

THE LOST PASSENGERS: INSIGHTS INTO THE GROUP OF PASSENGERS THAT STOPPED TRAVELLING BY TRAIN AFTER COVID-19

Menno de Bruyn, Danique Ton
NS, Netherlands Railways
Niels van Oort
Delft University of Technology

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ABSTRACT

The COVID-19 pandemic has strongly impacted people's travel behaviour and public transport was most affected. Now the pandemic is over, we can see the structural impact on current train travel behaviour. Train ridership in the Netherlands at the end of 2022 is still 15 to 20% lower than before the COVID-19 pandemic. This is caused by low influx of new travellers, travellers making fewer train trips, but also a group that has abandoned taking the train at all. This paper focusses on this last group.

Netherlands Railways (NS) and Delft University of Technology have carried out a large longitudinal research into the effects of the COVID-19 pandemic on train ridership, consisting of 8 waves. Each wave investigates current and intended travel behaviour, and experiences of travelling by train. These waves yielded a rich dataset, with in total over 52,000 respondents in at least one wave, 5,000 took part in all eight waves, and almost 19,000 participated in the last wave. This last (8th) wave was carried out in November 2022 and can be seen as the first 'post-COVID-19' wave of the research, thus giving insight in the structural effects of COVID-19 on train ridership.

The group that has indicated to have quit traveling by train altogether consists of roughly 900 respondents (~5%). While at first, a group of 5% of the total population that quit travelling by train seems large, the effect on total train ridership is small. This is mainly caused by them not travelling very frequently pre-COVID. Most of these travellers already had a negative attitude towards the train and a positive attitude towards the car: they only needed a small push to leave the train. When confronted with a large push like COVID, they quit travelling by train, most of them already in the second COVID year. Also, anxiety for COVID is, even in November 2022 with the big waves of infection already half a year in the past, still a problem for some travellers and a reason why they quit travelling by train. The lost passengers are older than the average train traveller: more than half of the group is over 55, while this is around 30% for the reference group. The oldest segment of 75+ is even three times as big as reference.

Getting these travellers back seems like a difficult task: the majority does not plan to return travelling by train in the near future. Better train services (less crowding, higher frequencies and reliability) are mentioned often as conditions to return, next to improved (personal) financial circumstances and improved health conditions.

1. INTRODUCTION

The COVID-19 pandemic has strongly impacted people's travel behaviour. Due to imposed government restrictions, recommended or mandatory working from home, and in-person activities being cancelled or organized online, people's trip frequencies dropped significantly (e.g., Abdullah et al., 2020; Mouratidis & Papagiannakis, 2021; Parady et al., 2020). However, not all travel modes suffered from the pandemic to the same degree. Public transport was most affected, as many people shifted (partly) to teleworking and/or alternative modes, such as active modes, cars, or even ride hailing services (e.g., Bhaduri et al., 2020; Eisenmann et al., 2021; Monahan & Lamb, 2022, van Hagen et al., 2021, Bickel et al. 2023). Train ridership in the Netherlands dropped to below 10% of the pre-COVID levels. Since then, it has gone up and down with the rhythm of outbreaks, government measures taken, and relaxations. Last government measures were abandoned in March 2022, when facemasks were no longer mandatory in public transport. Ever since there was only a slight increase in train ridership. In many regions, public transport levels are still significantly below the levels before the pandemic (e.g., Beck et al., 2021; Javadinasr et al., 2022).

The drop in public transport ridership during the pandemic was not surprising, as crowdedness and close distances from other passengers result in a significant risk of infection (Hafsteinsdottir et al., 2022). At the start of the pandemic, only essential workers were allowed (government orders) to use public transport. Public transport operators often responded to these reduced ridership levels by making service cuts, thereby making it less appealing for people to return (e.g., Gkiotsalitis & Cats, 2020). Furthermore, studies have shown that the pandemic resulted in less favorable attitudes towards public transport, while attitudes towards other modes remained stable (de Haas et al., 2020).

