

Train traveller behaviour during and after Covid: insights of a longitudinal survey of Dutch train passengers

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Abstract: *The pandemic had (and still has) an obvious impact on public transport (use). To gain insights into passenger behaviour during and after the pandemic, a longitudinal survey is organised with the goal to capture behaviour, attitudes and intentions related to train usage. Four surveys were held between April and December 2020, involving 23,000-47,000 passengers each. The results provide valuable, quantitative insights that help to recover and rethink public transport after the pandemic, for instance by adjusted planning, design and operations. Findings show that 30% of the passengers want to avoid the peak hour after Covid and 72% will telework more often, saving multiple trips per week. The most popular days for teleworking will be Friday and Wednesday. Related future research directions are for instance developing more flexible and demand-driven schedules and services.*

Keywords: Train travel, behaviour, Covid, Longitudinal survey data

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.

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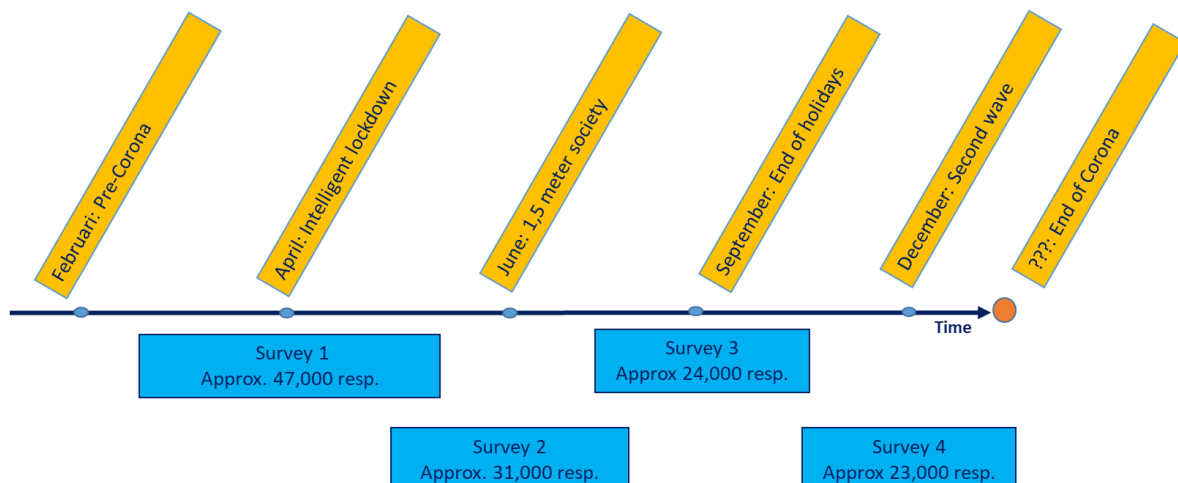
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To gain insights into passenger behaviour during and after the pandemic, NS (Dutch Railways) and Delft University of Technology started a joint data collection and research amongst Dutch train passengers. Chapter 2 presents the research approach and 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.

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) and December (second wave and news about a vaccine), 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



