

Covid-19 and train travel behavior



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Abstract: *The pandemic had (and still has) a clear impact on public transport (use). In order to gain insight into passenger behaviour during and after the pandemic, NS and Delft University of Technology are conducting a longitudinal study with the aim of mapping behaviour, attitudes and intentions regarding train use. Between April 2020 and April 2021, five surveys were held, each with 23,000-47,000 travellers taking part. The results provide valuable, quantitative insights that will help in the recovery and possible redesign of public transport after the pandemic, for example by adjusting the timetable and/or operation.*

During the pandemic, people's travel behaviour and attitudes changed. After a strong decrease in the beginning of the crisis, the number of people with a positive attitude towards travelling by train increased from 20% to 42% from April 2020 to April 2021 and more and more people indicate to choose the train because of its sustainable character (30%). We see in the use of transport to and from the station a shift from local public transport to bicycle and car (passenger). A small part (1.5%) of all respondents has purchased a car or (E-)bike during the pandemic to replace their train trips. The findings show that 30% of the passengers will avoid rush hours after Covid, and 72% will telecommute more often, saving several trips per week. The most popular days to telecommute are Friday and Wednesday. The most important conditions for travelling again are: increasing vaccination coverage (48%) and the elimination of corona measures (40%) such as no longer having to wear a mouth mask (31%) or keep a distance of one and a half metres (28%).

Related future research directions are the development of more flexible and demand-driven services. In addition, we see small indications in the survey of the trend to move out of the city to more rural areas. This is probably caused by the need for a bigger house (with a bigger garden), more nature to enjoy, a quieter environment, and is made possible by the intention to commute less days per week than before Covid. Follow-up research will provide more clarity on this. In September 2021 the sixth survey among rail passengers will be held.

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1. Introduction

The Covid pandemic had (and still has) an obvious impact on mobility patterns and transport systems (De Vos et al., 2020, De Haas, 2020). Worldwide, public transport (PT) was affected heavily (see e.g. Astroza, et al. 2020, Jenelius and Cebecauer, 2020, Bucsky, 2020). As governments imposed Covid lockdown restrictions in Spring 2020, PT usage dropped substantially. In sharp contrast to normal circumstances, PT agencies and governments advice(d) to avoid public transport where possible. In many cities worldwide, PT demand was down to 90% compared to the pre-Covid times (Van Oort and Cats, 2020). As a result, services were reduced to limit financial losses and to handle higher staff absence rates, whilst still providing services to people working in vital sectors. It was a difficult dilemma for the PT sector: providing essential services, whilst losing millions of Euros every month.

Our hypothesis is that passenger behaviour will remain (to some extent) adjusted after the Covid pandemic compared to the situation before. Teleworking and online education, for instance, are well established and might continue to be part of our daily routines (López-Igual et al. 2020, Ton et al. 2020). To plan and operate efficient and high-quality public transport in the post-Covid period, it is important to understand these changes in current and future passenger behaviour. This way, policies and plans can be adjusted accordingly and if needed, interventions in design and policy can be applied to influence the behaviour, in such a direction that they better match policy goals regarding sustainability and accessibility for instance.

To gain insights into passenger behaviour during and after the pandemic, NS (Dutch Railways) and Delft University of Technology started a joint data collection and research amongst Dutch train passengers. Chapter 2 presents the research approach and in Chapter 3, the main results are shared with regard to travel behaviour. In Chapter 4, we share insights into passenger perceptions and experiences. This paper concludes with an outlook and brief main conclusions and recommendations in Chapters 5 and 6. This paper is a follow-up paper of Van Hagen et al. (2021), with additional insights and updates based on our 5th survey in April 2021.

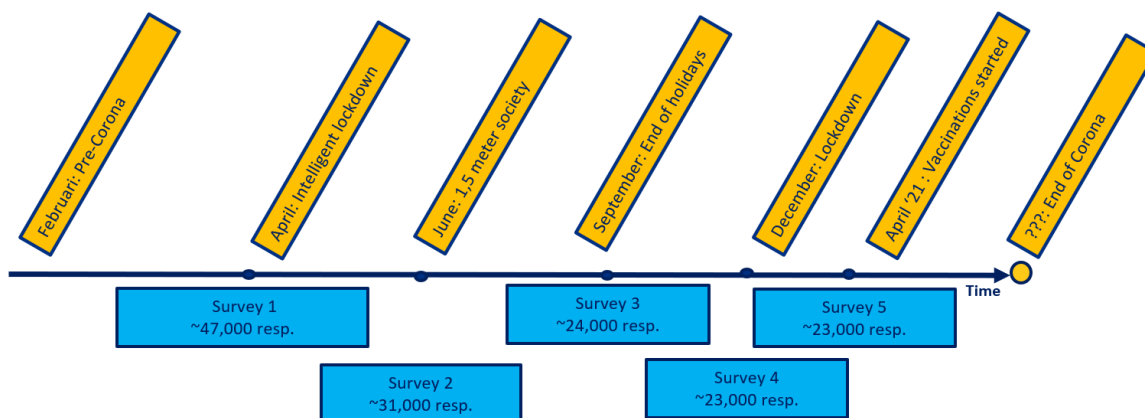
2. Research approach

To gain the required insights into passenger behaviour during and after the pandemic, a longitudinal survey is organised by NS and Delft University of Technology with the goal to capture behaviour, attitudes and intentions regarding train usage. The participants of the survey are part of the existing panel of NS (NS, 2020). This panel represents all train travellers in the Netherlands and participation is voluntary. The total panel encompasses more than 80,000 members and members can receive invitations for a variety of research initiatives related to train travel. Since it was expected that behaviour, attitudes and intentions change during the pandemic, multiple surveys were planned and held (see Figure 1). The first survey was distributed among all panel members and about 47,000 respondents (roughly 57% response rate) completed the survey, which aimed at capturing respondents' behaviour in the week of 19-25 April 2020 during the "intelligent lockdown". In this period, train travelling was only allowed for people working in vital sectors. 96% of the respondents agreed to participate in a longitudinal study to monitor trends and changes. In June (end of lockdown, but still many limitations), September (more working allowed in the office), December (second wave and news about a vaccine) and April 2021 (easements were announced), follow-up surveys were held. In addition, more in-depth specific questions were asked to zoom in on specific topics, for instance regarding teleworking (see Ton et al. 2020),

international travel and home moving behaviour. Every survey, more than 20,000 panel members participated.

