Change in train travelling behaviour during and after Covid-19 due to anxiety

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CHANGE IN TRAIN TRAVELLING BEHAVIOUR DURING COVID-19 DUE TO ANXIETY

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1. INTRODUCTION

Studies all over the world have been performed to investigate the impacts of Covid-19 on public transport usage and passenger attitudes and intended behaviour (see e.g. De Vos, 2020 and De Haas et al., 2020). Reduction in public transport usage related to anxiety from Covid-19 proved to be a problem everywhere and it is important to investigate this group of anxious passengers further (see e.g. Jenelius & Cebecauer, 2020 and Currie et al., 2021). These insights will support future forecasting and planning, such as timetable design and rolling stock purchases. This will also support to get this group back on the trains.

In this paper, longitudinal surveys are used to gain insights into the groups of anxious and non-anxious train travellers in the Netherlands. This project is part of a larger project, which focuses on the impacts Covid-19 has on train travelling behaviour, by NS and TU Delft (Van Hagen et al., 2021; Ton et al., 2022a). This paper focuses on the effects of anxiety on train travelling behaviour during and after Covid-19, and is based on Hafsteinsdóttir (2021). The data from the surveys are used to divide the participants into groups based on their anxiety levels: anxious, neutral, and not anxious. The groups are divided based on how participants answered the question if they feel free to travel by train. If they answer this question negatively, they are considered anxious while those that answer that they do feel free to travel by train are considered not anxious.

Since the Covid-19 pandemic started, the usage of public transportation has reduced a lot. As anxiety might have some influence on people's behaviour, it was wanted to investigate this group further. The main goal of this research is to gain more insights into the effects on anxiety on train passenger attitudes and (intended) train travelling behaviour. This is done by investigating what are the typical characteristics of the anxious group, how their attitude towards the train is, and how their current and future expected travel behaviour will be.

The remainder of the paper is as follows. Chapter 2 discusses results from literature studies that have been performed on the subject of Covid-19, anxiety, and public transport usage. Chapter 3 discusses the methodology used in this research. Chapter 4 discusses the findings of the research, followed by chapter

5 which discusses the effects that anxiety has on attitude towards the train and travel behaviour. Chapter 6 discusses the limitations of the research, its conclusions and recommendations.

2. LITERATURE REVIEW

This section includes literature review of studies that have been performed on behaviour changes in public transportation usage during Covid-19, and focus on factors that relate to anxiety. This allows for comparing the results of this study to other countries.

Research by Dong et al. (2021) shows that train passengers are less anxious when they perceive more safety on board public transport. They note that anxiety in general can also have negative effects on perceived safety in public transportation. Their results also show that passengers experience more anxiety when they are “psychologically closer to the pandemic” (Dong et al., 2021).

The research by Kassaw & Pandey (2021) shows that one third of their respondents experienced anxiety. Those that are more likely to experience general anxiety in public transportation are females, daily labourers, people with families lager than three persons and people that do not use face masks (Kassaw & Pandey, 2021). Their study was performed in Addis Ababa, Ethiopia in March 2020. Similar studies have also been performed about anxiety and public transport usage. A study from China that was performed in the beginning of the pandemic shows that about 54% of the respondents experience anxiety (Wang et al., 2020), while a study in India, from April 2020, shows that 25% of the respondents experience anxiety (Wilson et al., 2020). The research by Wilson et al. (2020) also shows that women are twice as likely to experience anxiety, moderate to severe stress, and depressive symptoms than men.

Przybylowski et al. (2021) performed research in Gdansk, Poland, in May and June 2020 where they look into how Covid-19 has impacted mobility behaviour in terms of safety and comfort among public transport users. Their results show that about 90% of respondents limited their usage or stopped using public transport, however, 75% of those that reduced or stopped using public transport plan to use public transport again after the pandemic has stabilized (Przybylowski et al., 2021). When asked about the reasons for reducing usage or stop using public transport, the most common answer (about 50%) is because the respondents had switched to working or studying from home and therefore are not using public transport like before (Przybylowski et al., 2021). Another reason for not travelling by public transport as frequently as before is due to fear of getting infected (40%) and 14% changed their mode of travel to a private mode (Przybylowski et al., 2021). As the feeling of safety in public transport was less than before the pandemic, Przybylowski et al. (2021) asked the respondents about what factors affected their feeling of comfort and safety in public transport during the pandemic. Their results show that the number of people on board, the behaviour of other passengers, and the fear of other

passengers not following hygiene and safety precautions were the most important factors (Przybylowski et al., 2021).

The study by Przybylowski et al. (2021) suggests that the past travelling behaviour and characteristics might not be the best indicators of future travelling behaviour after the pandemic. The perceived safety and comfort during the pandemic and therefore, the attitude toward travelling by train, could rather be better indicators about future usage of public transport. However, the studies by Dong et al. (2021) and Kassaw & Pandey (2021) suggest that characteristics such as gender, age and closeness to the pandemic do affect level of anxiety and how people perceive safety on board public transport vehicles. This indicates that even if gender, age, place of residence, etc. might not directly affect the future behaviour as the results by Przybylowski et al. (2021) indicate, those characteristics might affect the perceived comfort and safety which affects future behaviour. Therefore, this research will investigate these characteristics and factors among other factors that could potentially affect future travelling behaviour and usage of public transport.

To wrap up, the main findings in the literature review are that females are more likely to experience anxiety in public transportation. Also, that people with families and daily laborers are more likely to experience anxiety. Additionally, anxiety can be influenced by how close a person is to the pandemic and how close attention they pay to the media. When the reasons for reduced usage of public transportation were investigated, the main reasons were because of more work from home or fear of getting infected, and the factors that affected their safety were the number of people in the vehicle and the behaviour of other passengers.

3. THEORY AND METHODOLOGY

To gain further insights into the anxious group and their behaviour, their characteristics are investigated. Furthermore, a behavioural model based on the theory of planned behaviour by Ajzen (1991) is used. The theory of planned behaviour states that that current behaviour is determined by behavioural intentions (Kan & Fabrigar, 2017). The theory of planned behaviour is adapted to fit this project better. The surveys did not have questions that asked about subjective norms and therefore, that factor is removed. Additionally, this project both focuses on current behaviour and intended future behaviour. Figure 1 shows the adapted schematic of the theory of planned behaviour. The figure shows that anxiety level falls under the factor of perceived behavioural control because anxiety level can influence how difficult or easy a person views the behaviour.

