655	22 386	17 583	13 330	47 140	1 000 000
Pardubice hl.n.	19:11	18,35	259 257	177 118	134 278	102 413	78 091	59 229	45 402	34 515	25 968	20 061	15 164	11 706	36 798	1 000 000
Česká Třebová	20:00	20,97	230 182	163 593	128 364	101 335	79 778	62 497	49 602	39 367	30 959	24 121	19 117	15 126	55 959	1 000 000
Olomouc hl.n.	20:43	25,30	195 585	143 485	118 593	97 847	79 892	65 444	53 721	43 749	36 337	29 811	24 056	19 858	91 622	1 000 000
Hranice na Moravě	21:12	31,51	159 753	124 087	105 278	89 471	76 703	65 322	55 440	47 179	40 664	34 698	29 475	25 552	146 378	1 000 000
Ostrava-Svinov	21:45	32,44	156 005	120 611	103 353	88 512	76 051	65 161	55 374	47 578	40 921	35 286	30 430	26 209	154 509	1 000 000
Bohumín	22:02	32,24	156 153	121 487	103 872	88 599	76 446	65 224	56 258	47 772	41 093	35 033	29 881	25 494	152 688	1 000 000

FIGURE 3. Number of occurrences of delayed trains.

cided to graphically illustrate the delays on the IC 548 connection in Figure 2, where the dark green color shows the arrival of a train to the station with a delay of up to 5 minutes, light green up to 10 minutes, yellow up to 15 minutes, orange up to 20 minutes, red up to 30 minutes, dark red up to 60 minutes and black above 60 minutes, and the trains not running are then shown in white.

From the above, it can be seen that train IC 548 performs significantly better than train IC 549, even though it runs part of its route in the morning peak. IC 549, even though it departs at the end of the afternoon peak, managed to depart from its departure station only 43 % of the time with a delay of up to 5 minutes in the period under review. It reached the station Návší with a delay of 5 minutes only in 3 % of cases.

On the basis of the obtained frequency of delays on arrivals to the stations, it is possible to determine the individual statistical parameters that will be used to build a Monte Carlo simulation model. In particular, the mean value of the occurrence of delays  $\lambda$ . It is also known that train delays follow an exponential probability distribution. For simplicity, the authors decided that for train IC 548 the simulation will be performed only at the stations Ostrava-Svinov, Hranice na Moravě, Olomouc Main Station, Česká Třebová, Pardubice Main Station, Kolín and Prague Main Station, which are important interchanges. For train IC 549, simulations will take place at the same stations, except for the station Praha hl.n., which is the departure station for the train and will be replaced by the station Bohumín. Within each station, 1 000 000 train delays will be simulated. The simulation was carried out on the basis of a script written in Python programming language.

The tables at Figure 3 show the results of the fre-

quency of delays for trains IC 548 and IC 549 in the simulation. At first glance, it can be seen that there is an increase in the average delay for trains in both directions over the course of the train journey. For a better demonstration of this phenomenon, the Figure 4 show the frequency of delays for the IC 548 service at Ostrava-Svinov and Praha hl.n stations and for the IC 549 service at Kolín and Bohumín stations.

It can be seen from the graphs at Figure 4 and Figure 5 that the average delay is indeed increasing during the train journey, which points to the fact that the timetable of IC 548 and IC 549 is very unstable and is not able to absorb the resulting delays, which clearly has a detrimental effect on connecting links, and therefore it is evident that these will subsequently lead to an increase in dissatisfied passengers, which may escalate into a passenger exodus from public transport and this problem needs to be addressed more. However, it is necessary to add in one breath that during the period under review there were three closures, namely the Přerov junction, the Ústí nad Orlicí – Choceň section, Kolín – Poříčany, which had a clearly negative impact on train travel.