Figure 1: Survey planning in 2020 and number of respondents

Longitudinal survey train travellers Dutch Railways



To check for bias and self-selection among the internal NS panel, an external panel was approached in parallel, where a sample representative for the train traveller population was invited (1,500 respondents) to verify the behaviour, attitudes and intentions of the internal panel members. These two panels showed largely the same patterns; hence, we conclude that the internal panel can be considered representative for train travellers in the Netherlands. Multiple statistical methods (e.g. latent class cluster analysis) are used to analyse and present the findings of all surveys. In this paper, we share the highlights. All results are available via Van Oort et al. (2020).

3. Travel behaviour impacts

The survey consists of questions focussing on multiple aspects of the (consequences of the) pandemic. In this section, we will focus on two major impacts with regard to mobility behaviour during the pandemic and the expectations for the post-Covid-19 period, being:

- Avoid travelling (mainly due to teleworking and online education);
- Modal shift (purchasing and/or using other modes than public transport).

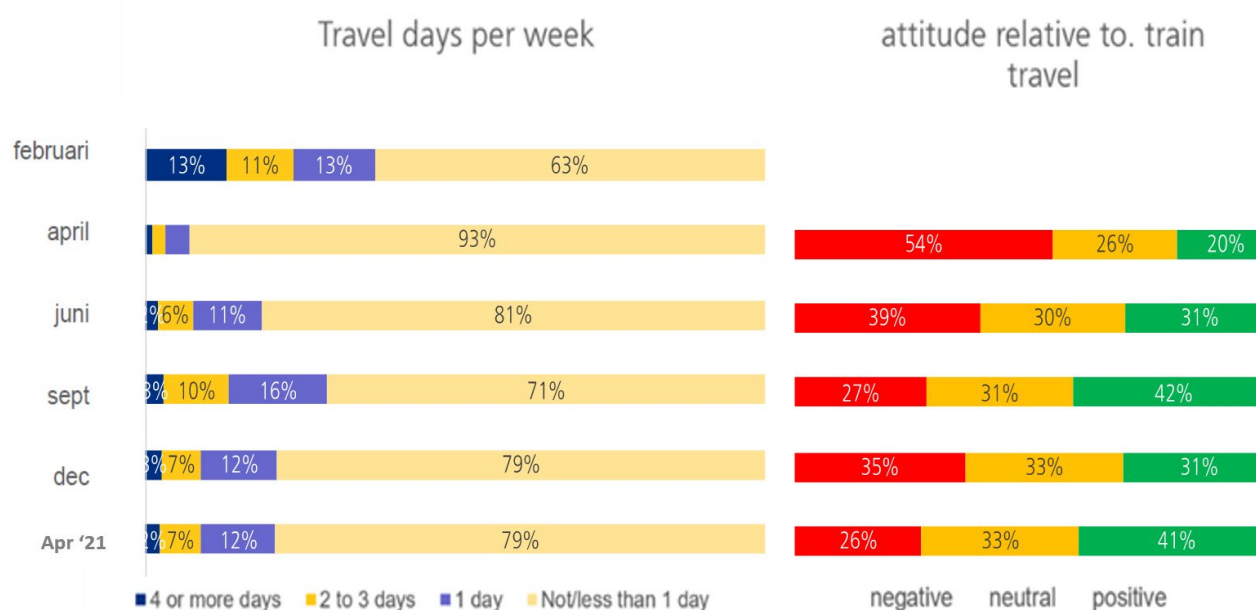
3.1 Travel frequencies

Figure 2 shows that the number of people avoiding train journeys completely, was highest in the beginning of the pandemic. In April, 93% of the participants did not travel by train at all, while during an average week in February (pre-Covid-19), 37% of the participants travelled by train once per week or more. The number of people not travelling decreased after relaxing the strict lockdown restrictions, namely towards 81% in June and 71% in September. In December, in the second wave with corresponding limitations, this number increased again (to 79%), but not to the level of the first wave. Figure 2 also illustrates the increase of people that have a positive attitude regarding train travel, i.e. from 20% in April to 41% in April 2021. In the intervening period, attitudes follow the sentiment associated with tighter measures or easing. Again, this

is higher than the value in the first wave (April; 20%). The two waves and limitations have evidently left their impact on travel frequencies and attitudes. It is interesting to see though that during the second wave, the negative impacts were less than in the first wave. This suggests that even though restrictions were similar (potentially even stricter), people kept travelling more frequently.

Figure 2: Train travel days per week per traveller and attitudes towards train travel from February to December

Travel frequencies



3.2 Teleworking

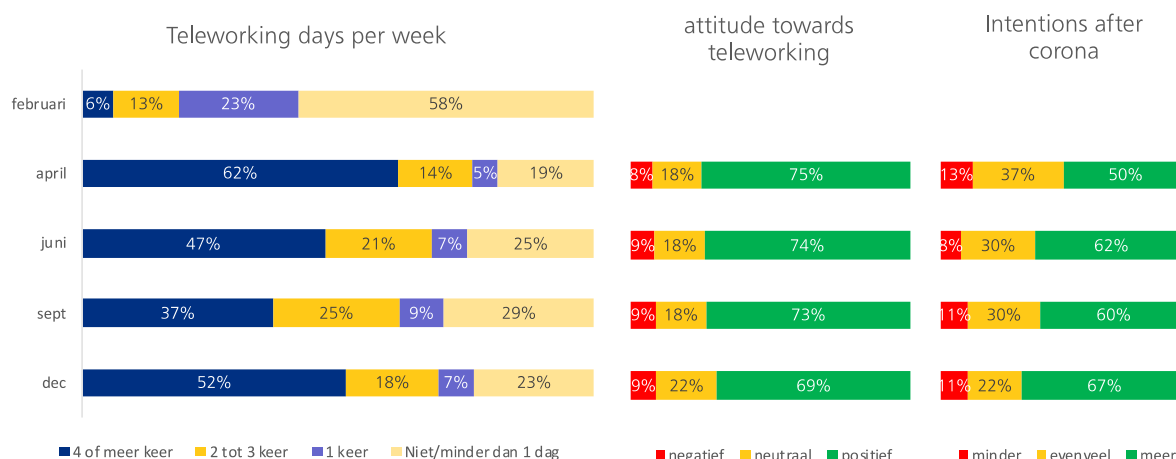
Before the Covid-pandemic one in three employed people in the Netherlands teleworked occasionally, with around 6% doing this almost full-time (Hamersma et al., 2020). During the pandemic, this percentage increased manifold, as people were urged to telework as much as possible and avoid using public transport (unless necessary). During the intelligent lockdown approximately 45-56% of the working population teleworked, where many did this full-time (Hamersma et al., 2020). Furthermore, the largest switch towards teleworking was found among those who commuted by public transport (Hamersma et al., 2020).