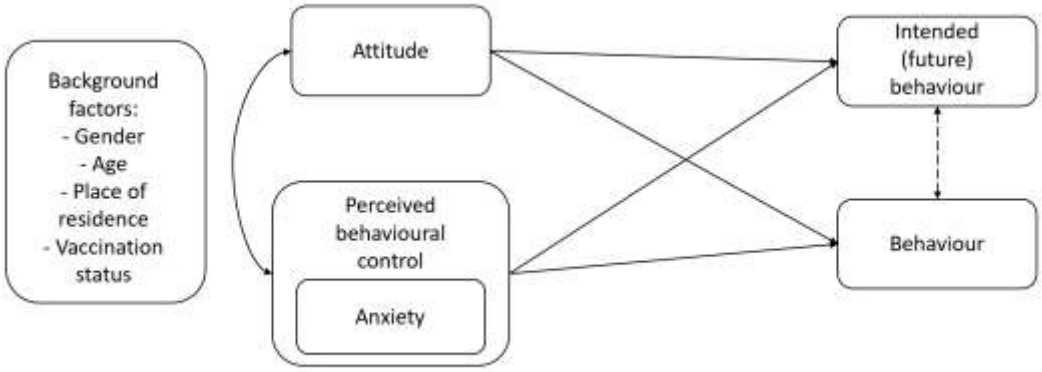

Figure 1 Adjusted schematic of the theory of planned behaviour

The data used for this research is from a longitudinal survey by NS and TU Delft (Ton et al., 2022b). The data from all the surveys are weighted for every respondent so that the survey results resemble the train travelling population. The survey from April 2021 is the mostly used one in this paper.

To determine if there is a statistical relationship between a variable and anxiety levels, statistical tests are used. The first statistical test performed for all variables is a chi-square test ("Using Chi-Square Statistic in Research," n.d.) as all the variables considered are categorical. However, there are some limitations to a chi-square test. One limitation is that the expected frequency of the cells has to be 5 or larger. If the expected frequency is less than 5 in more than 20% of the cells, then the chi-square test should not be used as the reported p-value will be lower than it actually is, which could lead to skewed results ("Some limitations of chi-square," n.d.; "Using Chi-Square Statistic in Research," n.d.). To adjust for this limitation, some groups are excluded or combined with other groups. For instance, the respondents that are younger than 18 years old are excluded from the analysis because of the small group size. Another limitation is when a sample size is very large, then the chi-square test determines even very small differences to be statistically significant ("Using Chi-Square Statistic in Research," n.d.). To adjust for this limitation, a smaller random sample is taken out of the dataset. The sample size used is 5% out of the whole April 2021 survey, which has 23000 participants, resulting in a size of about 1100 participants. With this size the confidence level is 95% and the margin of error between 2 and 3%. Here the margin of error denotes how much the sample is allowed to deviate from the mean. Five random samples are used, and the chi-square tests are compared. This is done to reduce the chance of getting Type I or Type II errors in the results. Type I errors occur when the null hypothesis is rejected while it is true, i.e., the result is significant while it should be insignificant. Type II errors occur when you fail to reject the null hypothesis while it should be rejected, i.e., the result is insignificant while it should be significant.

Chi-square tests only tests if at least one of the category combinations have a statistically significant relationship. To find out which categories are significant, post hoc tests are used to test for cell significance for each combination of category levels. Furthermore, Bonferroni Correction ("Post Hoc tests", n.d.) is used to avoid Type I error inflation. Since there are five random samples, this is done for all samples. When combinations are significant in at least 4 out of the 5 cases, the relationship is considered significant.

An additional method to identify different groups and categories within the variables for anxiety levels is classification tree analysis. This method groups categories together that have similar answers to the decision variable, which is anxiety level. In order to prevent overfitting, which is a limitation of classification tree analysis, pruning is used.

Finally, Cramer's V coefficient (AcaStat, 2015) is used to test the strength of association between the variables and anxiety levels. If the coefficient is 0.1 or lower, the association is not significant. And if the coefficient is 0.5 or higher, the association is high between the two variables.

These tests help to identify the anxious group and see if it is different from other anxiety level groups.

Identifying the anxious group

To identify the anxious group, the responses to the question I feel free to travel by train are investigated. The participants that answered that they did not feel free to travel by train are classified as anxious. Another question from the surveys asked the participants if they were afraid of getting infected. The responses to this question were crosschecked with the question of feeling free to travel in the train to see if there was a connection between the people that do not feel free to travel by train and are afraid of getting infected. The crosscheck resulted in that people that do not feel free to travel by train, are also afraid to get infected. Therefore, it can be concluded that the people classified in the anxious group based on the travelling question are anxious and are mostly anxious due to Covid-19.

Figure 2 shows the change in percentage in anxious people between surveys and the number of Covid-19 cases in the Netherlands. The figure indicates that the number of anxious people is related to the number of cases. Additionally, the number of vaccinations increased a lot between April and September 2021, where a large drop in anxious people was also noticed. This indicates that there is also a relationship between the vaccination status and number of anxious people.