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

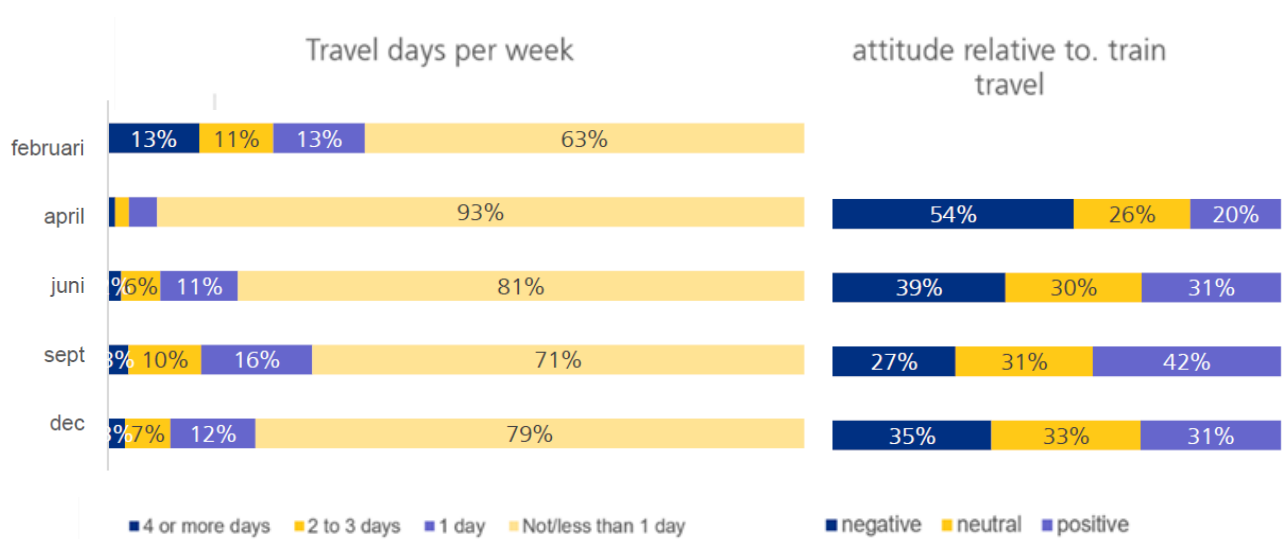
The survey consists of questions focussing on multiple aspects of the (consequences of the) pandemic. In this section, we will focus on two major impacts with regard to mobility behaviour during the pandemic and the expectations for the post-Covid-19 period, being:

- 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 42% in September, with a decrease in December again to 31%. 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



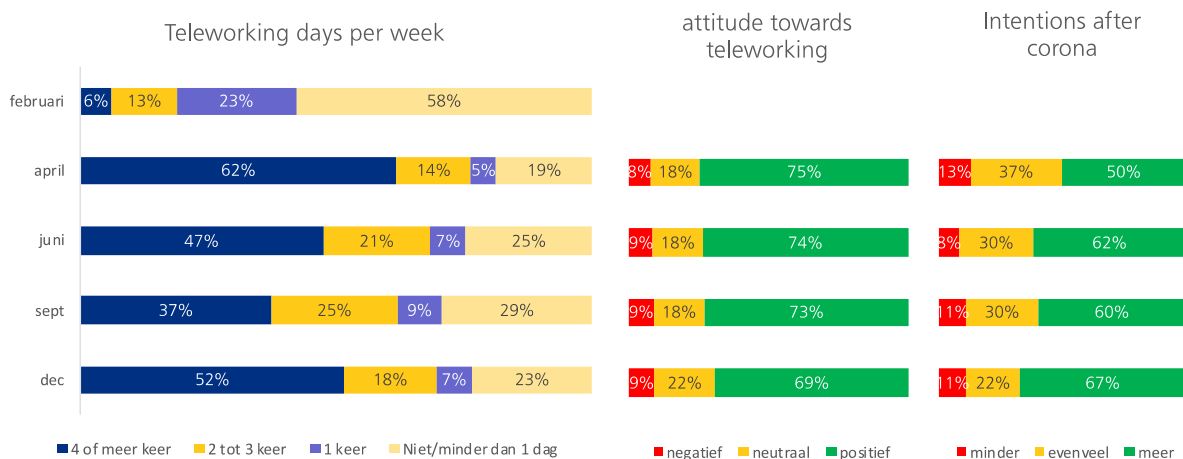
3.2 Teleworking

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



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%) intend 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.