Successful teleworking requires combined efforts of both employers and employees. In June, 73% of the respondents said their employers wanted them to work from home and in addition, the employers advised them to avoid public transport (20%) and to avoid peak hours (29%). In September more employers were welcoming people at the office again. To avoid crowds and also due to increased opportunities of teleworking during and after the pandemic, 30% of the people expect to avoid the peak hours also in the post-Covid period.

Figure 3 shows that train travellers switched to teleworking more frequently than measured on average (62% full-time versus the 45-56% reported by Hamersma et al.

(2020)). After the lockdown, this frequency decreased in June and September, as measures were lifted and travel and work in office were increasingly possible. In December, the week before the complete lockdown, stricter measures were imposed again and the share of full-time teleworkers among the train travelling population increased again.

Figure 3: Teleworking frequency, attitude and intentions



3.3 Groups of homeworkers

To understand the effect of teleworking on the use of public transport, we should also consider attitude towards teleworking (how do I like teleworking?) and intentions for teleworking after the pandemic (how often do I want to telework in the future?). The majority of the train travelling population likes teleworking (see Figure 3), and it remains this way over time, although there is a slight shift from positive to neutral. On the other hand, the intentions of teleworking after the pandemic ends are increasing, where more people want to telework more often compared to before the pandemic. This suggests that the teleworking full-time is too much, but that people like it enough to continue teleworking more often compared to before Covid. Furthermore, the fact that there is a large variety in the frequency, attitudes and intentions of train travellers in relation to teleworking over time, suggests that not everyone is equally satisfied with the situation. In another study, we investigated the teleworker typologies based on the aforementioned aspects and relate them to current and intended use of public transport (Ton et al., 2020). By applying a latent class cluster analysis, we identified six different teleworker typologies, which we will highlight below.

1. **Enthusiastic full-timers (31%):** This group consists mostly of highly educated people, where many work at government organisations. They had some experience with teleworking before the pandemic, 93% of them was able to telework before the pandemic. During the lockdown they teleworked full-time. Afterwards they slightly decreased their teleworking frequency, however in general this group teleworked most often over the course of the pandemic. They are also very happy to telework. As a result, this group rarely travels with public transport and has the lowest train use of all types. 44% of them intends to travel less often by train compared to before the pandemic.
2. **Positive part-timers (21%):** This group consists of relatively many people who have one or more children under the age of 12 at home. They are satisfied with

teleworking but do so only part-time. During the lockdown 57% of them teleworked full-time, after that this share decreased and the majority teleworked 2-3 times a week. 76% of them was able to telework before Covid, so they had less experience compared to the first type. Their new experience was positive. As a result, many of them (35%) intent to use the train less often after the pandemic ends compared to before.

3. **Neutral new part-timers (19%):** This group consists of many high educated people that live in households with one or more adults. They are never self-employed. They are also relatively new to teleworking (even though for the majority this was possible before Covid). During the lockdown they teleworked full-time, but after the lockdown they reduced their frequency. They are satisfied with teleworking, but not as enthusiastic as types 1 and 2. Regarding their future intentions of using public transport, they are also less negative compared to types 1 and 2. 29% intends to decrease their train use.

These first three types of teleworkers are positive and intent to telework more often after the pandemic than before. Their intended decrease in using public transport is in line with this new working pattern. Hence, these people are not switching to other modes of transport; they instead reduce their commuting frequency.