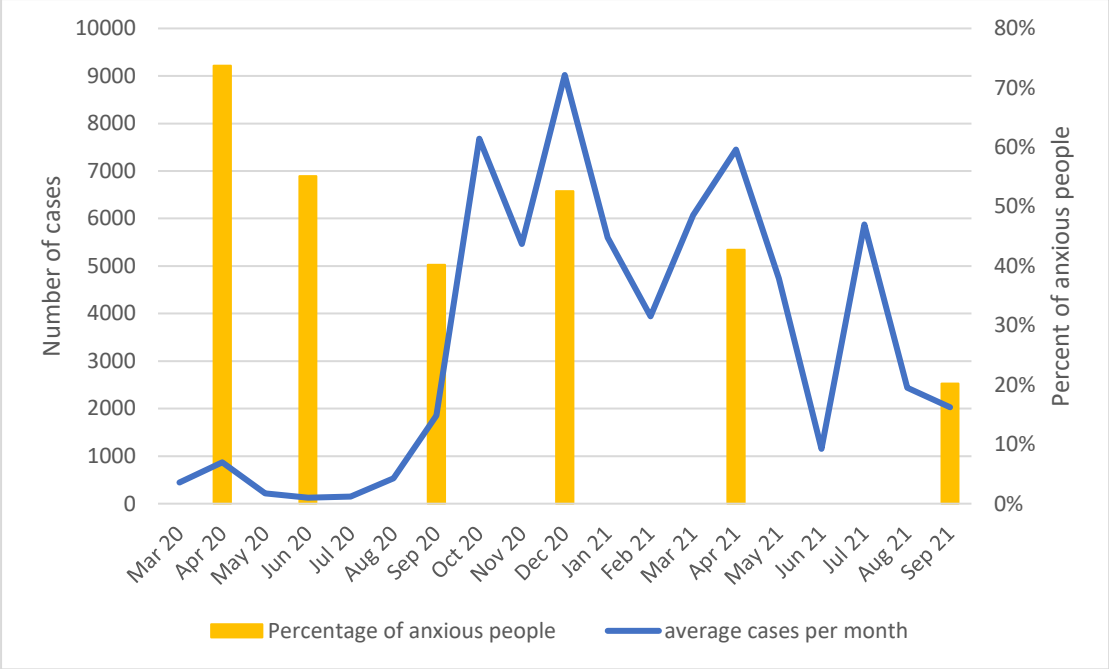

Figure 2 Change in percentage of anxious people compared with average Covid-19 cases per month

4. FINDINGS

This chapter shows and discusses the main findings of the study. Section 4.1 discusses the three characteristics of the anxious group that are determined to be the most important factors to determine the anxiety level of a person. Section 4.2 discusses how the different anxiety levels differ for different attitudes toward the train and travel behaviour.

4.1 Characteristics of the anxious group

To investigate which factors are the most important to determine the anxiety level, a classification tree analysis (explained in section 3) is performed on the whole dataset. This results in that age is the most important factor for anxiety level, followed by gender, then vaccination status in April 2021. These three factors that are deemed the most important are investigated in more detail in this section.

Age group

The respondents are divided into seven age groups from the age of 18 to 70 years old and older. Classification tree analyses are performed with age, where the anxiety levels are divided into groups based on age. This analysis results in that the age groups are split into two groups, where the younger people (18-24 years old) are less likely to be anxious.

Figure 3 shows the distribution of anxiety levels per age group. The figure shows that the youngest age group (18-24 years old) has the lowest amount of anxious people, while the other age groups show that the anxious group is the largest out of the three anxiety levels.

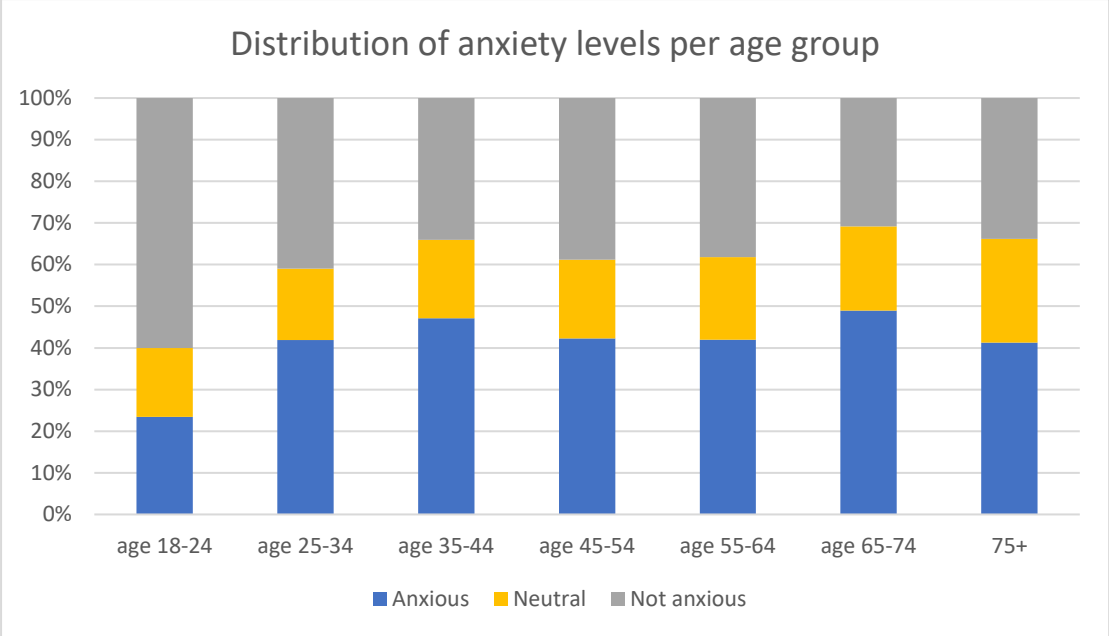

Figure 3 Distribution of anxiety level per age group

To test if there is a statistical significance between age group and anxiety levels further analysis is performed. More detailed results of the statistical tests can be found in Hafsteinsdóttir (2021). A chi-square test resulted in that the statistics and p-values are significant for all samples. This means that at least one combination in statistically significant. A classification tree analysis is performed in order to investigate if there would be a further division into groups based on age. This results in that only the 18-24 year old group is not anxious, while all the others are grouped together in an anxious group. Finally, Cramer's V coefficient is computed and resulted in a coefficient between 0.1 and 0.2 for all five samples tested. This means that the association between age group and anxiety level is low, but significant.

Gender

The second most important factor for anxiety level is gender. Literature also shows that females are more likely to experience anxiety in public transport. This is also seen in this research, where figure 4 shows that 46% of females are anxious, while only 38% males are anxious.

