Delft University of Technology (TU Delft)

Nederlandse Spoorwegen (NS)

Effects of anxiety on train travelling behaviour during and after Covid-19

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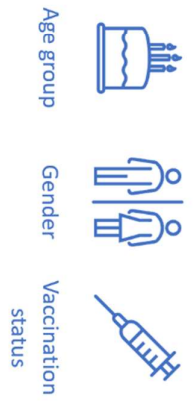Student number: 5301009

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This project was made for the course CIE5050: Additional Graduation Work at TU Delft 2021. The supervision team for this project consisted of Niels van Oort and Renate van der Knaap from TU Delft along with Menno de Bruyn from NS.

Infographic

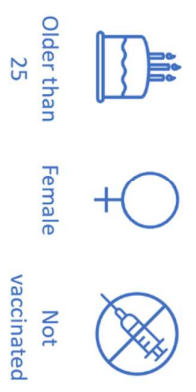# Effects of anxiety on train travelling behaviour before and after Covid-19
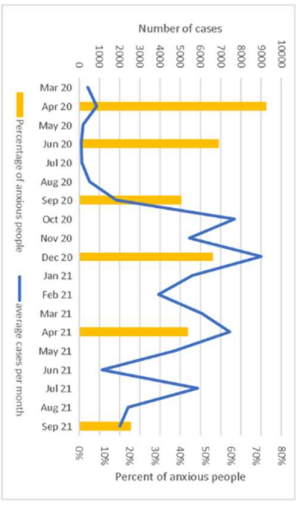
Number of anxious people seems to relate to number of cases and hospitalizations
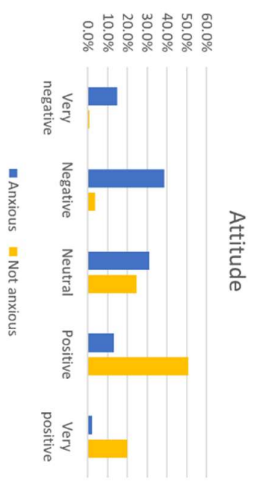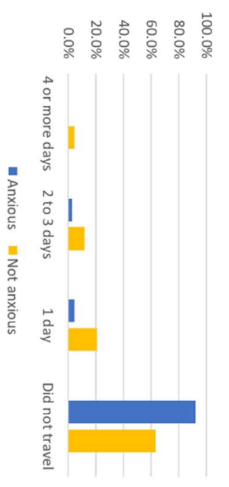
Number of cases

Percentage of anxious people — average cases per month

Percent of anxious people

Anxious people have more negative attitude towards the train

Attitude

■ Anxious ■ Not anxious

Very negative, Negative, Neutral, Positive, Very positive

Most important factors for anxiety level

Age group   Gender   Vaccination status

Typical profile of anxious person

Older than 25   Female   Not vaccinated

Anxious people travel less by train in April 2021

Current travel behaviour

■ Anxious ■ Not anxious

4 or more days, 2 to 3 days, 1 day, Did not travel

Anxious people expect to travel less by train in the future

Expected travel behaviour

■ Anxious ■ Not anxious

Much less, Less, As much, More, Much more

23.12.2021

Table of Contents

1. Introduction

Covid-19 has had a major impact on people's lives all over the world and has had an impact on mode choice, trip purposes and frequencies of travel. The Dutch intelligent lockdown in March 2020 had a big impact on mobility (Drift, Wismans, & Olde Kalter, 2021; Haas, Faber, & Hamersma, 2020). People's activities, work and travel behaviour changed (Haas et al., 2020). As a result of the intelligent lockdown, around 80% of people reduced their outdoor activities and there was a 55% reduction in number of trips travelled (Haas et al., 2020). Additionally, more people were working from home and about 27% planned to work more from home in the future (Haas et al., 2020). More people (about 20%) expect to use bicycles or walk more often in the future and fly less (Drift et al., 2021; Haas et al., 2020). The time of travels during the day has also changed as not everyone is travelling during the peak hours anymore (Drift et al., 2021).

During the intelligent lockdown, public transportation saw a drastic reduction in usage (Drift et al., 2021). In the Netherlands, the impact on public transport usage reduced up to 90% per day during the Covid-19 crisis compared to the year before (2019). In June 2021, when travelling by public transport was allowed again, the usage was only half compared to similar weekday in 2019 ("Covid-19 impact on public mobility," 2021). Public transport is, however, an important part of the transport network and a crucial part that integrates with active modes such as walking and cycling and a more sustainable mode of travel than private cars (Drift et al., 2021). The mobility impact that Covid-19 has had on public transport can be positive if public transport is integrated as an important travelling alternative again (Drift et al., 2021). In order to do that and to adjust to the new mobility patterns, insight into the travellers is needed.

Due to these impacts on mobility, Nederlandse Spoorwegen (NS) and Delft University of Technology (TU Delft) started researching travel behaviour during Covid-19 and expected behaviour after Covid-19. It was expected that there would be a major change in travel behaviour, both on the short term and the long term. Additionally, they wanted to know how people are experiencing travelling by train throughout the pandemic and how the passengers can be made feel safe during their travels. Also, knowing the long-term changes such as the effect on number of trips are critical information for being able to do forecasting that will have an effect on future planning such as timetable design and rolling stock purchases (M. Bruyn, personal communication, October 14, 2021).