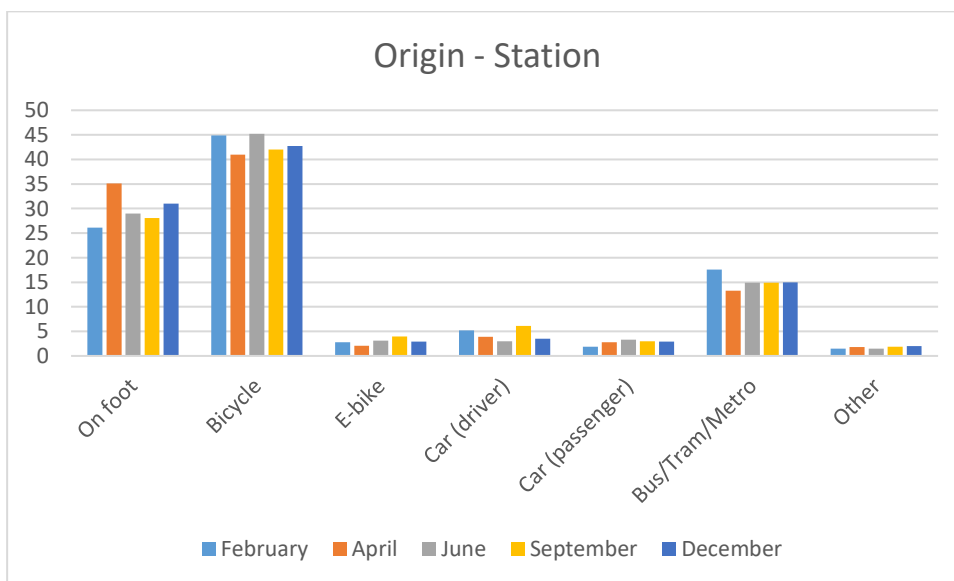
6. Negative and occasional (8%): This group did not telework full-time during the pandemic. They did telework a bit more frequently during the intelligent lockdown (2-3 days), but decreased their frequency afterwards. They are more often working in education and the vital sector. In addition, they mostly 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.

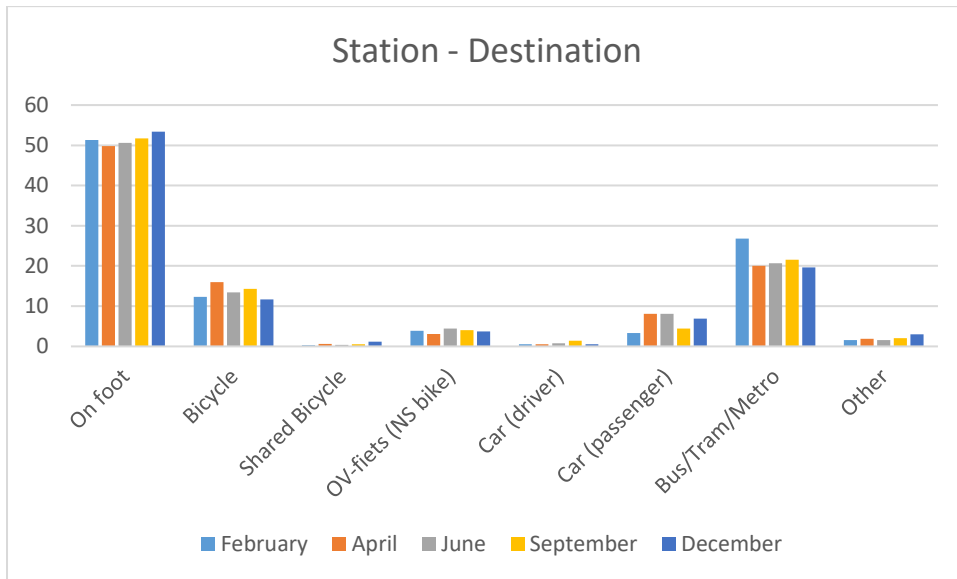
To summarize, the majority (72%) is positive towards teleworking and intends to continue (to a certain extent) after the pandemic. In order to manage this in terms of peak demand, policies could help in spreading over hours and days. The negative teleworkers will return to public transport if allowed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