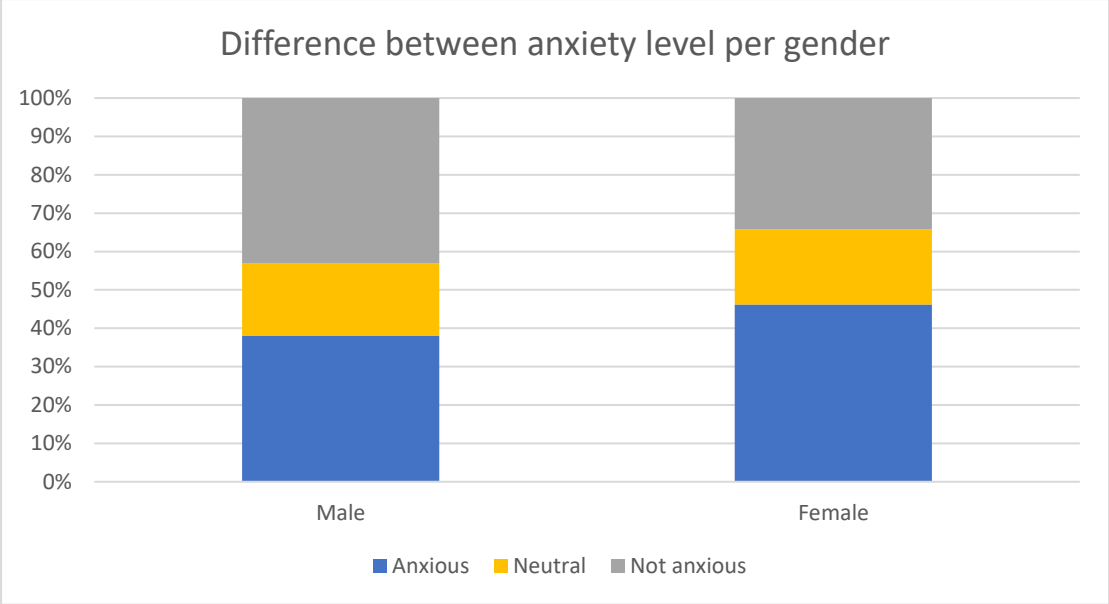

Figure 4 Difference between gender and anxiety level

Figure 4 shows that there is a difference between gender and anxiety level but does not show if this difference is significant. A chi-square test shows that most samples result in a significant value, however, one of the samples results in an insignificant relationship, but it is likely that it is type II error. A post hoc test is done to see which combinations are significant. This results in that every combination of gender and anxiety level are significant. A classification tree analysis shows that females are more likely to be anxious than males. Lastly, Cramer's V coefficient is computed and ranged between 0.1 and 0.2. This means that there is a significant association between gender and anxiety level, but the association is low.

Vaccination status

Vaccination status is the third most important factor for anxiety levels in the overall classification tree. Also, there seems to be a relationship between the number of anxious people and vaccination rates, as the number of anxious people decreased a lot in September. This indicates that there might be a relationship between vaccination status and anxiety level.

The results from the April 2021 survey show that those that are fully vaccinated are less likely to be anxious, while those that are still waiting to get fully vaccinated are more likely to be anxious. Because not everyone had gotten the chance to get a vaccine in April 2021, the survey of September 2021 is considered, where 90% of train travellers are fully vaccinated at this time. The September 2021 results show that majority in all groups are not anxious, but those that are not vaccinated have the highest share of anxious people.

Another interesting aspect is the relationship between vaccination status and anxiety level over time. Therefore, the participants that participated in the surveys in December 2020, April 2021, and September 2021 are investigated

further. Figure 5 shows the change in anxiety level based on vaccination status from April to September 2021. The figure shows that there are four categories for the change in anxiety. The 'other' category is where there are inconsistencies in the answers, as well as it includes those that respond that they would rather not say about their vaccination status, because it was not known if their vaccination status has changed or not. There is also a category called 'other' in the change in vaccination status. This category includes those that were still partially vaccinated in September, those that prefer not to say and don't know of they will get vaccinated.

Figure 5 shows that many people that got vaccinated between April and September experienced a decrease in anxiety. Those that were fully vaccinated in April and those that chose not to get vaccinated mostly experienced the same level in anxiety in all three surveys. This indicates that there is a relationship between vaccination status and anxiety level.

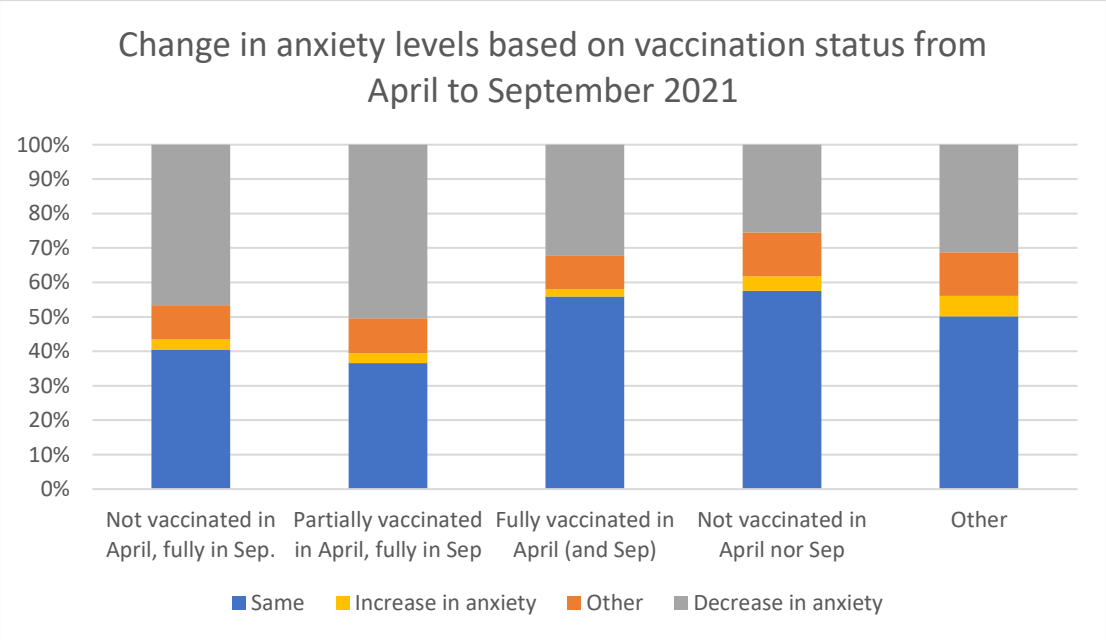

Figure 5 Change in anxiety levels based on vaccination status from April to September 2021

Multiple statistical tests are performed on the difference in anxiety levels and vaccination status in April 2021. This cannot be done for the September 2021 survey because of low expected number in many of the cells. A chi-square test for the survey of April 2021 results in that all values are significant. This means that at least one combination is statistically significant. To determine which combinations are significant, classification tree analysis is performed. This results in that the vaccination status can be split into two categories based on anxiety level. Those that are not yet vaccinated but planning to, partially, or would rather not say are more likely to be anxious. On the other hand, people that are fully vaccinated, are not planning to get vaccinated, and those that are unsure are more likely to be not anxious.