To gain information on travel behaviour, NS and TU Delft organized longitudinal surveys in April 2020, June 2020, September 2020, December 2020, April 2021, and September 2021. These surveys give quantitative insights on current and future travel behaviour that help to restore and redesign public transport properly after the Covid-19 pandemic (Hagen et al., 2021a, 2021b). Each survey had about 23000 to 47000 participants, and about 11000 have participated in every survey so far (M. Bruyn, personal communication, October 14, 2021; Hagen et al., 2021b). The participants are a part of the NS panel and therefore can be weighted to represent the whole train travelling population.

More papers and information on the impacts of Covid-19 on train travelling behaviour can for instance be found at the TU Delft weblog of Niels van Oort (Oort, 2021).

In the surveys, there was always a group of people that answered that answered some questions indicating that they could be anxious about travelling by train as a result of Covid-19. Since anxiety might have some influence on people's behaviour, it was wanted to investigate this group further. By

investigating this group, features such as their characteristics and behaviour change can be identified and there will be a more insight into the behaviour and expected behaviour of this group. The existing survey database has a lot of information from the surveys and participant's information from the NS panel. This database will be used for answering the research questions and reaching the aim of the project.

The aim of this project is to gain more insight into the effects of anxiety on train travelling behaviour. In order to reach the aim, the following research questions are proposed:

What are the effects of anxiety on train travelling behaviour, attitude towards the train and intended train travelling behaviour during and after Covid-19?

To answer the research question, the following sub-questions are proposed:

- What factors/characteristics influence anxiety?
- How does anxiety develop over time during the pandemic?
- Does anxiety have influence on behaviour and attitude?
- What is the relationship between anxiety and attitude, and anxiety and behaviour?

This project will focus on anxious train travellers. There was no question in the surveys that directly asked if participants were anxious about travelling by train, however, there was a question that asked if participants felt free to travel by train. This question was chosen to best determine if people were experiencing anxiety on the train because if people were anxious about travelling by train, they would probably not feel free to travel by train. There were also questions in the surveys that asked about anxiety in more general terms. Those questions asked participants if they were afraid of getting infected or if they were feeling anxious in general. In order to include all anxious people and check if people experiencing anxiety in general were also the people that were anxious about travelling by train, a crosscheck was performed, which will be explained further in section 4.2.

The remainder of the paper is set up in the following way. In section 2 is a literature review, section 3 explains the methodology used for the analysis. Section 4 include the analysis where a theoretical model is explained, the characteristics of the different anxiety level groups and the effects of anxiety on attitude and behaviour are investigated. Section 5 includes a discussion and section 6 concludes the project.

2. Literature

Research by Dong, Ma, Jia, and Tian (2021) showed that train passengers are less anxious when they perceive more safety on board public transport. They also noted that anxiety in general can also have negative effects on perceived safety in public transportation. Their results also showed that passengers had more anxiety when they were "psychologically closer to the pandemic" (Dong et al., 2021). The people that were closer to the pandemic were for example those that were close to someone that had Covid-19 or passed away from Covid-19, or were working in healthcare (Dong et al., 2021). The passengers that were close to the pandemic were more likely to pay closer attention to media and other information than those that were further away. Those that paid less detailed attention to the media and the pandemic were more likely to think that current prevention measures were working and the pandemic was under control and thus, they perceive more safety on board (Dong et al., 2021).

Kassaw and Pandey (2021) performed research about anxiety disorder among people using public transportation in Addis Ababa, Ethiopia. They did a study among 420 public transport users in March 2020 and used logistic regression to determine what variables were associated with general anxiety disorder. Their results showed that about a third of the respondents had general anxiety disorder. Females, daily laborers, people with families lager than three persons and people that do not use face masks were more likely to experience anxiety in public transportation than other groups (Kassaw & Pandey, 2021). In their study, they mentioned other similar studies that have been done about anxiety and public transportation usage. A study from China that was performed in the beginning of the pandemic showed that about 54% of their respondents experienced anxiety, while a study in India, from April 2020, showed that 25% of their respondents experienced anxiety (Kassaw & Pandey, 2021). The research in India also showed that women are twice as likely to experience anxiety, moderate to severe stress, and depressive symptoms than men (Wilson et al., 2020).

Przybylowski, Stelmak, and Suchanek (2021) performed research in Gdansk, Poland, in May and June 2020 where they looked into how Covid-19 impacted mobility behaviour in terms of safety and comfort among public transport users. Their results showed 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 stopping using public transport, the most common answer (about 50%) was because the respondents had switched to working or studying from home and therefore not using public transport like before (Przybylowski et al., 2021). Another reason for not travelling by public transport as frequently as before was due to fear of getting infected (40%) and 14% changed their mode of travel to a private mode (Przybylowski et al., 2021). When they looked at only the people that stopped using public transport, the reasons were similar as above, however, 42% indicated that they had switched to a private mode of transport (Przybylowski et al., 2021). 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. Additionally, their results show that the feeling of safety and comfort in public transport before the pandemic was statistically insignificant when looking at groups that were likely to return to using public transport after the pandemic (Przybylowski et al., 2021). Interestingly, variables such as age, gender, place of residence and socio-economic status were also not significant when looking at groups that were likely to return to using public transport after the pandemic. The significant variables were how people perceive safety and comfort in public transport during the pandemic (Przybylowski et al., 2021). Przybylowski et al. (2021) therefore recommend that policies should focus on improving the perception of safety and comfort in public transportation as the future behaviour and usage of public transport is highly affected by how passengers perceive comfort and safety during the pandemic.