The tables in Figure 6 show the cumulative probability of train delays on arrival at the monitored stations. This information is very relevant for determining the appropriate changeover time for connecting trains. Within the transfer times, the authors decided to establish three categories – stable transfer link (90–100 % probability of securing a transfer), partially stable transfer link (75–90 %) and unstable transfer link (less than 75 %). The table below then shows the individual transfer links at the stations listed. A connecting train is defined as a connection running a maximum of 30 minutes after the arrival of the first train (at Praha hl.n. station this time was set at 45 minutes) and is not a return connection or a

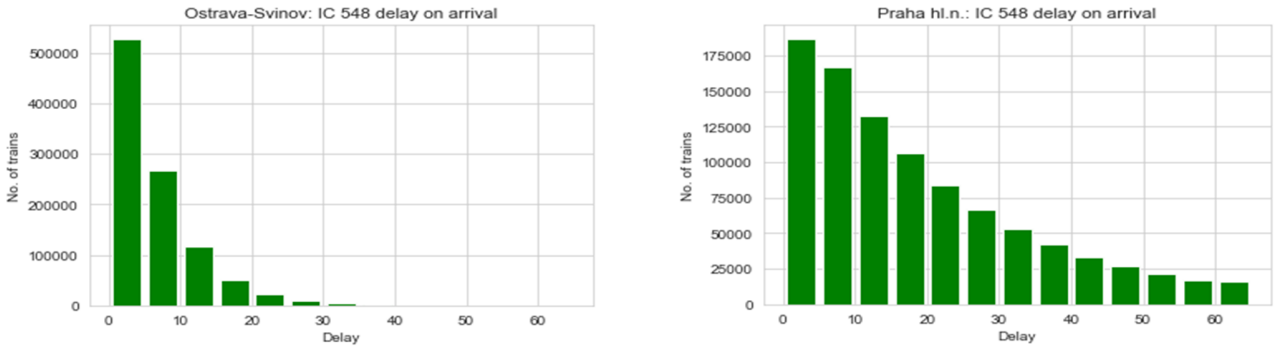


FIGURE 4. Numbers of delayed trains of train number 548 according to individual time intervals.

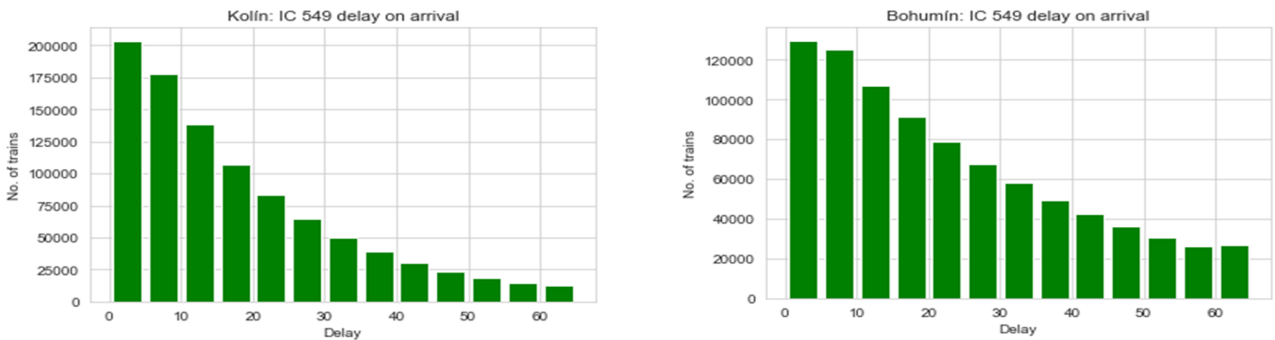


FIGURE 5. Numbers of delayed trains of train number 549 according to individual time intervals.

		Cumulative probability of train delay on arrival IC 548													
Station	Arrival	$\lambda$	<0,5>	(5,10>	(10,15>	(15,20>	(20,25>	(25,30>	(30,35>	(35,40>	(40,45>	(45,50>	(50,55>	(55,60>	(60,inf)
Ostrava-Svinov	6:05	6,01	0,601	0,826	0,924	0,967	0,986	0,994	0,997	0,999	1,000	1,000	1,000	1,000	1,000
Hranice na Moravě	6:40	6,83	0,554	0,785	0,897	0,950	0,976	0,989	0,994	0,997	0,999	0,999	1,000	1,000	1,000
Olomouc hl.n.	7:12	8,27	0,485	0,719	0,846	0,916	0,954	0,975	0,987	0,993	0,996	0,998	0,999	0,999	1,000
Česká Třebová	7:58	11,59	0,378	0,596	0,738	0,830	0,889	0,928	0,953	0,970	0,980	0,987	0,992	0,995	1,000
Pardubice hl.n.	8:43	15,02	0,307	0,503	0,644	0,745	0,817	0,869	0,906	0,932	0,952	0,965	0,975	0,982	1,000
Kolín	9:05	15,60	0,297	0,490	0,629	0,731	0,804	0,858	0,897	0,925	0,946	0,961	0,971	0,979	1,000
Praha hl.n.	9:52	21,73	0,223	0,383	0,510	0,610	0,690	0,754	0,804	0,845	0,876	0,902	0,922	0,938	1,000