Worldwide, not all population groups stopped using public transport during the pandemic to the same extent. Especially people with higher incomes reduced their ridership, as they often had the chance to work from home or switch to car use, while low-income individuals often have no other choice than to commute to work (Kim et al., 2021; Parker et al., 2021). Hu and Chen (2021) found that ridership especially declined in areas with higher percentages of white, educated, and high-income individuals, while Palm et al. (2022) found that especially young adults (ages 18-29) and recent immigrants shifted to car use and often even purchased a car.

In the Netherlands, the marginal difference in ridership levels between the last pandemic periods and post-COVID times are mostly caused by people travelling less often, but also by people not travelling by train at all anymore. These two groups may differ and call for different measures to get them back to using the train or taking the train more often. Until now much remains unclear about the group of people that has abandoned the train. What is the size and profile of this group? And most important, especially to the transit operators, how can they be convinced to return to public transport? This paper investigates these questions by means of a large-scale data collection effort from NS (Dutch train operator) and Delft University of technology. From the onset of the

pandemic in March 2020, a total of eight waves of surveys have been collected among the same group of people (panel) (Van Hagen et al. 2021, Ton et al. 2022a, Ton et al. 2022b).

The paper is organised as follows. Section 2 discusses the methodology and conceptual framework for this research. Section 3 describes the data collection effort. In sections 4 to 7 the results are presented and finally, in section 8 the paper is concluded.

2. METHODOLOGY

This research focusses on lost passengers. A clear definition is needed for when a passenger is considered as 'lost'. In this research we define a passengers as 'lost' when both of the following conditions are met:

1. The passenger did travel by train before COVID-19;
2. The passenger does currently not travel anymore by train (no trips made during the last week in the eighth wave of the survey and the participant also indicated not to travel anymore by train in general).

The outline of our research is shown in Figure 1. We want to know causes for not travelling by train anymore in the post-Covid-19 period. Furthermore, the timing of when a passenger stopped travelling is of essence as this provides information on the reason for leaving, but also whether there is potential for returning later. The profile(s) of the lost passenger itself is of importance as well. All these insights help to develop strategies to get (part of) these passengers back in the train and also develop robust plans to not lose passengers again.

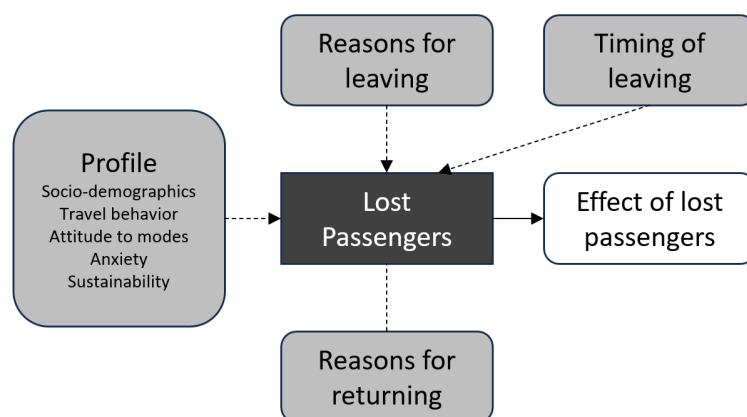


Figure 1: Research outline

The profile of lost passengers, compared to remaining passengers is identified using binary logistic regression. This is a common analysis method for a binary dependent variable (Berkson, 1944), with in our case values 0 = remaining and 1=lost. Then from the last survey wave causes of leaving are identified. From previous waves we conclude when the lost passengers left: was this only during the last wave or were they lost somewhere along the way in the pandemic? Finally, we look into possibilities to win them back, based on responses from the last wave.

3. LARGE SCALE DATA COLLECTION

NS and Delft University of Technology have carried out a large longitudinal research into the effects of the COVID pandemic on train ridership, consisting of 8 waves (Ton et al. 2022b). Each wave investigates current and intended travel behaviour, and experiences of travelling by train. On top of that, specific topics are included in each research, like alternative vehicle purchasing, experiences in working from home or commercial opportunities.