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 in the future. However, the studies by Dong et al. (2021); Kassaw and 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.

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. Methods

In this section the methods used for the project are explained along with limitations encountered during the project and reasoning behind the critical decisions regarding the methods and analysis. For the analysis of the data from the surveys, statistical tests were used. The characteristics and variables used to identify the anxious group were in line with what was found in the literature review (section 2).

Data

The data from all the surveys are in SPSS. The data are weighted for every respondent so that the result from each survey resembles the train travelling population. In the analysis of this project, the April 2021 survey is mostly used. The data from that survey are taken separately out of the whole dataset. For finding the percentage of each anxiety level for each variable and category, crosstabs in SPSS are used to get the frequencies per category combination. This is then moved to Excel where the percentages were found, and the figures made.

For the analysis of this paper statistical tests will be used to determine if there is a significant relationship between a variable and anxiety level. For testing, SPSS is used.

Chi-square test

The variables that are being investigated are categorical variables, therefore a chi-square test is used to test if there is a significant relationship between the variable and anxiety levels.

There are some limitations to the 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 p value that is reported from the chi square test will be lower than it actually is, which could lead to skewed results ("Some limitations of chi-square," ; "Using Chi-Square Statistic in Research,").

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,"). To adjust for this limitation, a smaller random sample is taken out of the dataset. To know how large the random sample must be, the statistical sample size is calculated using sample size calculators online ("Determining sample size: how to make sure you get the correct sample size," ; "Sample size calculator,"). This results in, for the April 2021 survey where there were 23031 participants, the sample size needed is 1020, with a 95% confidence level and with a margin of error of 3%, where the margin

of error is how much percentage the sample is allowed to deviate from the mean. This sample size is 4.4% of the sample. For simplification purposes, 5% of the survey was used for the random samples, resulting in a sample size of around 1100. With this size the confidence level is still 95% and the margin of error between 2 and 3%.

Since the random samples can also differ from the population, five random samples are taken from the dataset and chi-square test is used, and then compared. This is done because in every chi-square test there is a change of getting Type I errors and Type II errors. 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. By performing the test on multiple samples, the chance of getting these errors is reduced significantly.

Post-hoc tests

One thing that is important to keep in mind when working with variables with multiple categories is that the chi-square test only tests for if at least one of the category combinations have a statistically significant relationship. In order to find which combinations are significant, a post-hoc test after a statistical chi-square test is performed. This post-hoc test tests for cell significance for each combination of the category levels and uses Bonferroni Correction to avoid Type I error inflation ("Post Hoc Tests,").

This is done for all five random samples and the combinations that are significant in four or five cases will be determined significant. Similarly, those with no samples that are significant or only one will be determined insignificant. Additionally, a post-hoc test is performed on the whole survey in order to help with the cases where only two or three out of the five samples are significant.

When performing the post-hoc tests, there could be a lot of inconsistencies and hard to draw conclusions for some of the cases. In those cases, classification tree analysis is used to see how the categories of the variable could be split up with respect to anxiety level.

Classification tree analysis

An additional method to identify different groups and categories within the variables for anxiety levels is classification trees. Classification trees group together categories that have similar answers to the dependent variable, which is anxiety level in this case.

When performing a classification tree analysis, the whole survey of April 2021 is used. In order to prevent overfitting of the tree, leading to a solution that would only fit this specific case, a function called pruning is used. This is a built-in function in SPSS for preventing overfitting.

Cramer's V coefficient

The Cramer's V coefficient is used to test the strength of association between anxiety levels and the other variables. This coefficient is between 0 and 1 where 1 is a perfect association between the variables. A coefficient of 0.1 is used as a minimum threshold value for a significant association (AcaStat, 2015). If the coefficient is larger than 0.5 then there is high association between the two variables (AcaStat, 2015)

These statistical tests and methods are used in the next section of the project, especially in section 4.3 and 4.4. These tests will help identifying the anxious group and see if it is different from other anxiety level groups.

4. Analysis

In this section the data is analysed and checked what characteristics and behaviour have significant relationships with the anxiety level of train travellers. In order to make a scheme of the analysis it is related to the theory of planned behaviour. This makes it easier to understand how some of the variables could have influence on each other which then leads to behaviour. This theoretical model is further explained in section 4.1. In section 4.2 the process of identifying the anxious group from the survey data is explained along with investigation of how the number of anxious people changed over time. Section 4.3 investigates the characteristics of the anxious group. The methods mentioned in section 3 are used in this section and the variables tested are similar to the variables mentioned in the literature review in section 2. In section 4.4, the statistical relationship between anxiety levels, attitude and behaviour are tested with the statistical tests mentioned in section 3. Finally, section 4.5 investigates the effects of anxiety on attitude and current and future behaviour.