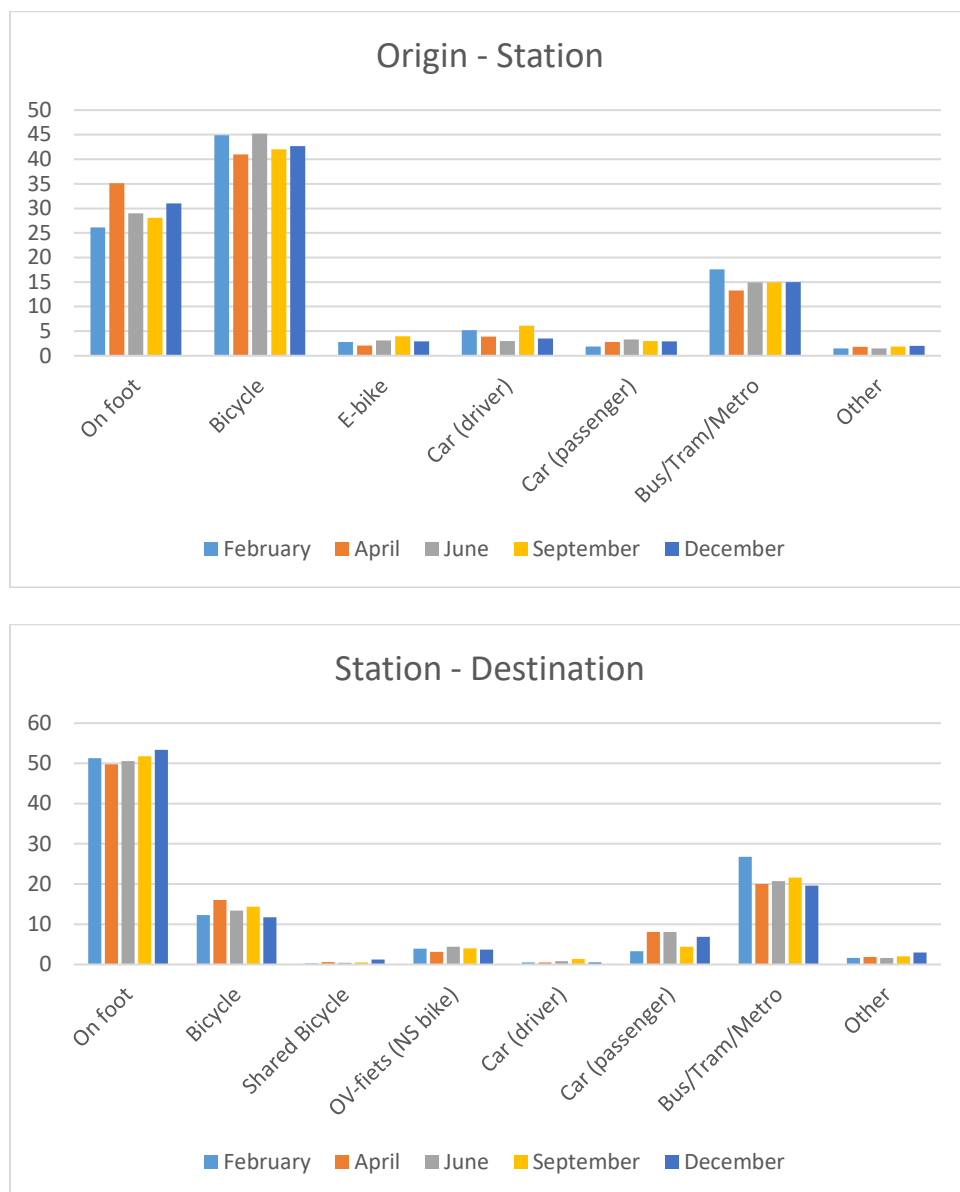
4. **Content self-employed (12%):** This group consists mostly of self-employed people. This group therefore is used to working from home, as they usually have their main office located at home. This is reflected in the fact that 64% of this group already teleworked full-time before Covid. Hence, for them the changes in their behaviour were less drastic. During Covid, their share of full-time teleworking increases, but after the intelligent lockdown they quickly return to their behaviour as it was before Covid. This is also reflected in their future intentions. This group therefore remains largely unaffected on the long-term from the pandemic in terms of their travel behaviour.
5. **Forced and done with (8%):** This contains (relatively) many people who work in education and live alone; they are also in relation more often practically educated. This group does not like teleworking; most of them could not telework before the pandemic, which suggests that their employer was not ready for this sudden change. This combination results in a group of people who had to telework often during the lockdown, but as soon as possible they reduced their telework frequency. Their future intentions towards teleworking are also negative; preferably, they will never telework again. This is also reflected in their public transport intentions, where they mention they want to increase their use compared to the pre-Covid situation.
6. **Negative and occasional (8%):** This group did not telework full-time during the pandemic. They did telework a bit more frequently during the intelligent lockdown (2-3 days), but decreased their frequency afterwards. They are more often working in education and the vital sector. In addition, they mostly had no possibility to telework before Covid, suggesting that their employer was not ready for teleworking. They kept on travelling by train most during the pandemic and are for the largest part thinking about returning to their previous behaviour.

To summarize, the majority (72%) is positive towards teleworking and intends to continue (to a certain extent) after the pandemic. In order to manage this in terms of peak demand, policies could help in spreading over hours and days. The negative teleworkers will return to public transport if allowed again.

3.4 Modal shift

With regard to alternative modes, 32% of the respondents had an alternative for their train journeys, while 15% has only partial access to another mode. The car is often mentioned as the main alternative (74%). We observe multiple shifts regarding the mode choice of the respondents. The first one implies mode choice regarding access to and egress from the train station. Figure 4 shows that especially local public transport (bus, tram and metro) is affected. Also shown is the growth in usage of private cars to get to or from the station (as a passenger).

Figure 4: Access (upper) and egress (lower) mode usage from February to December

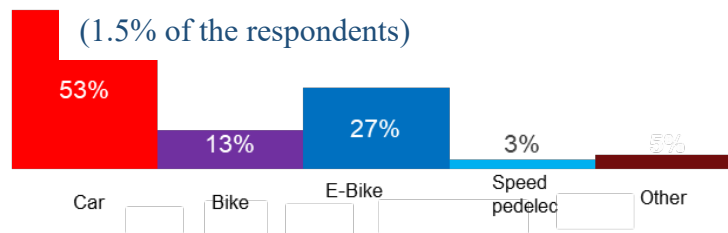


The second, more structural impact on modal shift, is shown in Figure 5, which presents the purchase of a new vehicle during the pandemic, with the purpose of

replacing train trips. In our panel, 15% of the participants bought a new vehicle of which 10% (i.e. 1.5%) had the purpose of replacing train trips. 53% of these vehicles are cars and approximately 43% are (E-)bikes and speed pedelecs.

Figure 5: Alternatives vehicles purchased to replace train trips (by 1.5% of the respondents)

Which mode of transport did you buy as a replacement?