Wave 1 was carried out in April 2020. We then invited the complete NS internet panel. This is a voluntary panel, consisting of about 80,000 people. They are invited to participate in different types of research, mostly online, but also on-site. Our COVID research was based on internet surveys. As an extra check on bias due to using the NS internet panel the first wave was also carried out on an external panel. In order to ensure representative results data was weighed in classes of train frequency, trip purpose and age (Ton et al, 2022b).

Almost 46,000 of them participated in the first wave (see table 1). At the end we asked if they were willing to participate in follow-up research, and 96% of them were. This resulted in 44,000 respondents, that were invited in each of the waves 2 till 8. As response slowly decreased, we decided to boost the response in wave 7, by inviting everyone from the NS panel that did not participate thus far, excluding the small group of almost 2,000 respondents that indicated they did not want to participate in this research. This yielded about 6,700 new respondents, that were invited in the last wave as well. See Tables 1 and 2 for details about the surveys and participants.

The 8 waves resulted in a rich dataset, with in total over 52,000 respondents in at least one wave, 5,000 took part in all eight waves, and almost 19,000 participated in the last wave (see table 2). This wave was carried out in November 2022 and can be seen as the first 'post-COVID' wave of the research, thus giving insight in the structural effects of COVID on train ridership.

Table 1: number of respondents per wave

Wave	Respondents
1: Apr '20	45,937
2: Jun '20	30,632
3: Sep '20	24,427
4: Dec '20	23,202
5: Apr '21	23,031
6: Sep '21	18,185
7: Mar '22	24,514
8: Nov '22	18,821
TOTAL	208,247

Table 2: Number of times respondents participated in the surveys

	From participants wave 1	From extra participants wave 7	Total
1 time	6,187	4,070	10,257
2 times	6,514	2,675	9,189
3 times	5,986		5,986
4 times	5,722		5,722
5 times	5,509		5,509
6 times	5,462		5,462
7 times	5,505		5,505
8 times	5,052		5,052
TOTAL	45,937	6,745	52,682

4. PROFILE OF LOST PASSENGERS

In the previous section, we defined the “lost passengers” as passenger that did travel before COVID-19, but did not anymore after (wave 8). Of the total of 18,821 respondents that participated in wave 8, 52% mentioned to travel less by train. Of these 9,967 respondents 69% did not travel by train last week. And of these 5,753 respondents there were 910 (16%) that currently travel 100% less than pre-COVID, see table 3. That is ~5% of the total participants of wave 8. Even though there seems to be redundancy in the definition of lost passengers (a person that travels 100% less also will not have travelled last week), there were some minor inconsistencies: there were 17 respondents that travel 100% less, but still did travel last week. These were not included in the lost passengers.

Table 3: Definition and number of lost passengers

Total passengers of wave 8	18,821 (100%)		
Travel frequency compared to pre-COVID	more	as much	less
	953	8,171	9,697 (52%)
Train travel last week	yes		no
	3,944		5,753 (31%)
% less compared to pre COVID	<100%		100%
	4,843		910 (5%)

By comparing the group of lost passengers with the reference group (the rest of the population), a quite clear distinction of this group can be made, as shown by Table 4. The lost passengers are older than the average train traveller: more than half of the group is over 55, while this is around 30% for the reference group. The oldest segment of 75+ is even three times as big as reference. Also, they were already low frequent train travellers pre-COVID: almost half of them travelled less than once every 2 months by train, whereas this is a quarter in the reference group. The group of lost passengers travels more often by car: one third travels at least 4 days a week by car; twice as much as reference. They are also more positive towards car, and more negative towards train. To conclude, this group is more anxious to travel by train and they have higher fear of contamination and are less likely to use the train more often because of sustainability.