3.3 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

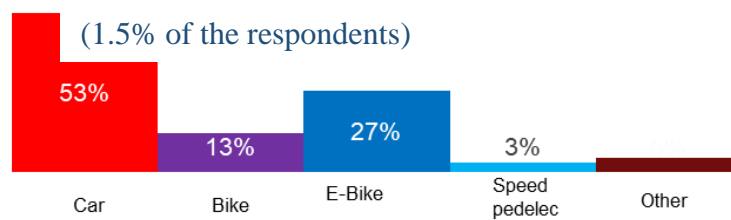




The second, more structural impact on modal shift, is shown in Figure 5, which presents the purchase of a new vehicle during the pandemic, with the purpose of replacing train trips. In our panel, 15% of the participants bought a new vehicle of which 10% (i.e. 1.5%) had the purpose of replacing train 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)

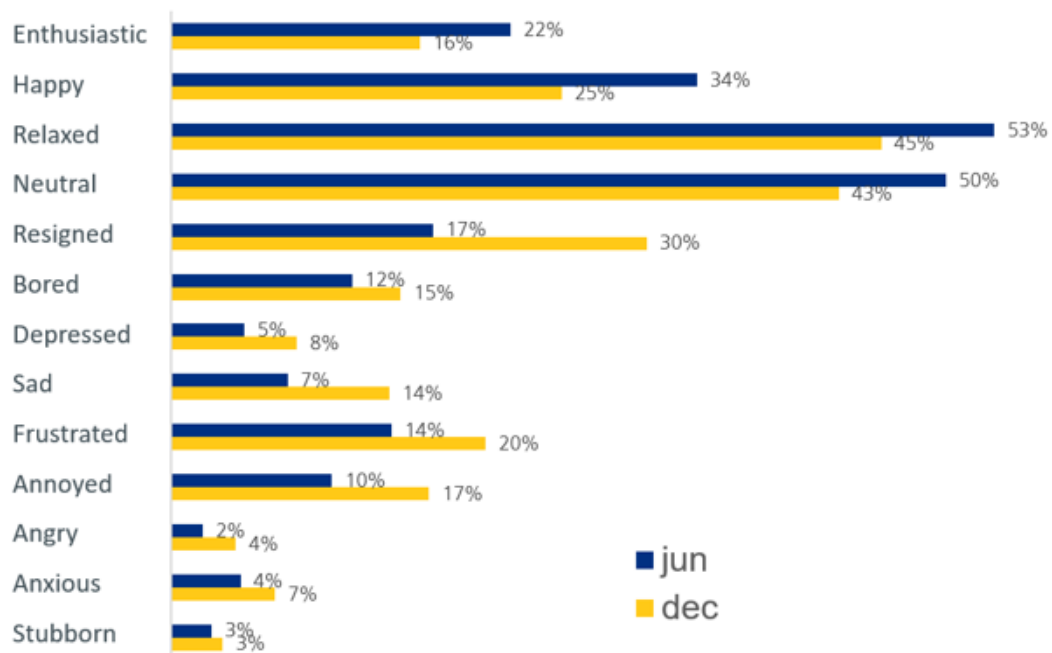
Which mode of transport did you buy as a replacement?