These tests show that vaccination status does influence anxiety levels and that getting vaccinated reduces anxiety levels

Other characteristics, such as region of residence, trip purpose, usual time of travel are also tested, but they are not determined to be the main factors. Furthermore, these characteristics are correlated with the main factors such as age and are therefore excluded in this paper. We refer the interested reader to the study of Hafsteinsdóttir (2021).

4.2 Travelling behaviour and attitude

Attitude

Attitude is one of the elements that influences behaviour and is influenced by and influences anxiety level. One of the questions in the surveys asks about their attitude towards travelling by train.

Figure 6 shows that those with negative attitude towards the train are mostly anxious. The opposite is seen for those that have a positive attitude towards the train, they are mostly not anxious.

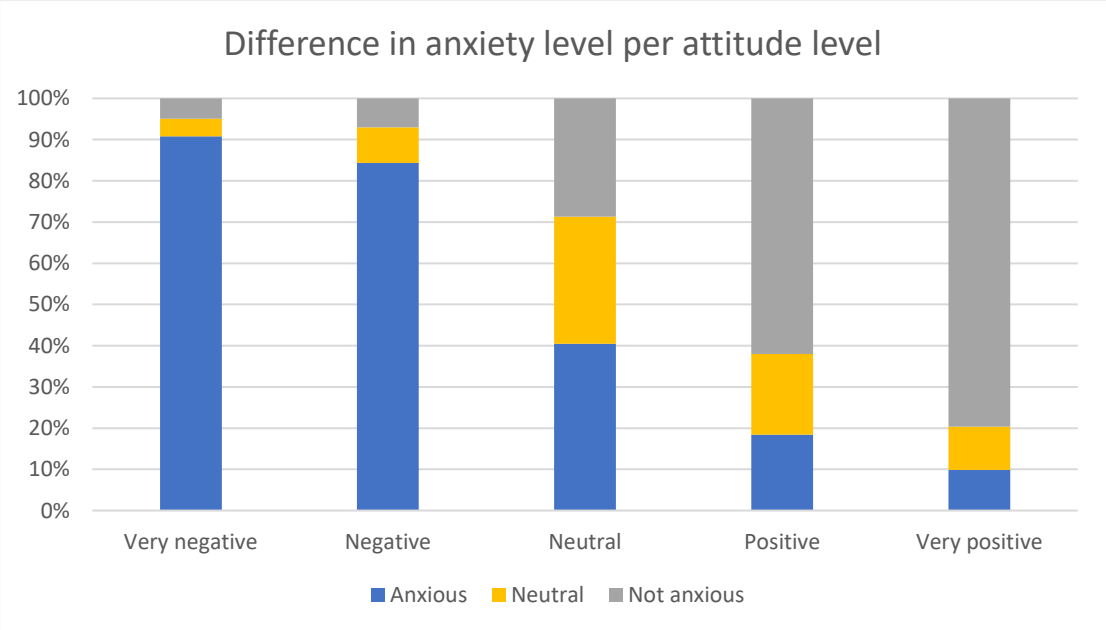

Figure 6 Difference in anxiety levels per level of attitude

Statistical tests are performed to determine if this difference is statistically significant. A chi-square test results in that there is a statistical significance between at least one combination of anxiety and attitude. To determine which combinations are significant, a post hoc test is performed. The post hoc test reveals that most combinations are significant, with the exception of the combinations of neutral attitude – anxious, neutral attitude – neutral anxiety level, and very positive attitude – neutral anxiety level. Lastly, Cramer's V coefficient resulted in values between 0.42 and 0.48, which means that that

there is a moderate association between attitude and anxiety level, which makes sense since the two variables influence each other.

Travelling behaviour

The current travelling behaviour of participants is also examined, where one of the survey questions asked how often they travelled last week (in April 2021).

Figure 7 shows the difference between travel behaviour and anxiety levels. The figure shows that those that did travel that week are mostly not anxious.