Table 4: Profile of lost passengers compared to remaining passengers

Profile		Remaining passengers	Lost passengers
age	55-64	12%	19%
	65-74	11%	20%
	75+	5%	14%
train trips	low frequency (1-5x a year)	24%	48%
	high frequency (4x a week)	15%	32%
car trips	increasing frequency	24%	56%
	positive to car	40%	64%
attitude	negative to train	12%	48%
	don't feel free to travel by train	9%	44%
anxiety	avoid crowded places	44%	66%
	fear of contamination	18%	42%
sustainability	consider train more often b/o sustainability	15%	32%

There are some correlations between these variables. Hafsteinsdottir et al (2022) already showed that age and anxiety are correlated, and from Kroesen et al (2023) we know that train attitude and train ridership are correlated. Also, people that have a negative attitude towards the train tend to be more positive about the car.

To deal with these correlations we carry out a binary ordinal regression (Berkson, 1944), where we estimate the lost passengers from trip frequencies of other modes, attitudes, COVID fear related variables, reasons for travelling less by train and age groups. This gives the model as shown by table 5, with a McFadden pseudo R² of 0,205. The table also shows the probability of being a lost passenger based on each specific aspect.

Table 5: Model estimation lost passengers

	Estimate	Wald	Sig	Probability of being a lost passenger is high when:
Threshold (Lost=0)	-0,378	0,165	0,685	
Frequency bike	0,212	31,775	0,000	Frequency of bike use is low
Frequency shared bike	-0,621	8,696	0,003	Freq. of shared bike use is high
Frequency car	-0,194	20,336	0,000	Frequency of car use is high
Attitude bike	0,312	37,588	0,000	Attitude towards bike is positive
Attitude PT bike	-0,259	24,193	0,000	Attitude towards PT-bike is neg.
Attitude scooter	0,137	10,469	0,001	Attitude towards scooter is pos.
Attitude car	0,203	17,118	0,000	Attitude towards car is positive
Attitude train	-0,676	280,971	0,000	Attitude towards train is negative
Fear of contamination	0,115	9,150	0,002	Fear is high
Avoid busy places	0,234	26,450	0,000	Avoidance is high
Work from home more often	-0,492	14,863	0,000	less often travels less b/o more WFH
Make less leisure trips	-0,302	11,016	0,001	less often travels less b/o less leisure
Use other mode of transportation	0,429	23,525	0,000	more often travels less b/o other mode
Have less money to spend	0,368	9,950	0,002	more often travels less b/o less money
Train runs less frequent	-0,703	36,884	0,000	less often travels less b/o lower frequency
Other reasons* to travel less	0,543	36,686	0,000	more often travels less b/o other reasons*
Age 18-24	-0,805	10,670	0,001	are not in age 18-24
Age 25-34	-1,385	55,888	0,000	are not in age 25-34
Age 35-44	-1,017	37,750	0,000	are not in age 35-44
Age 45-54	-1,280	79,698	0,000	are not in age 45-54
Age 55-64	-0,490	10,868	0,001	are not in age 55-64
Age 65-74	-0,280	3,527	0,060	are not in age 65-74
Age 75+	0a	0,000	0,000	reference age group

* most common other reasons are: reliability of train service, COVID-19 or health related, commercial reasons like pricing or ticket subscriptions, travelling with other modes and being retired.

From this we see that especially old people (aged above 65 or even more so above 75), people that travel a lot by car or shared bike, people with positive attitude towards car, bike or scooter, and with fear of COVID-19 are more likely to be a lost passenger. On the other hand, people that have a positive attitude to train or are within the age group of 25 to 54 are less likely to be lost.

As shown by Table 3, about 5% of the passengers are lost. But we already noticed that this group consists of less frequent train travellers. So, what is the effect on the number of trips? As compared to pre-COVID train ridership per person in wave 8 (November 2022) dropped with 21%. This can be split between current travellers traveling less, and lost passengers not traveling anymore. The lost passengers account for roughly 3% drop in total train ridership, while the remaining passengers account for the other 18% drop. So traveling less by remaining passengers is a bigger problem than not traveling

at all. On the other hand, the lost passengers make up for only 5% of the population, but still cause almost 15% (3% out of the total of 21%) of the total drop in train ridership.