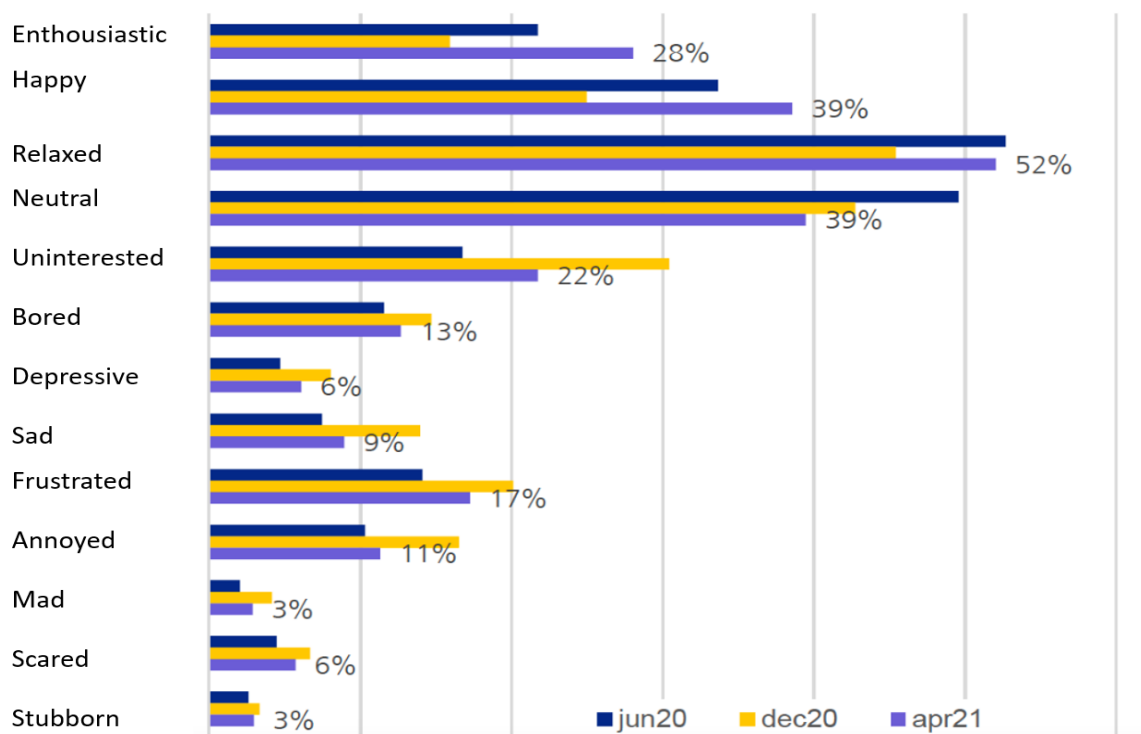


4. Perceptions and experience

Besides monitoring actual (choice) behaviour, we also asked about travellers' perceptions and experiences. If we compare the emotions in the week before the survey, we can see in Figure 6 that at the moments when easing was announced (June 2020, April 2021), the positive emotions dominate, while during the lockdown (December 2020) the negative emotions were more important.

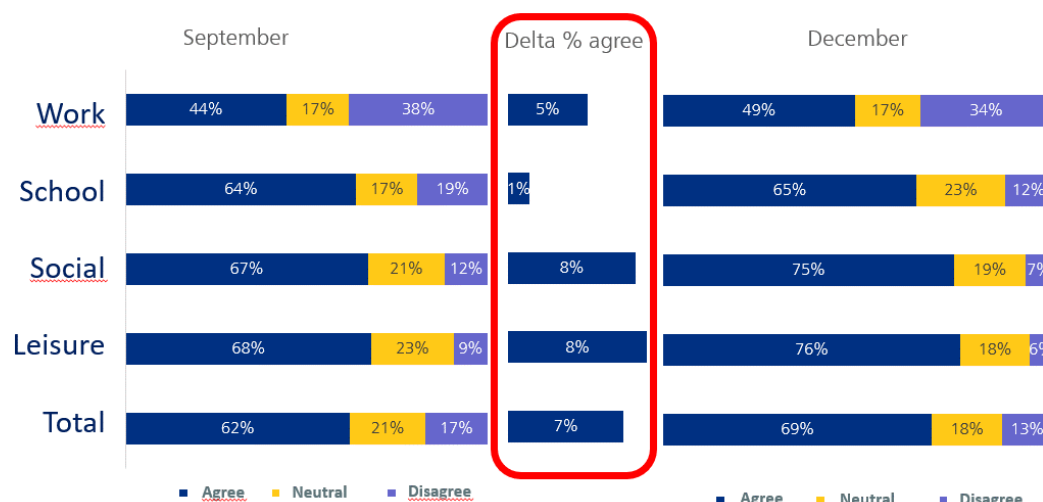
Figure 6: Emotions during Covid (the week before the surveys in June and December)

Emotions



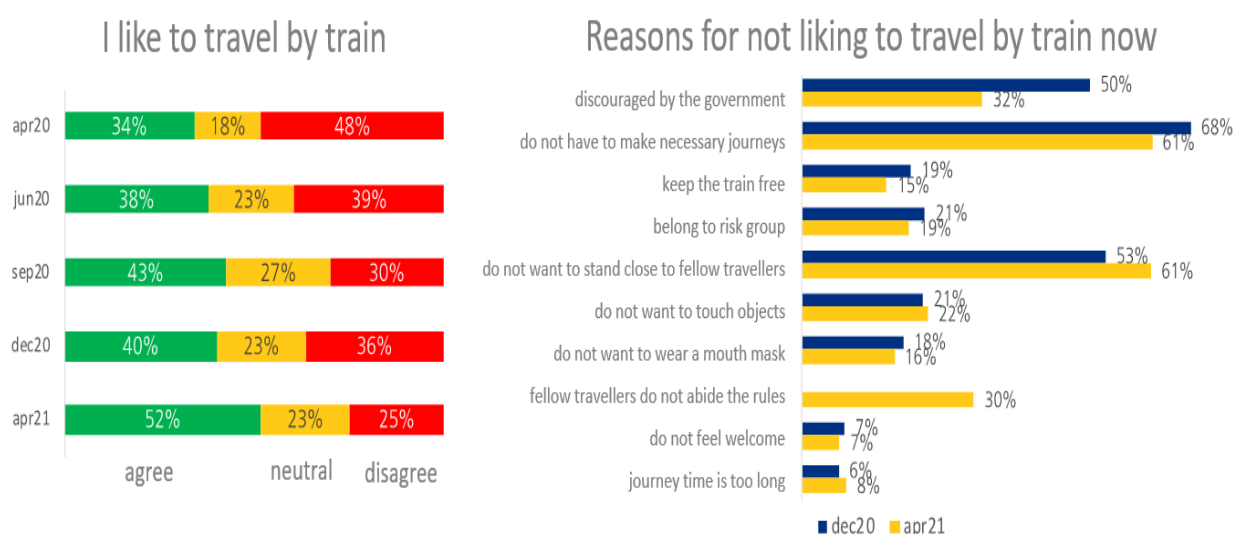
These negative emotions are reflected in the desire to return to pre-Covid behaviour (see Figure 7). We see an increase in the expectation to return to pre-Covid behaviour for all travel purposes, but for goal-oriented purposes like school, it is the smallest (1%), while for more hedonic trips like social recreational purposes it is the largest (8%).

Figure 7: Expectations to resume normal travel behaviour after Covid (September and December)



The negative emotions also affect the attitude towards the train. Between April 2020 and April 2021, the positive attitude towards train travelling increased (see Figure 8). Factors towards negativity are the stricter government measures, such as mandatory teleworking and closing non-essential stores, bars, restaurants, museums, and so on.