		Cumulative probability of train delay on arrival IC 549													
Station	Arrival	$\lambda$	<0,5>	(5,10>	(10,15>	(15,20>	(20,25>	(25,30>	(30,35>	(35,40>	(40,45>	(45,50>	(50,55>	(55,60>	(60,inf)
Kolín	18:47	19,78	0,243	0,412	0,543	0,645	0,724	0,786	0,834	0,871	0,900	0,922	0,940	0,953	1,000
Pardubice hl.n.	19:11	18,35	0,259	0,436	0,571	0,673	0,751	0,810	0,856	0,890	0,916	0,936	0,951	0,963	1,000
Česká Třebová	20:00	20,97	0,230	0,394	0,522	0,623	0,703	0,766	0,815	0,855	0,886	0,910	0,929	0,944	1,000
Olomouc hl.n.	20:43	25,30	0,196	0,339	0,458	0,556	0,635	0,701	0,755	0,798	0,835	0,864	0,889	0,908	1,000
Hranice na Moravě	21:12	31,51	0,160	0,284	0,389	0,479	0,555	0,621	0,676	0,723	0,764	0,799	0,828	0,854	1,000
Ostrava-Svinov	21:45	32,44	0,156	0,277	0,380	0,468	0,545	0,610	0,665	0,713	0,754	0,789	0,819	0,845	1,000
Bohumín	22:02	32,24	0,156	0,278	0,382	0,470	0,547	0,612	0,668	0,716	0,757	0,792	0,822	0,847	1,000

FIGURE 6. Cumulative probability of trains delays.

connection in the same category going to the same destination station. The table shows the station, arrival time, number of the connecting train, time until departure of the connecting train, destination station of the connecting train, direction, stability of the connecting link based on the cumulative probability of train delay, number of the next train going in the given direction (without change), time from departure of the first connecting train to departure of the second train, the risk of missing the connection (this is a two-dimensional quantity consisting of the complement of the stability of the connection and the time in minutes until the departure of the next train going in that direction) and the proposed transfer time based on the cumulative probability of train delay, so as to ensure a lower bound of the stability of the connection, i.e. 90%.

The tables in Figures 7 and 8 show that for train IC 548 all interchanges beyond Olomouc hl.n. station are unstable. The transfer coupling at Kolín station to train R 1302 in the direction of Poděbrady, Mělník and Ústí nad Labem hl.n. is the least stable. The highest transfer risk is then the transfer link at Prague Main Station to train EC 333 in the direction of České Budějovice and Linz, where the stability of the transfer link is only 38.3% and the next connection takes 4 hours. For train IC 549 the situation is even more desperate. None of the interchanges are stable, even for the last connections of the day. In practice, these connections are obliged to wait for the arrival of the delayed train even with a longer delay, but the whole situation leads to disillusionment for passengers.

IC 549		Time to		Via	Stability of the transfer	Next train no.	Time to next train dep [min]	Risk of transfer detention	Proposed transfer time	
Station	Arrival	Train no.	con.train dep [min]							Destination
Kolín	18:47	Os 5037	5	Pardubice hl.n.	Chvalčovice – Přelouč	24,3	Os 9349	57	4315	40
		R 1312	27	Ústí nad Labem hl.n.	Poděbrady – Mělník	72,4	R 1314	120	3312	40
Pardubice hl.n.	19:11	Os 6252	22	Hradec Králové hl.n.		67,3	Os 6206	60	1962	40
Česká Třebová	20:00	Os 3789	4	Zábřeh na Moravě	Rudoltice v Čechách	23,0	Os 12705*	543	41811	45
		Os 24779	17	Moravská Třebová		52,2	Os 12753*	137	6549	45
Olomouc hl.n.	20:43	Os 3741	9	Prostějov hl.n.		19,6	Os 3743	50	4020	55
		R 800	25	Břeclav	Přerov – Otrokovice	55,6	Os 3811*	431	19136	55
Hranice na Moravě	21:12	R 1131	30	Bohumín	Studénka – Ostrava-Svinov	55,5	R 1133	60	2670	60
Ostrava-Svinov	21:45	Os 3450	13	Opava východ	Háj ve Slezsku	27,7	Os 3452	58	4193	60

Note:  
Os 12705: This is not a direct connection, a change at the station Rudoltice v Čechách is required.  
Os 12753: This is not a direct connection, a change at the station Třebovice v Čechách is required.  
Os 3811: This is not a direct connection, a change at the station Přerov is required.