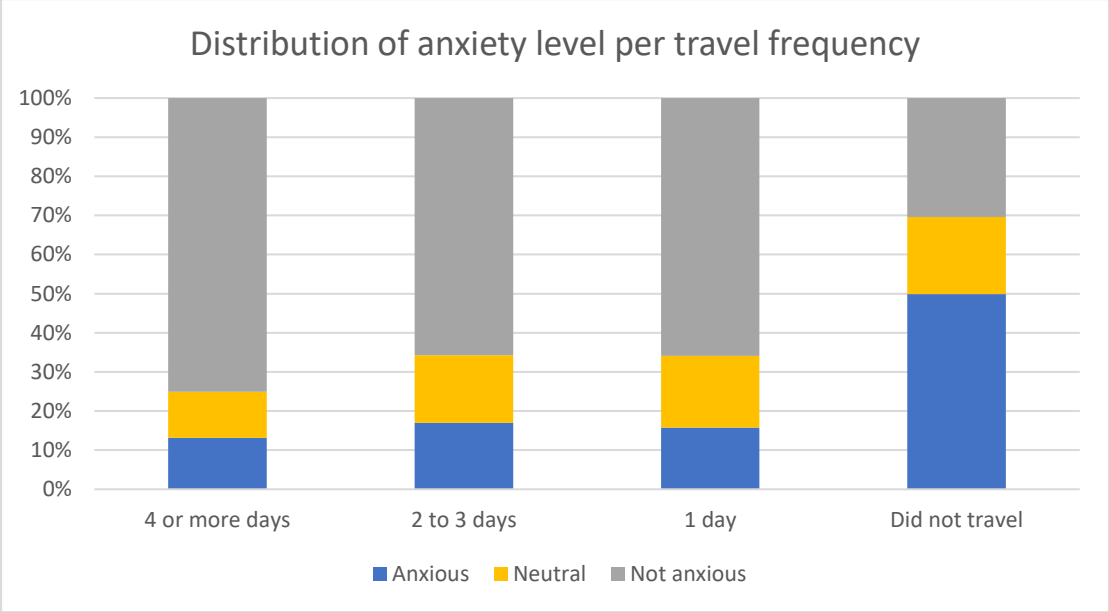

Figure 7 Distribution of anxiety level per travel frequency

To determine if this difference is statistically significant, statistical tests are performed. A chi-square test results in that the values of all samples are significant, and therefore, at least one combination is significant. A post hoc test showed that most combinations are significant, with the exception of the combinations of 1 day – neutral anxiety level, and 2-3 days – neutral anxiety level. A classification tree analysis shows that those that did not travel are more likely to be anxious. Finally, Cramer's V coefficient calculations resulted in a coefficient between 0.17 and 0.34, meaning that there is a low to moderate association between current travel behaviour and anxiety levels.

In addition to the current train usage, participants were asked about their future, expected train usage, by asking if people intend to travel less or more after the pandemic, compared to their usage before the pandemic.

Figure 8 shows that those that expect to reduce their train usage are mostly anxious.

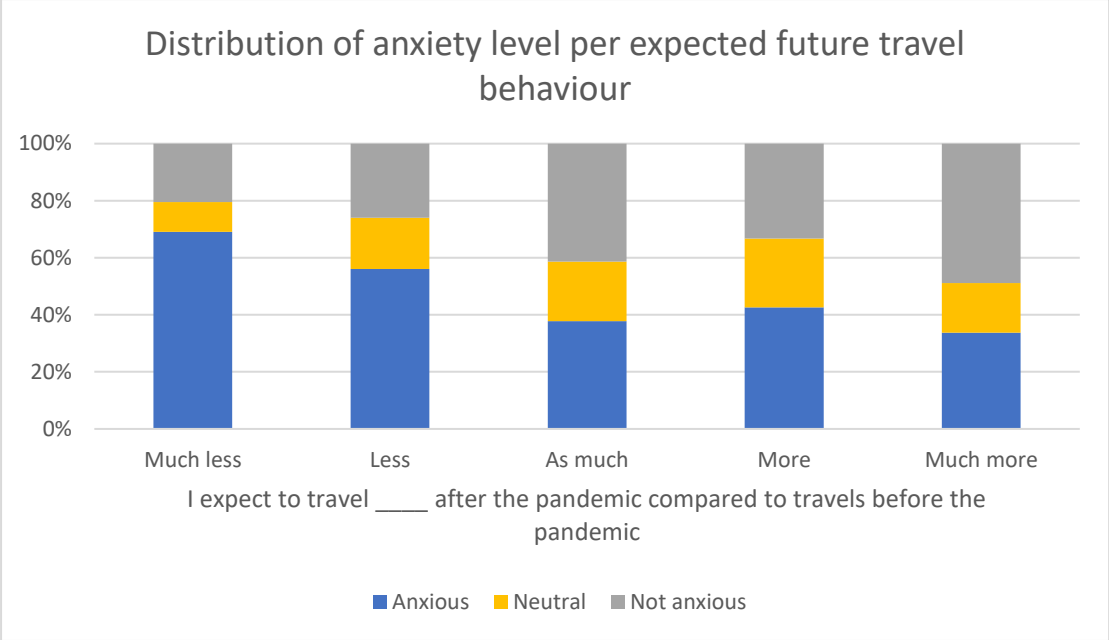

Figure 8 Distribution of anxiety level per expected future travel behaviour

To determine if this difference is statistically significant, statistical test are performed. A chi-square test shows that at least one combination is significant, as all values for each sample is significant. Post hoc test is performed to determine which of the combinations are significant. This results in that there is only a significant relationship between all the anxiety levels and those that plan to reduce their train usage, or plan to travel the same. Classification analysis results in that those that plan to travel less and much less are most likely to be anxious, those that expect to travel more are anxious, and those that plan to travel the same and much more are likely to be not anxious. Finally, Cramer's V coefficient is computed and results in values between 0.15 and 0.23. This shows that there is a significant, but low association between future travel behaviour and anxiety level.

5. EFFECTS ON TRAVELLING BEHAVIOUR AND ATTITUDE

The main purpose of the research is to investigate the effects of anxiety on behaviour, attitude and intended behaviour. Even without anxiety, there is a strong relationship between attitude and intention and therefore behaviour. Hence, it is important to investigate what the additional effects anxiety has on attitude, behaviour, and intended behaviour.

Figure 9 shows the difference in attitude between the anxious group and not anxious group. The yellow bars show a scenario where all train travellers are anxious and the blue show a scenario where all train travellers are not anxious. The figure shows that if all train travellers are not anxious the attitude would mainly be positive towards the train. But when people are anxious, their attitude towards the train becomes more negative.