4. Perceptions and experience

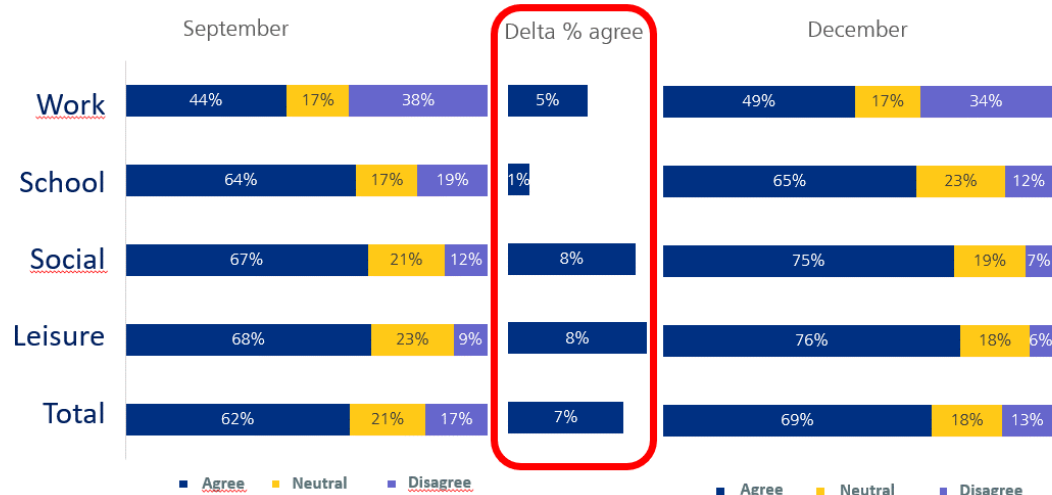
In addition to monitoring actual (choice) behaviour, we also investigated people perceptions and experiences. If we compare the emotions between June and December (see Figure 6), we see that the emotions of respondents were still predominantly positive in June, but are predominantly negative in December. The emotions relate to the week before the lockdown and are logical against the background of the developments. After all, in June the number of infections decreased strongly and the number of measures accordingly, while in December infections increased again and so did measures.

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



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 and September, the positive attitude towards train travelling increased, but in December with the negative prospects again, we saw more negative attitudes (see Figure 8). Factors increasing this 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

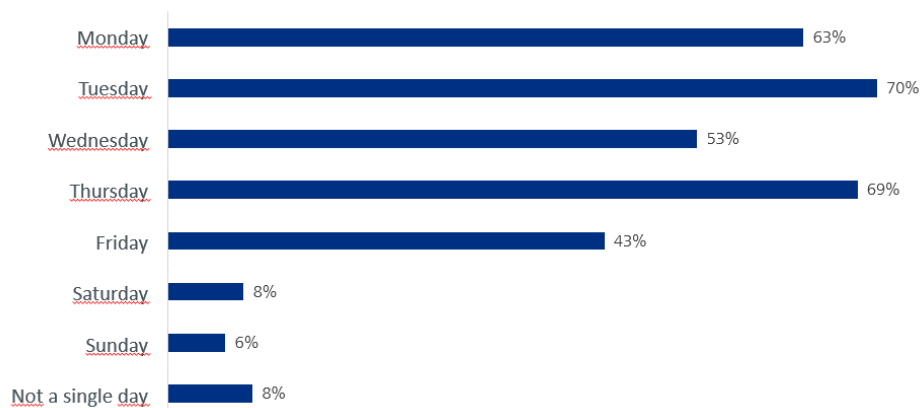


5. Outlook

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

On what day do you expect to travel to work after COVID? (commute only)



In our last survey of December, 17% of all respondents expected to travel less by train in the post-Covid era, compared to pre-Covid, and 6% expects to travel more. Just over 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