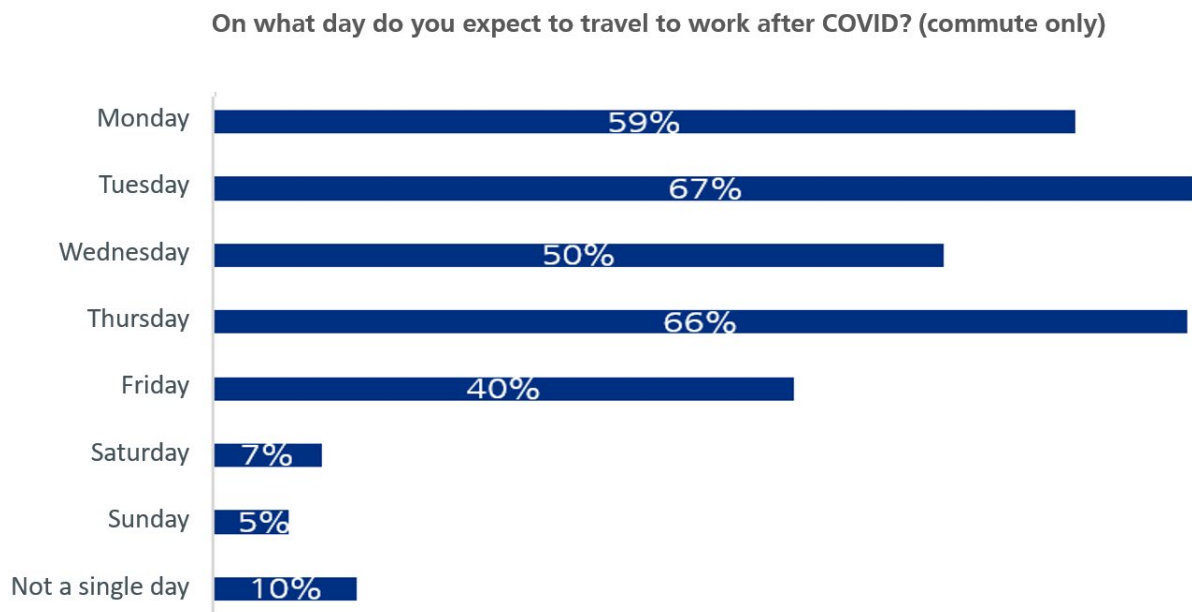
Figure 8: Expectation to resume to normal travel behaviour after Covid



5. Outlook

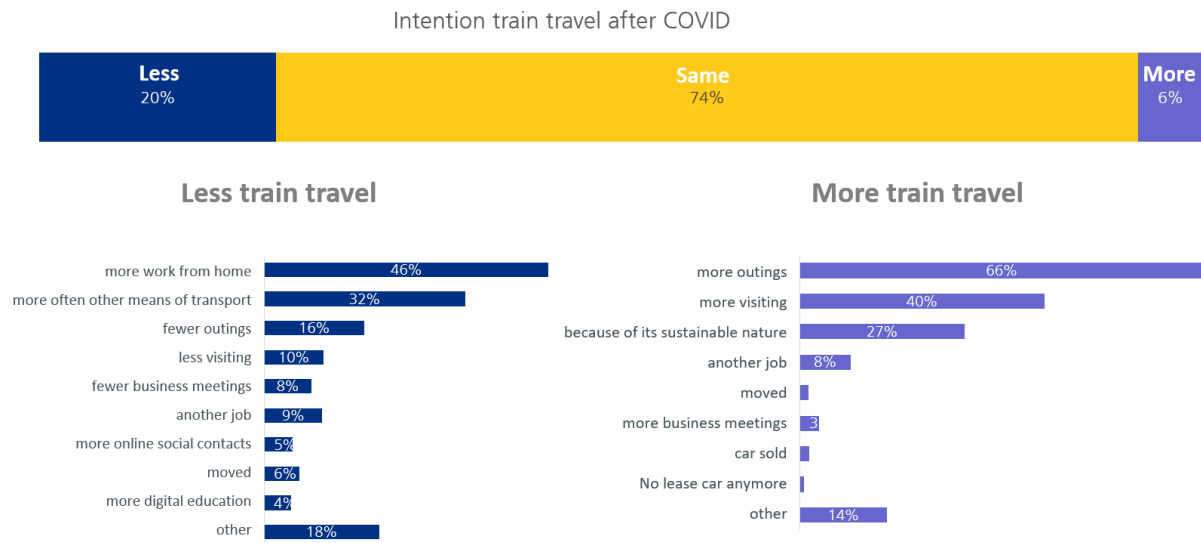
With many people teleworking and studying at home and multiple restrictions and measures in place, it is relatively quiet in the trains during the pandemic, even during rush hours. Where the rush hour used to cause very full trains on some routes, we now see that at those moments it is much more quiet. Respondents also indicate that when they start travelling they consciously avoid the rush hour and want to continue doing so after Covid (30%). This can be an opportunity for operating more efficiently, because the demand is then more evenly spread throughout the day. At the same time, continuing to work or learn at home after Covid also ensures that certain days are preferred for travel to work or study, which can create an imbalance of transport demand over the week. NS is now in discussion with universities and schools as well as with companies to see if a more balanced distribution of passengers over the week is possible (see Figure 9).

Figure 9: Expected working days after Covid



In our last survey of April 2021, 20% of all respondents expected to travel less by train in the post-Covid era, compared to pre-Covid, and 6% expects to travel more. Slightly less than 75% expects to travel as often as before. The most important reasons to travel less (dark blue) and more (purple) are indicated in Figure 10. The main reasons for travelling again is to make trips and to visit others when this is allowed again. There are also circumstances not directly related to Covid, such as a moving or a different job, which on one hand can lead to less, but on the other can lead to more train journeys.

Figure 10: Reasons for less or more train travel after Covid



Sustainability appears to play a more important role in choosing the train. When asked, 30% of the respondents indicate that sustainability considerations are an important reason for choosing the train (figure 11). This has even increased very slightly between December 2020 and April 2021.