5. REASONS FOR NOT TRAVELLING BY TRAIN ANYMORE

In wave 8 every respondent that showed a change in train travel behaviour compared to pre-COVID was asked what the reasons for this change in a multiple response question were. There were 12 predefined choices, with an 'other' option as well. For the 'other' option the respondent could write down his/her own specific reason. The 'other' option was chosen a lot, so it was analysed and broken down into some main categories. Table 6 shows the reasons to quit travelling by train.

Table 6: Reasons why lost passengers don't travel by train anymore

Reasons for not travelling anymore	
Use other mode of transport	40%
Train is too busy	33%
Make less recreational trips	31%
Make less social trips	18%
Have less money to spend	16%
Train frequency too low	14%
Am working more from home	11%
Have other job	9%
have less physical meetings	7%
Social contacts are more online	6%
Have moved	6%
Am studying from home	1%
Other	38%
- Train reliability	8%
- COVID	6%
- health	6%
- tickets and prices	4%
- other modes of transport	3%
- retired	3%
- other reasons	8%

The most important reason to quit travelling by train is the use of another mode of transport. This is for 80% of the lost passengers the car (70% as driver, 10% as passenger), and for 14% bike (9% regular bike and 5% e-bike). But also the quality of travelling by train plays an important role in leaving the train: 33% chooses 'train is too busy', 14% thinks train frequency is too low and 8% thinks train is unreliable. During wave 8 NS had to reduce frequency and length of trains due to a lack of staff. During that time almost every week the time schedule changed. As a result of that trains were more crowded and less reliable.

6. WHEN DID THEY LEAVE?

As each lost passenger in wave 8 participated in at least one of the previous researches we can track what their travel behaviour was during previous waves and compare that to the group that still travels by train ('remaining'). From figure 2 it is clear that even before COVID-19 the lost passengers travelled less by train than the reference group. This difference remains during the first waves, but especially becomes larger from wave 5 on (September 2021). In all waves 90% or more of the group of lost passengers do not travel by train during the last week, where in the reference group this percentage gradually drops to 50% in November 2022.

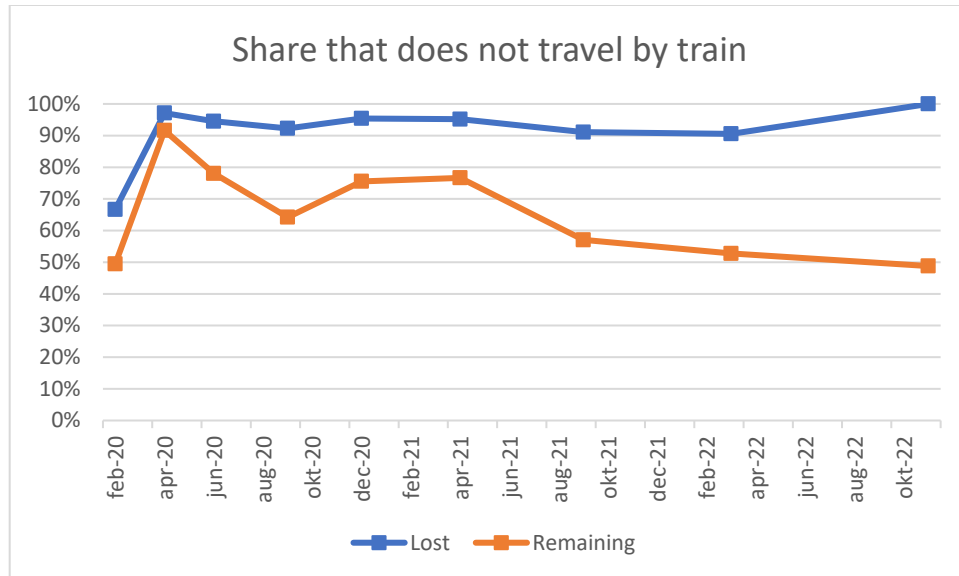


Figure 2: when did lost passengers stop travelling by train

In wave 2 and 3 we asked if respondents bought an alternative vehicle to replace their train trips. Among all respondents that participated in either wave 2 or wave 3 almost 1% bought a car to replace train trips (Van Hagen et al. 2021). Among the group of lost passengers this is over 4%. This is another indication that shift to car plays an important role in quitting to travel by train.