4.1 Theoretical model

The theory of planned behaviour by Ajzen (1991) is used to understand and predict behaviours (Ajzen, 1991; Kan & Fabrigar, 2017). The theory states that current behaviour is determined by behavioural intentions (Kan & Fabrigar, 2017). Behavioural intentions are determined by three factors: attitude, subjective norms, and perceived behavioural control (Ajzen, 1991; Kan & Fabrigar, 2017). Subjective norms are dependent on the person and their beliefs about what the people close to them think about the behaviour (Ajzen, 1991). The part of perceived behavioural control consists of the person's perception on how easy or difficult the behaviour is (Ajzen, 1991). Figure 1 shows the schematic of the theory of planned behaviour from Ajzen (1991).
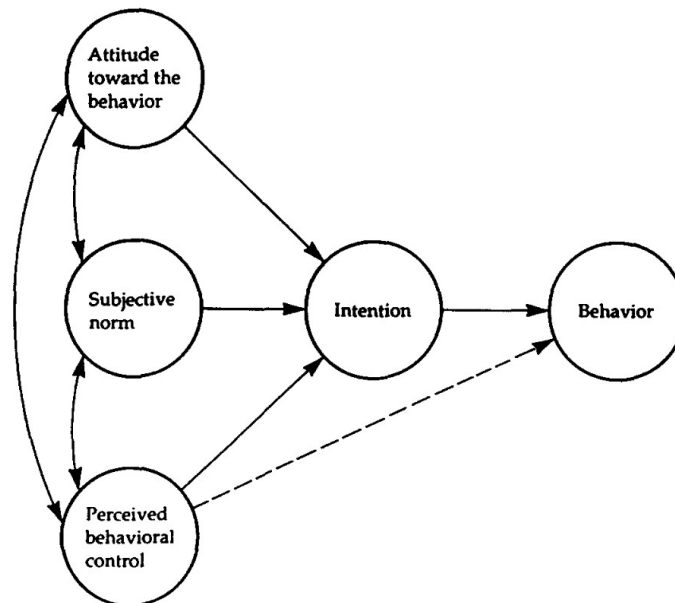

Figure 1 Theory of planned behaviour schematic (Ajzen, 1991)

The three factors of attitude, subjective norms and perceived behavioural control can be influenced by various background factors such as gender, personality, mood, attitude, experience, age, and culture. These background factors also influence anxiety levels. A classification tree analysis was performed to determine which factors in this research are most important for anxiety level. The factors that were included were gender, age, place of residence, and vaccination status in April 2021. The classification tree analysis resulted in that age was the most important factor, then gender and third, vaccination status as seen in figure 2. The figure shows that when it comes to anxiety, people in the age group of 18-24 years old are less likely to be anxious. The group of people that are older than 25 years old can then be split up by gender, where females are more likely to be anxious. Gender is then split up based on vaccination status, where females that are not yet vaccinated but are planning to or partially vaccinated are most likely to be anxious. The male group can be split up based on if they are fully vaccinated or not, which are then further split based on age group again where the older age groups are more likely to be more anxious than the younger groups.
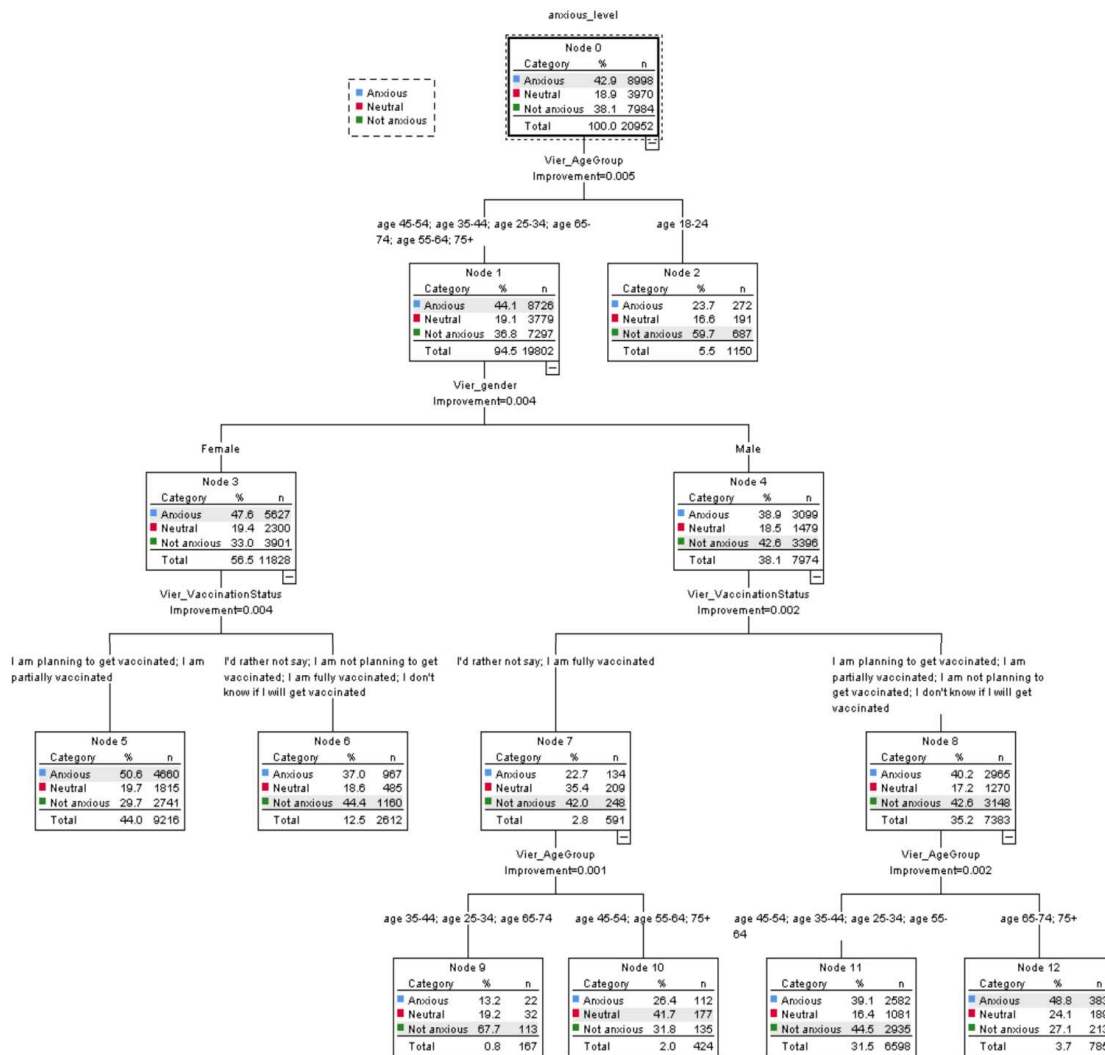