Figure 11: Sustainability is an important reason for choosing the train.

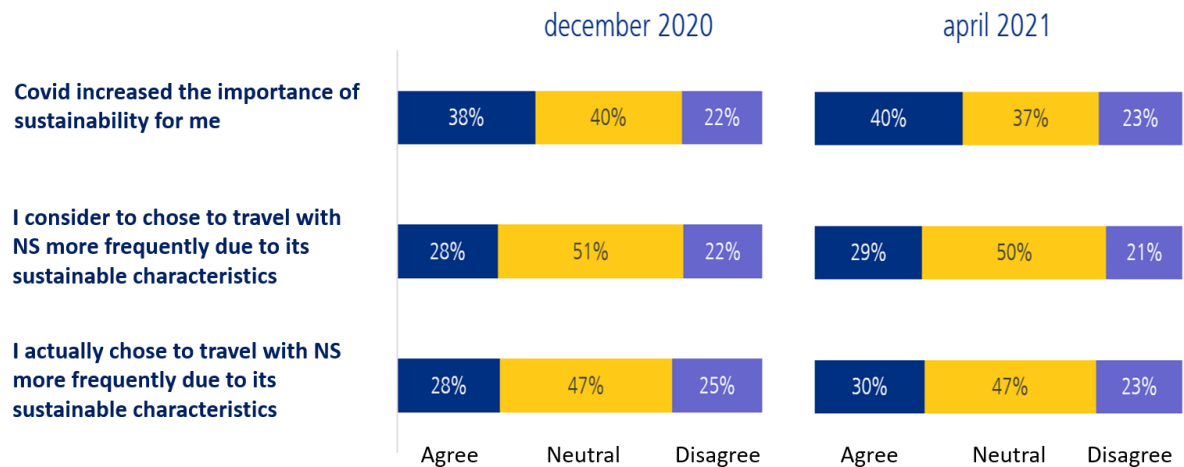
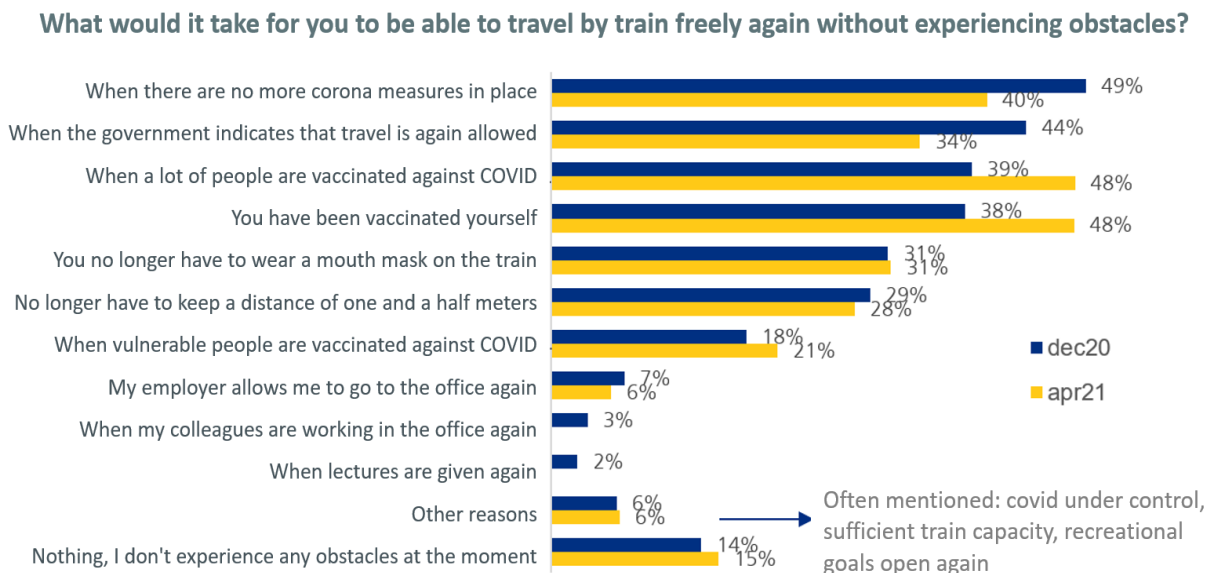


Figure 12 shows the main conditions to travel by train again, showing the large impact of the measures and advice by the government, next to the vaccination rate and opening up of schools and offices.

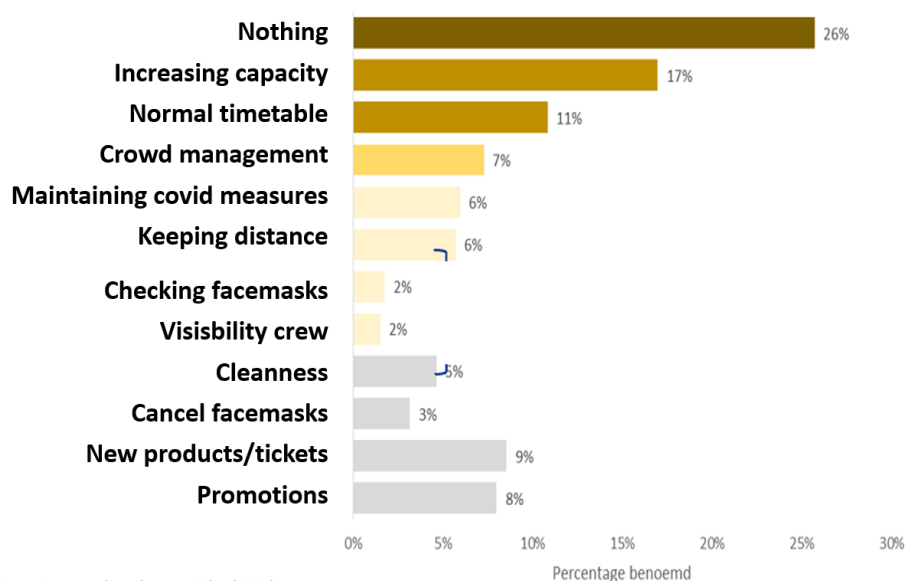
Figure 12: Main conditions to travel by train again



In an open question, customers could indicate what NS could do to welcome them back on the trains. An extensive text analysis via topic modelling shows that the deployment of sufficient trains and enforcement are the two priorities in the transition period to win back passengers in the trains (Figure 13).