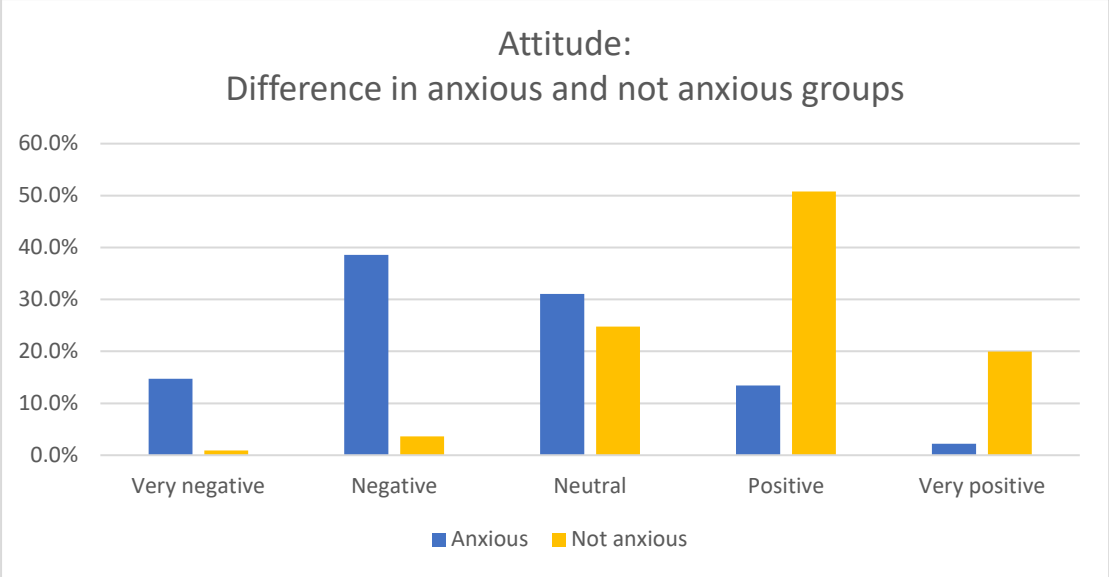

Figure 9 Difference in anxious and not anxious groups in attitude towards the train

Figure 10 shows the same scenarios as figure 9, but for current travel behaviour. The figure shows that when people are anxious, they reduce their trips by train and more people do not travel by train.

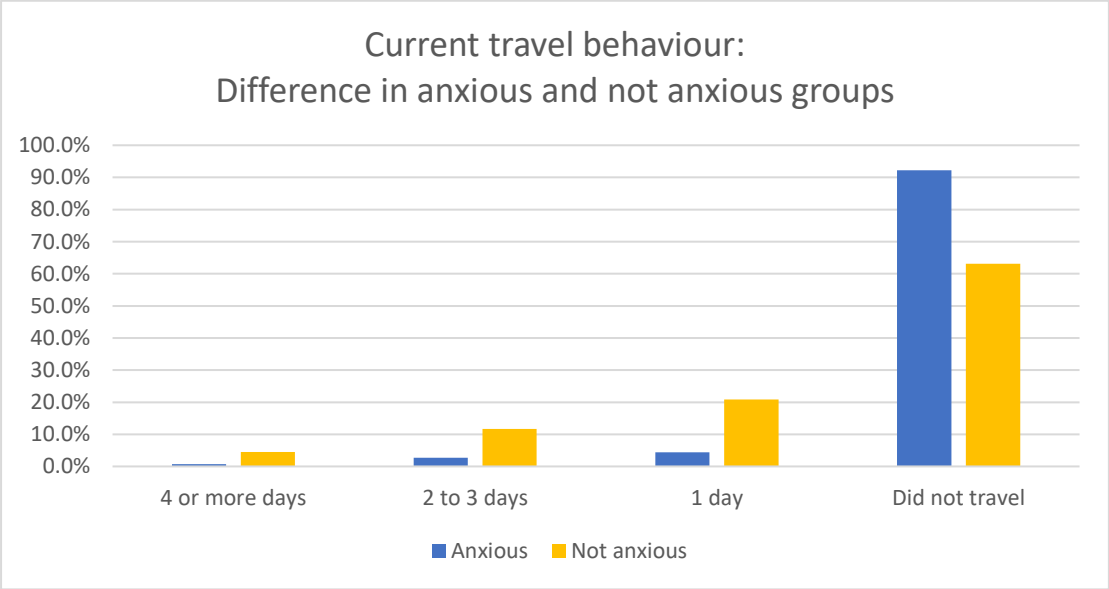

Figure 10 Difference in anxious and not anxious groups in current travel behaviour

Figure 11 also shows the same scenarios as above, but for future, expected travel. The figure shows that when people are anxious, similar percentage of people expect to travel. But generally, anxious people expect to travel less than they did before Covid-19, but the majority expects to travel as much as they did before.

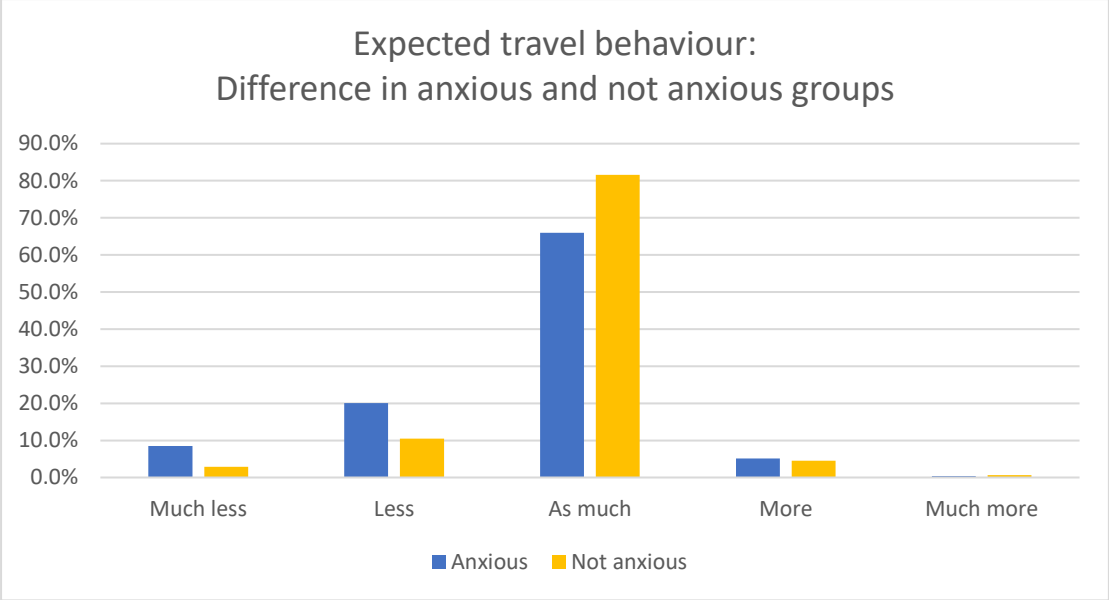

Figure 11 Difference in anxious and not anxious groups in expected future travel behaviour

These figures (figure 9-11) show that the attitude becomes more negative when people are anxious, which leads to less train usage.