Figure 2 Classification tree analysis. Factors for anxiety level

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 3 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.
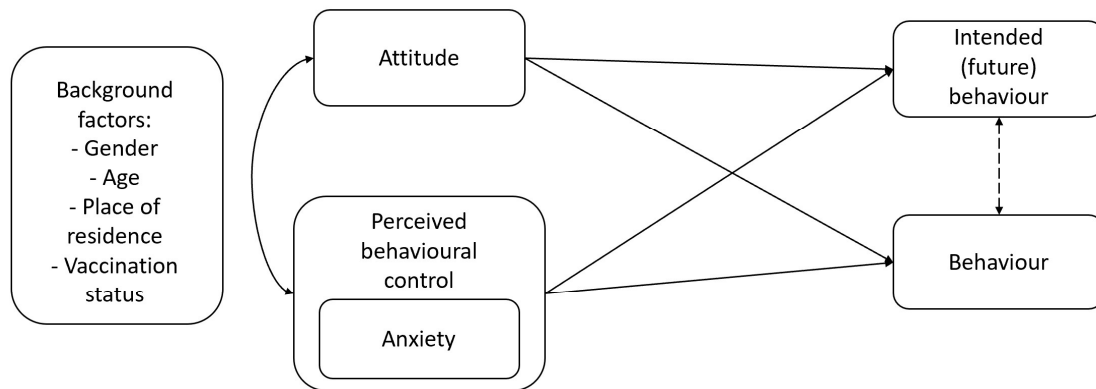

Figure 3 Adjusted schematic of the theory of planned behaviour

Anxiety partially influences attitude, but attitude also influences anxiety level. When the attitude is included in a classification tree for anxiety level, the attitude becomes the most important variable that determines anxiety level. The same occurs when it is examined what factors influence attitude. Then, anxiety level is the most important. Therefore, it can be concluded that there is a correlation between attitude and anxiety.

Based on this, it can be concluded that age, gender, and vaccination status influence anxiety level which in combination with attitude, influence current and intended future train travelling behaviour.

4.2 Identifying the anxious groups

Change in anxiety over time

In all the surveys there was the question about if respondents agreed or disagreed with the statement "I feel free to travel by train". Respondents could indicate if they strongly agreed, agreed, disagreed, strongly disagreed or were neutral towards the statement. Figure 4 shows how the percentage of anxious train travellers has changed throughout the pandemic. To compute these percentages the data was weighted in order to be representative to the entire train travelling population. Each percentage of anxious train travellers is split up based on if they answered strongly disagree (very anxious) or disagree (anxious). The percentages are split up to see if the ratio between very anxious travellers and anxious travellers stays relatively stable for all the surveys. The figure shows that the ratio between the groups in the middle surveys (from June 2020 to April 2021) stays very stable for all these surveys (with a standard deviation of about 3%). Around 40% of the total anxious group are very anxious and around 60% are anxious. The first survey (April 2020) and the latest survey (September