7. HOW CAN WE GET THEM BACK?

In wave 8 we also asked respondents about changes they expect in their travel behaviour in the next few months. Of the group lost passengers the majority does not have plans to come back. But also among the group that is remaining for now some have plans to quit travelling by train.

Table 7: Size and categories of lost and remaining passengers

Category	% of all passengers	% of lost passengers	% of remaining passengers
remaining and will remain	94,1%		98,7%
remaining but will leave	1,3%		1,3%
lost but will return	0,6%	12,5%	
lost and stays lost	4,1%	87,5%	

We asked respondents in an open question what is needed to make them travel by train more often. Of the lost passengers 21% did not bother to fill in this question, and 24% indicated there is not anything needed to make them travel more often. Some of them added text to explain. Some common remarks are that they are happy with their alternative mode of transport, do not commute anymore or are still anxious about crowded places. These travellers can be considered as lost. The other 55% can be won back, though this will be hard to do. What is needed to get them back is categorised in table 8. As a lot of respondents were very elaborate in their answers and they may fit more than one category. That is why the % sums up to way over 55%. There was also a long list of other reasons that did not fit any of the main categories.

Table 8: what is needed to get lost passengers back

	% of lost passengers
Do not come back	45%
Might come back, if...	55%
Better train service (crowding, reliability, frequency)	36%
Financial situation (more money to spend, lower prices)	16%
COVID completely over	9%
Competition with other modes becomes more favourable (e.g. more congestion or higher car cost)	5%
Better health situation	5%

8. CONCLUSION AND DISCUSSION

Train ridership in the Netherlands at the end of 2022 is still 15 to 20% lower than before the COVID-19 pandemic. This is caused by low influx of new travellers, travellers making fewer train trips, but also a group that has abandoned taking the train at all. This paper focusses on this last group.

While at first a group of 5% of the total population that quit travelling by train seems large, the effect on total train ridership is small. This is mainly caused by them not travelling very frequently pre-COVID. Most of these travellers already had a negative attitude towards the train and a positive attitude towards the car: they only needed a small push to leave the train. When confronted with a large push like COVID, they quit travelling by train, most of them already in the second COVID year. Also, anxiety for COVID is, even in November 2022 with the big waves of infection already half a year in the past, still a problem for some travellers and a reason why they quit travelling by train. The lost passengers are older than the average train traveller: more than half of the group is over 55, while this is around 30% for the reference group. The oldest segment of 75+ is even three times as big as reference. Finally, the reduction in train service from late 2022 did not help either: this made quite a lot of travellers to leave the train as well.

Getting these travellers back seems like a difficult task: the majority does not plan to return travelling by train in the near future. Better train services (less

crowding, higher frequencies and reliability) are mentioned often as conditions to return, next to improved (personal) financial circumstances and improved health conditions.

Though this research gives some valuable insight into the size and segmentation of the lost passengers and how to win them back, there are also some remarks that need to be made. First, also in normal times there are people that quit travelling by train. The train travelling population is a continuously refreshed population: every year people quit, and new people start travelling by train. Our research cannot easily be compared with the people leaving during normal times, and does not give insight into people that start travelling by train. To overcome this a separate research should be carried out during normal times, where also people that start travelling by train should be part of the population.

Second, the last wave was carried out during a period of reduced train service. This showed in a lot of answers given by respondents, while this may only be a temporary effect. In order to overcome this the research should be repeated once train service is stable and restored to normal levels.

Finally, the research was carried out on NS panel. Even though Ton et al (2022b) showed that most results derived from NS panel survey are similar to those serviced from an external panel survey, in the particular aspect of quitting to travel by train this may very well not be the case. NS panel members may be more loyal customers that do not easily quit travelling by train. This research may therefore be a slight underestimation of the actual effect. Repeating the research on an external panel may overcome this problem.

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