FIGURE 7. Stability of transfers during the way of train number 549.

IC 548		Time to		Via	Stability of the transfer	Next train no.	Time to next train dep [min]	Risk of transfer detention	Proposed transfer time	
Station	Arrival	Train no.	con.train dep [min]							Destination
Ostrava-Svinov	6:05	Os 3446	10	Opava východ	Háj ve Slezsku	60,1	Os 3406	26	1037	13
		Os 3304	24	Hranice na Moravě	Studénka	96,7	R 1104	18	59	13
Hranice na Moravě	6:40	Sp 1426	12	Olomouc hl.n.	Lipník nad Bečvou	78,5	Os 3334	3	65	17
		Os 3334	15	Přerov	Lipník nad Bečvou	78,5	Os 3204	65	1398	17
		Os 3203	16	Vsetín	Valašské Meziříčí	89,7	Os 3205	58	597	17
Olomouc hl.n.	7:12	R 883	19	Luháčovice	Přerov – Otrokovice	84,6	R 885	120	1848	20
		Os 3541	21	Hrubá Voda		91,6	Os 3543	124	1042	20
		Os 3712	21	Kouty nad Desnou	Mohelnice – Šumperk	91,6	Os 3716	60	504	20
		Os 3713	21	Nezamyslice	Prostějov hl.n.	91,6	Os 3717	120	1008	20
		Os 14011	22	Senice na Hané	Olomouc město	91,6	Os 14013	60	504	20
Česká Třebová	7:58	Os 3775	6	Lanškroun	Rudoltice v Čechách	37,8	Os 12719	60	3732	27
		Os 95454	10	Choceň	Ústí nad Orlicí	37,8	Os 95456	120	7464	27
		Os 24757	16	Moravská Třebová		73,8	Os 24761	123	3223	27
		R 872	17	Praha-Vršovice	Choceň – Pardubice hl.n.	73,8	R 892	60	1572	27
Pardubice hl.n.	8:43	R 1064	20	Liberec	Hradec Králové hl.n.	64,4	R 1066	120	4272	32
		Os 5333	20	Slatiňany	Chrudim	64,4	Os 5321	50	1780	32
Kolín	9:05	R 1302	10	Ústí nad Labem hl.n.	Poděbrady – Mělník	29,7	R 1304	120	8436	37
		Os 3924	19	Praha Masarykovo n.	Velim – Pečky	62,9	Os 9326	60	2226	37
		Os 5816	27	Praha Masarykovo n.	Poděbrady – Nymburk hl.n.	80,4	Os 65818	60	1176	37
Praha hl.n.	9:52	EC 333	12	Linz Hbf	České Budějovice	38,3	EC 335	240	14808	47
		Os 2529	13	Benešov u Prahy	Říčany	38,3	Os 2533	60	3702	47
		R 770	16	Klatovy	Plzeň hl.n.	51,0	R 768	120	5880	47
		Os 8828	29	Beroun	Řevnice	69,0	Os 8832	60	1860	47
		EC 174	33	Hamburg Altona	Ústí nad Labem hl.n.	75,4	EC 378	120	2952	47
		R 713	38	České Budějovice	Tábor	80,4	R 715	60	1176	47

FIGURE 8. Stability of transfers during the way of train number 548.

#### 4. CONCLUSION

The analysis of the interchange links and the subsequent simulation shows that the current form of the timetable of trains IC 548 and IC 549 and the timetable of departures of connecting trains is very unstable, where only 5 out of 34 interchange links can be described as stable and 7 as partially stable, the remaining 22 links are unstable. For some links the probability of catching the connection is less than 50% (9 cases) or even 25% (3 cases). In many cases, the proposed changeover times are several tens of minutes higher than the current ones, which is definitely not a sustainable solution. Another issue may be the reintroduction of a fast train segment on the Prague – Ostrava route, which could solve the Ex1-R8 and Ex1-R19 interchanges and reduce the risk of double transfers (Ex1-Kopřivnice-Nový Jičín-Bílovec-Náchod-etc.).

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