2021) have different ratios between the two groups. In the first survey (April 2020) little more than half of the anxious travellers was very anxious, and in the latest survey (September 2021) just 30% of the anxious train traveller group was very anxious. Due to the similarity in the surveys from June 2020 to April 2021, the survey of April 2021 is used for the analysis of this project. However, when appropriate, other surveys might also be considered. Additionally, due to the similarities in the ratios between very anxious and anxious groups, they can be combined into one anxiety level group of anxious train travellers. Those that answered neutral to the statement were considered at a neutral anxiety level and those that answered agree or strongly agree were considered not anxious.
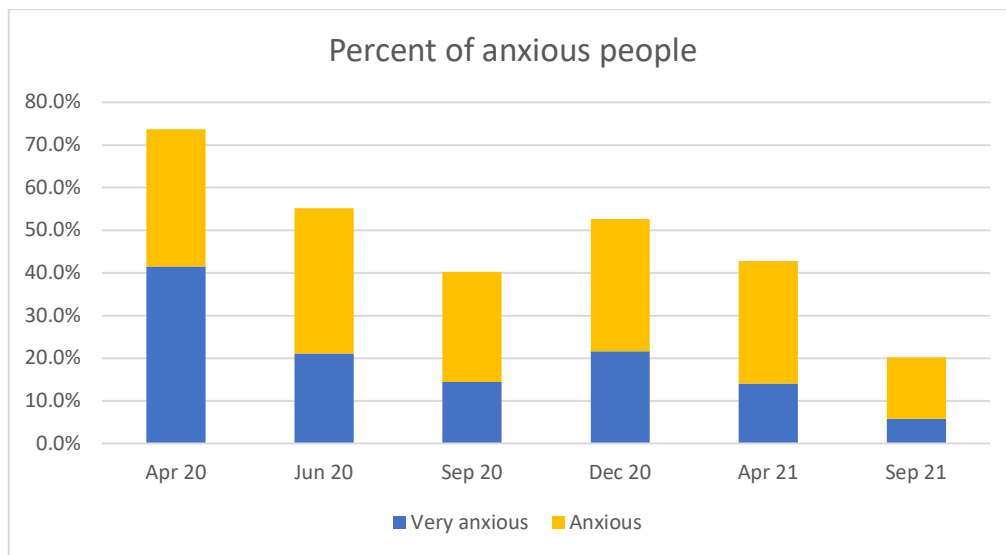

Figure 4 Percentage of anxious train travellers out of the general travelling population

Figure 4 shows that in the beginning of the pandemic, in April 2020, majority of train travellers experienced anxiety. In June 2020, the anxious group had decreased to around 55% of the train travelling population and continued to decrease. In September 2020 the percentage of anxious people was only 40% of the travelling population. The figure shows an increase again in percentage of anxious train travellers in December 2020 to 52%. Then, in April 2021, the number had decreased to 43% and continued to decrease so that in September 2021 the percentage of anxious train travellers was only 20%.

This change in percentage of anxious train travellers could be due to multiple factors such as number of cases or hospitalisation at the time, media coverage, or vaccination rates.

Figure 5 shows how the number of cases and hospitalizations have changed throughout the pandemic in the Netherlands (RIVM, 2021). The figure might not show accurate numbers of cases in the first months of the pandemic. In those months, the recording of new cases was not great yet and fewer people got tested at that time because the requirements to get tested were very strict which caused not all cases to be recorded.
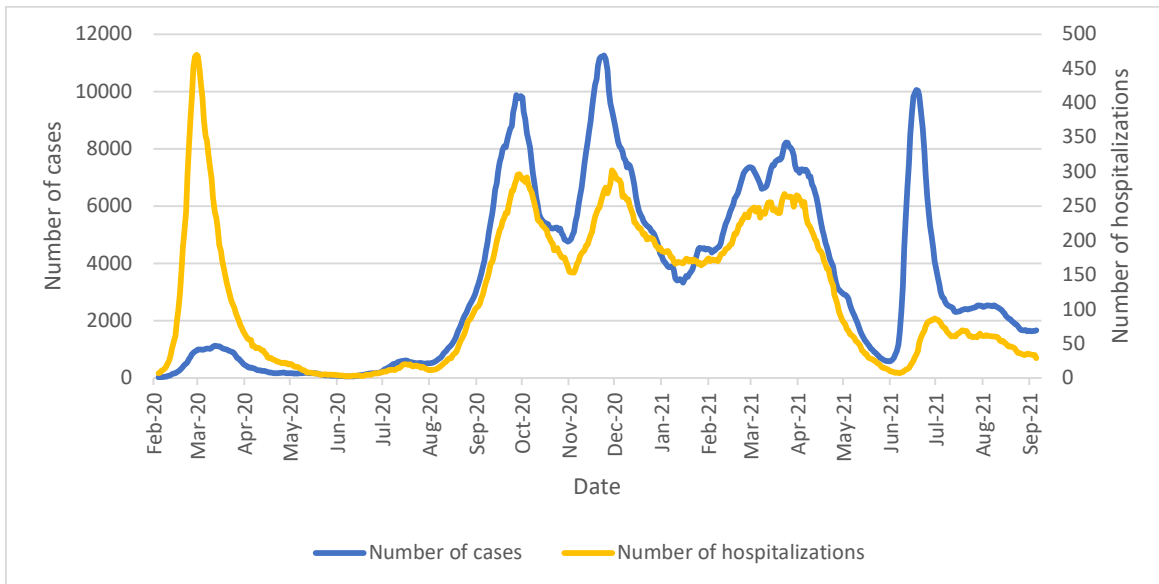
Figure 5 Number of cases and hospitalizations in the Netherlands from February 2020 to October 2021 (RIVM, 2021)
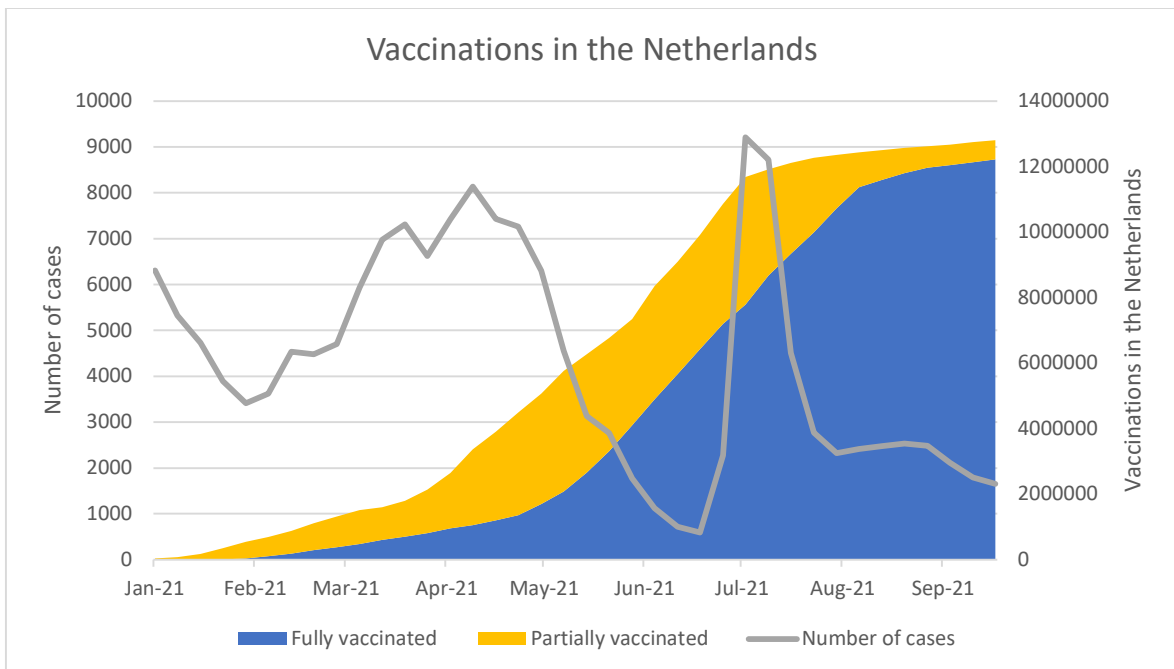