6. CONCLUSIONS

The results of the research can give an indication of how the expected situation will be after Covid-19. In September, there had been few restrictions and low number of cases, but still 20% of train travellers are still anxious, and 6% people still very anxious, as seen in Figure 12. This could mean that after Covid-19, the number of anxious people in the train might be similar to what is seen in September 2021. This means that it is likely that there will still be a group of people that will be anxious, at least for some time after the pandemic. Especially those that answered that they were very anxious in September, as it is less likely that they will change anxiety levels drastically in the near future.

Since it can be expected that there will be a percentage of train travellers that are anxious, it is important to look further into this group and see how it is possible to accommodate them in the train.

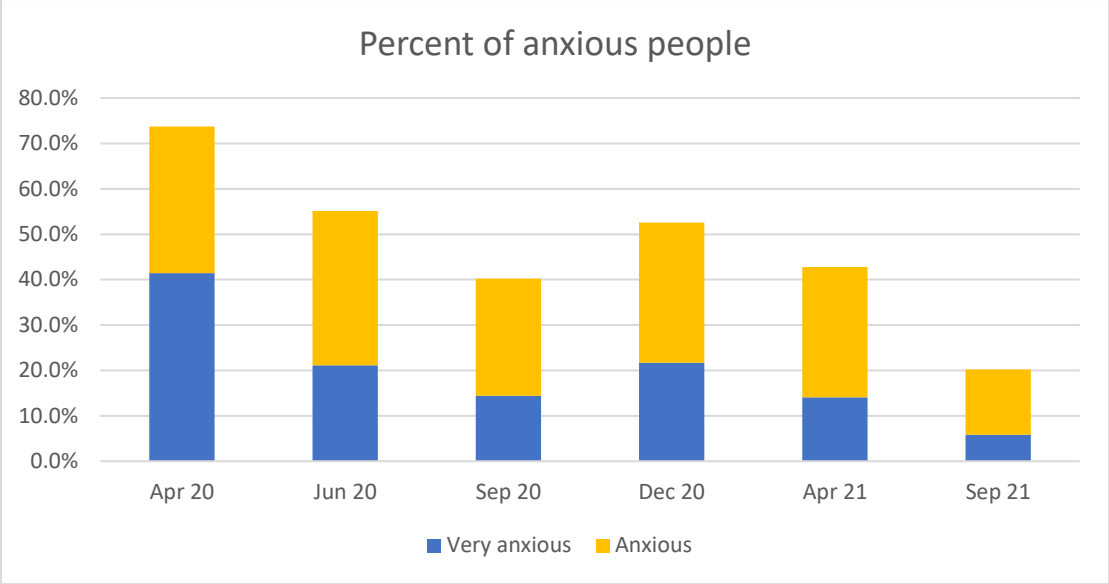

Figure 12 Percentage of anxious train travellers out of the general travelling population

This research results in showing that there is a change in percentage of anxious people over time, and there seems to be a relation between the number of cases and vaccinations in the country, where people get more anxious with higher number of cases but generally get less anxious after being fully vaccinated.

The behavioural model explained in chapter 4 and figure 1 indicates that attitude and anxiety influence each other to a certain extent. Behaviour is then influenced by attitude and anxiety. Attitude already has a strong relationship to both current and future behaviour, and this research shows that anxiety has a negative effect on attitude which leads to less train usage, both current and expected usage in the future. When people are anxious, they tend to generally have a negative attitude towards the train, while not anxious people generally have a positive attitude towards the train. In current train travelling behaviour, anxiety has the effect of people travelling less, and more people are likely to not travel at all. For future expected travels, anxious people are more likely to plan to travel less than not anxious people.

Based on the findings of this project, a typical profile of an anxious and not anxious persons is shown in table 1. The profile of an anxious person would be female, older than 25 years old, that is planning to get vaccinated, partially vaccinated (in April 2021), or not planning not get vaccinated (in September 2021) and would have mainly travelled by train for leisure and recreational trips before Covid-19. This person would have a more negative attitude towards the train and travel less. On the other side, a typical not anxious person would be in the age group of 18-24 years old, male, and fully vaccinated. This person would have a more positive attitude towards the train and likely to travel more frequently.

Table 1 Typical profile of anxious and not anxious persons

Characteristic	Anxious person	Not anxious person
Age	25 +	18 – 24
Gender	Female	Male
Vaccination status	Not (yet) vaccinated	Fully vaccinated
Travel attitude and behaviour	More negative attitude and travels less	Positive attitude and likely to travel more frequently

Limitations and recommendations

This research shows that anxiety influences the attitude towards train and travel behaviour. This research, however, also has some limitations. One of the limitations is that the sample sizes that are used might be too large for chi-square tests. However, a smaller sample size would mean that each sample could have been further from the population, while a sample should have the same features as the population. On the other hand, this large sample size could lead to that the chi-square tests result in a significant result where it should be insignificant. Another limitation is that this research only focuses on one survey, namely, the survey of April 2021. Other surveys might show a different relationship in some cases. Especially the survey of September 2021, as the number of anxious people decreased a lot. This could mean that the results of this project are very specific to the situation of April 2021 and there could be some differences if other surveys were included or investigated further.

This research also leads to suggestions for further research. One suggestion is to further study the relationship between number of Covid-19 cases and/ or vaccination numbers and anxiety level. This could establish a relationship between these variables which could lead to a better forecasting in train usage, which would help with planning. Another suggestion is to investigate further why there still is a group of very anxious people in September 2021, and what factors might contribute to this anxiety. This could also include further considering the group that is fully vaccinated but still anxious, or if people that are anxious changed to other modes of travel or use those modes more often. It would also be interesting to look further into if the importance of vaccination status has changed since April/September 2021. Since in the end of 2021, the number of cases are rising again, and most people are fully vaccinated, it would be interesting to investigate if this leads to more people getting anxious or less anxious because of vaccination status or previous infection.

The results of this paper help identify this group of anxious people and establish the effect of anxiety on attitude and behaviour, which helps for designing timetables and planning rolling stock purchases. It also sets a base for further research into the relationship between number of cases and anxious people which also can help better predict the number of anxious people in the future.

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