Figure 13: Analysis of open answers to the question of what NS could do for passengers

What should NS do (extra) coming period?



Bron: Corona onderzoek meting 5 (april 2021).
Vraagstelling: Wat kan NS doen voor de reiziger.
n = 17.212

Disclaimer: Voor deze resultaten zijn alleen de open antwoorden gebruikt die met acceptabele nauwkeurigheid konden worden toegewezen aan een onderwerp.

6. Conclusions

In this research, we investigated train passenger behaviour during the Covid-pandemic and in addition, we researched expectations of mobility behaviour in the post-Covid period. During the pandemic, ridership and attitudes of people changed. From April 2020 to April 2021, the number of people with a positive attitude towards travelling by train increased from 20% to 42% and more and more people are choosing the train because of its sustainable nature. Regarding modal shift in access to and egress from the station, we observed a shift from local public transport towards cycling and car (as a passenger). For the full journey, we found that 1.5% of the participants purchased a car or (E-)bike to replace their train trips. With regard to teleworking, the majority (72%) of the participants is positive and more teleworking is expected after the pandemic (compared to before). In April 2021, the most important conditions to start travelling again are: increasing vaccination coverage (48%) and the abolition of corona rules (40%) such as no longer having to wear a mouth mask (31%) or keep a distance of one and a half metres (28%).

To wrap up, we see a number of trends for the post- Covid era:

1. Less trips: Trips are replaced by digital alternatives, such as commuter trips by teleworking, business trips by online meetings and education trips by virtual lectures. This effect is expected to be strongest among commuter and business travellers. Because peak traffic mainly consists of commuters, peak travel will drop more than off-peak, potentially creating a better balance.
2. Changing mode of transport: During the pandemic, we see that part of respondents indicate that they continue to travel, but change their main mode of transport. For short distances, this causes a shift to (E-)bikes, but the main shift is expected towards car. A part of all respondents has even bought a car especially for this purpose, suggesting potential long-term effects.
3. Changing departure time: a part of all respondents plans to change their departure time for train travel, mostly from peak to off-peak. One of the main reasons for this is to avoid crowded trains. Because people have gotten used to teleworking, they may first telework in the morning and travel to the office in the afternoon. A second trend for commuters seems to be a change in days for commuting: Wednesday and Friday seem to be the most popular days to telework. The difference in ridership that was already there before Covid seems to get bigger because of this trend. Currently there are discussions with employers and universities to flatten the peak during the day and to try not to get a peaked curve during the week in return.

If commuters only have to travel three times a week instead of four or five, they can afford to increase their commuting distance. According to Hupkes' BREVER law (Peters, 2001), people travel on average about 70 minutes per day. We already saw before corona that mobility patterns are changing from a workday pattern to a weekday pattern. Corona has further strengthened this effect, so that it seems logical to look not only at the daily average but also at the weekly average in terms of time spent travelling. In our corona study, we already see small indications of the trend to move out of the city to more rural areas. This is probably caused by the need for a bigger house (with a bigger garden), more nature to enjoy, a quieter environment, but is also made possible by the intention to commute less days per week than before Covid. The

days that do travel can then, in accordance with the BREVER law, be made into trips that take more time. Follow-up research can provide more clarity on this.

Acknowledgements

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References

- Astroza, S., A. Tirachini, R. Hurtubia, J. Carrasco, A. Guevara, M. Munizaga, M. Figueroa, V. Torres. Mobility changes, teleworking, and remote communication during the covid-19 pandemic in Chile. *Transport Findings*, 2020.
- Bucsky, P. Modal share changes due to covid-19: The case of Budapest. *Transportation Research Interdisciplinary Perspectives*, 2020.
- De Haas, M., Faber, R., Hamersma, M. How COVID-19 and the Dutch “intelligent lockdown” change activities, work and travel behaviour: Evidence from longitudinal data in the Netherlands. *Transp. Res. Interdiscip. Perspect.* 100150, 2020.
- De Vos, J. The effect of COVID-19 and subsequent social distancing on travel behavior. *Transp. Res. Interdiscip. Perspect.* 100121, 2020.
- Hamersma, M., de Haas, M., Faber, R. Thuiswerken en de coronacrisis. <https://www.kimnet.nl/publicaties/rapporten/2020/08/31/thuiswerken-en-de-coronacrisis> (in Dutch), 2020.
- Jenelius, E. and M. Cebeacauer. Impacts of COVID-19 on public transport ridership in Sweden: Analysis of ticket validations, sales and passenger counts. *Transportation Research Interdisciplinary Perspectives*, 2020.
- Lim, V.K.G., Teo, T.S.H.. To work or not to work at home-An empirical investigation of factors affecting attitudes towards teleworking. *J. Manag. Psychol.* 2000
- López-Igual, P., Rodríguez-Modroño, P. Who is Teleworking and Where from? Exploring the Main Determinants of Telework in Europe. *Sustainability* 12, 8797, 2020
- NS. NS Panel. <https://nspanel.nl>, 2020
- Ton, D., K. Arendsen, M. de Bruyn, V. Severens, M. van Hagen, N. van Oort, D. Duives. Teleworking during COVID-19 in the Netherlands: Understanding behaviour, attitudes, and future intentions of train travellers, *Transportation Research Part A*, 2021 (submitted)
- Van Hagen, M., D. Ton, D. Duives, M. de Bruyn, V. Severens, N. van Oort, N. Train traveller behaviour during and after Covid: insights of a longitudinal survey of Dutch train passengers, BIVIC/GIBET Transport Research Day, Delft, 2021
- Van Oort, N. and O. Cats. Public transport and shared mobility during and after a social distancing society. TU Delft. Retrieved from <https://www.tudelft.nl/en/2020/transport-institute/public-transport-and-shared-mobility-during-and-after-a-social-distancing-society/>, 2020
- Van Oort, N., D. Ton, D. Duives, M. de Bruyn, V. Severens, M. van Hagen. Impacts of Corona on traveler behaviour. Overview of publications. Retrieved from <https://nielsvanoort.weblog.tudelft.nl/de-gevolgen-van-de-coronacrisis-op-treinreisgedrag/>, 2020