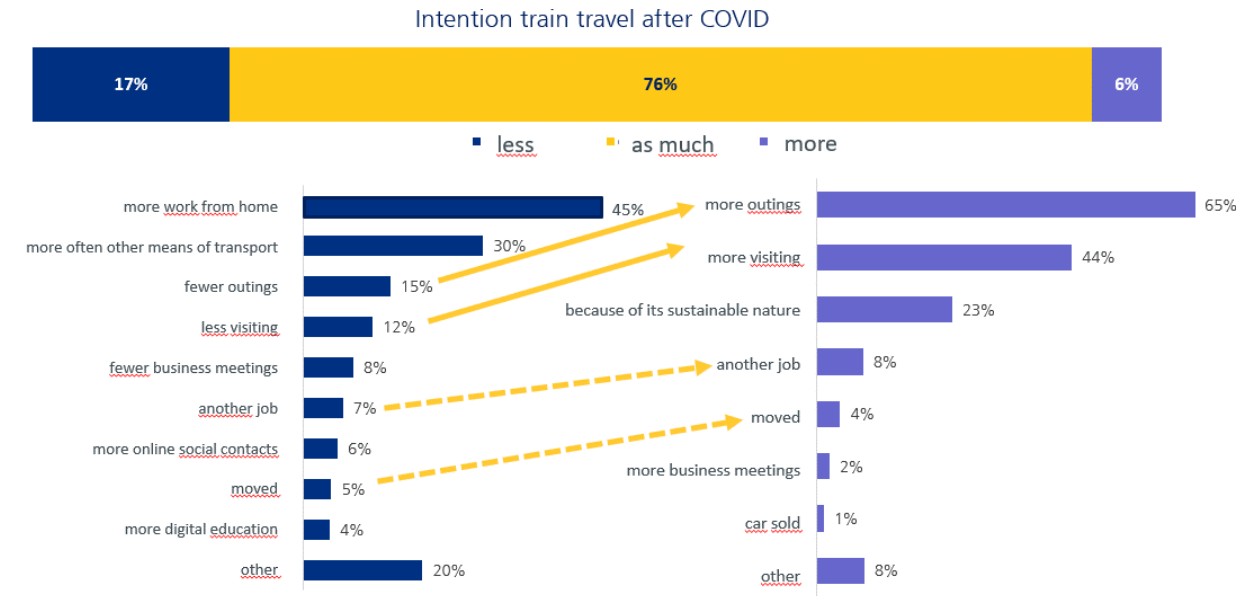
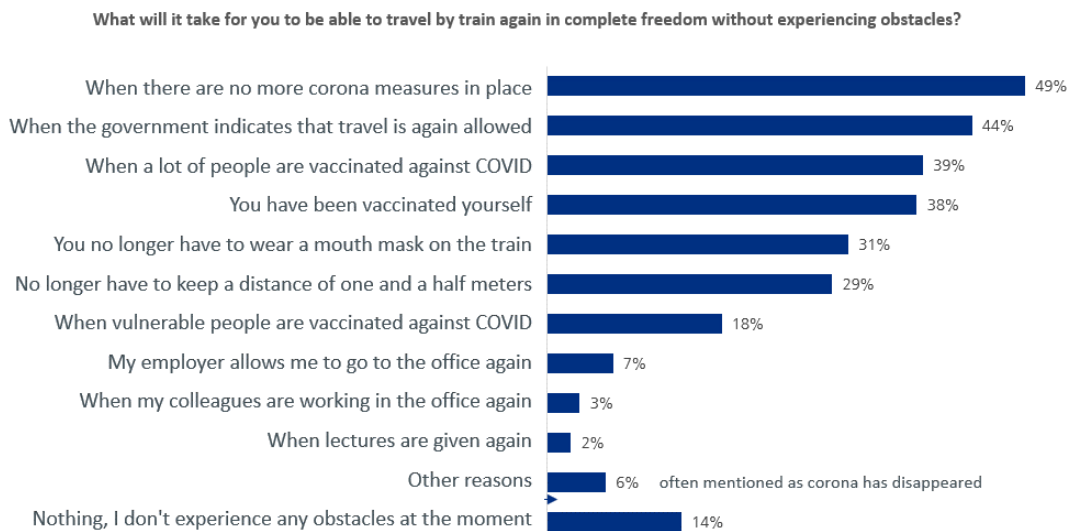


Figure 11 shows the main conditions to travel by train again, showing the large impact of the measures and advice by the government, next to the vaccination rate and opening up of schools and offices.

Figure 11: Main conditions to travel by train again



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 to September, the number of people with a positive attitude towards travelling by train increased from 20% to 42% and decreased to 31% in December. 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). Main conditions to travel again are end of Covid-measures (49%), allowance of travelling again by the government (44%) and vaccination rate (35%).

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.

In our research, we see some small indications for the trend to move out of the city toward more rural areas. This is probably caused by the need for a larger house (with a larger garden), more nature to enjoy, a quieter environment, but is also enabled by the intention to commute less days a week than before Covid. If commuters only have to travel three times a week instead of four or five, then they can afford to increase their commuting distance. In the next steps of this data collection and research effort, we will investigate this in more detail. More surveys are planned, providing more insights in the last part of the pandemic and the first part of the post-Covid era.

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