Figure 6 Number of vaccinations in the Netherlands compared to number of cases (Rijksoverheid, 2021; RIVM, 2021)

Comparing the percentage of anxious people in figure 4 to the number of cases and hospitalizations in figure 5, it can be observed that there is an increase in number of cases and hospitalizations in December 2020, which is also seen in the percentage of anxious people. Additionally, in April 2021, the number of cases and hospitalizations had not been increasing for a while and were starting to decrease as figure 5 shows and the number of anxious people in figure 4 is lower in April 2021 than in December 2020. Then in September 2021, the number of cases had been stable and low for a while.

Also, many people were fully vaccinated which could also have had an effect on the low number of anxious people, as seen in figure 6. These figures indicate that there could be a relation between number of cases and hospitalizations and percentage of anxious people. However, this project will not look at this relationship further and additional research is recommended to investigate this relationship.

The percentage of anxious people can also be affected by other things such as governmental measures and media coverage.

In the beginning of the pandemic, in March and April 2020, Covid-19 was new, and it was unknown what effects and long-term effects it could have. Countries all over the world had to decide what to do to keep the number of cases at minimum and hospitals were overflowing with Covid-19 patients. During the summer of 2020, cases worldwide were decreasing, and many countries relaxed their restrictions, which can indicate why the percentage of anxious people decreases in June and September 2020. In the Netherlands, schools, universities, workplaces, and other places were planning to resume normal in-person activities in September 2020 but the number of cases started rising again and strict restrictions and lockdowns were enforced again in the beginning of October 2020. With many countries, including the Netherlands, having to enforce lockdowns and strict restrictions again and rising number of cases, news about Covid-19 also increased, which could explain the rise in the number of anxious people in the December 2020 survey. At the end of 2020 and until the late spring/ early summer of 2021 people all over the world were getting vaccinated towards Covid-19 and during the summer of 2021 and into September 2021, most all restrictions in the Netherlands were removed, except for mask requirements in public transportation and airplanes. These events throughout the pandemic seem to be likely to have had strong influence on people's anxiety levels and further research is suggested to investigate this impact further.

Identifying anxiety levels

So far, the anxiety levels have only been based on the question if people are anxious of travelling by train, however, there were also questions in the surveys that could be related to anxiety in general, these questions were "I am afraid of getting infected" and "What three words best describe your mood in the previous week", where one of the options was anxious.

In order to be sure that by only using the groups based on the question about if participants feel free to travel by train also included people that are anxious based on the other two questions, each of the two general anxiety questions were crosschecked with the question of feeling free to travel by train. The crosscheck was done by plotting each general anxiety question with the train anxiety question. Then the plots were visually checked if the largest percentage of generally anxious people were also anxious train travellers.

The crosscheck resulted in that those that agree with being afraid of getting infected mostly also answered that they do not feel free to travel by train and thus are also anxious about travelling by train. All six surveys show a pattern that the percentage of people that are anxious about travelling by train increases as the agreement to the statement of being afraid of getting infected increases, while the opposite trend is shown for the not anxious train travellers (people that feel free to travel by train). All six surveys show this trend to some extent. The middle surveys (from June 2020 to April 2021) all show very similar percentage numbers, while the first survey (April 2020) and the latest survey (September 2021) show different results in percentages, while the trend is the same, which was expected based on figure 4. Figure 7 shows a typical trend of how the anxious train traveller group is

mostly also afraid of getting infected. The figure shows the percentage of each anxiety level (anxious, neutral, and not anxious) for each answer to the question "I am afraid of getting infected". The figure shows that majority of those that are afraid of getting infected fall into the anxious group.

The first (April 2020) and the latest (September 2021) surveys show more exaggerated graphs as the percentage of anxious people in the first survey was much higher and the percentage of anxious people in the latest survey was much lower than in the middle surveys, as is shown in figure 4.
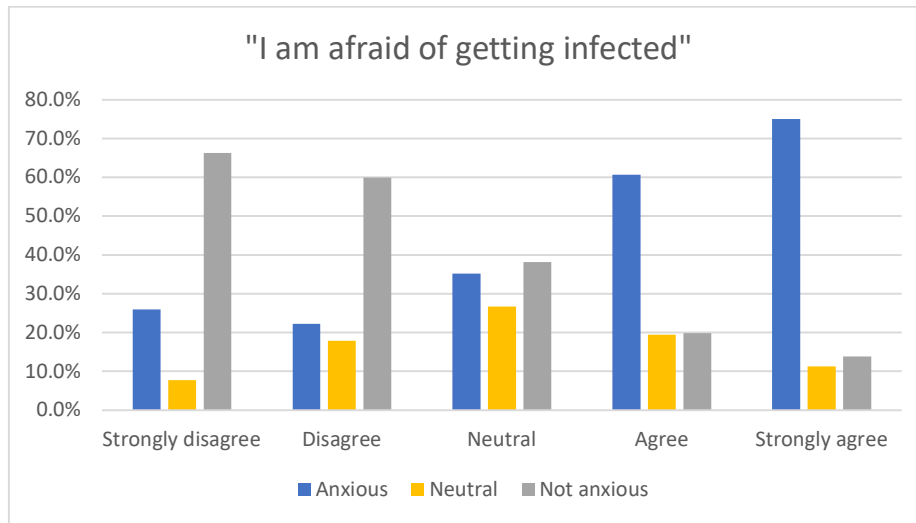

Figure 7 Example of trend between anxious train travelling levels and anxiety about getting infected.
Example from survey April 2021.

The crosscheck with the general mood question and anxiety level for train travellers resulted in that majority of respondents answered that they were not feeling anxious as the top three describing moods in the previous week. However, when only looking at the respondents that answered that they were anxious in the previous week, 50-70% answered that they were also anxious train travellers. The latest survey (September 2021) is an exception to this as the majority of people feeling anxious in general were not anxious train travellers. But in the latest survey there are still 13% of the people that feel anxious in general that are also anxious train travellers. These results of the crosscheck indicate that anxious train travellers are also experiencing anxiety in general. Therefore, for the remainder of the project the anxiety levels based on the statement "I feel free to travel by train" will be used as that question also grasps the people experiencing anxiety in general.

4.3 Characteristics of the anxious group

This section will focus on looking at the characteristics of the anxious group. Statistical tests will be used to determine if there are statistical differences between the characteristic and anxiety level. The data from the survey of April 2021 will be used for this analysis. This survey is chosen because the latest survey (September 2021) has much lower percentage of anxious people and the April 2021 survey has more similarities within the anxious group to the previous surveys, as discussed in section 4.2. However, in some cases, data from the latest survey will be used for example to see how that characteristic of the group changed between the two surveys.

Age group

The first characteristic that is investigated is age group. Age group was the most important variable for anxiety level based on the classification tree shown in figure 2 on page 12. The age groups were split into two groups where the younger people were more likely to not be anxious.

The dataset has 9 age groups: 4-11 years old, 12-17, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, and over 75. Due to a very low number of travellers that are 17 years old and younger, the lowest two age groups will not be considered in this analysis and thus the youngest age group is 18-24 years old.

Figure 8 shows how the age groups are distributed over the different anxiety levels. The figure shows that young people (18-24) are mostly not anxious. The age group of 25-34 years old have almost equal percentage in the anxious and not anxious groups, 42% and 41%, respectively. The distribution of the age groups of 45-54 and 55-64 are almost identical to each other in each anxiety level, where 42% are anxious and 39% are not anxious. The figure shows that the largest share of the older age groups, 65-74 and 75+ are anxious. Interestingly, the figure also shows that the largest share of people in the age group of 35-44 years old are also anxious. This could be due to that these people are working and might have to travel to work and also have families, which Kassaw and Pandey (2021) mentioned were groups that were likely to experience anxiety.
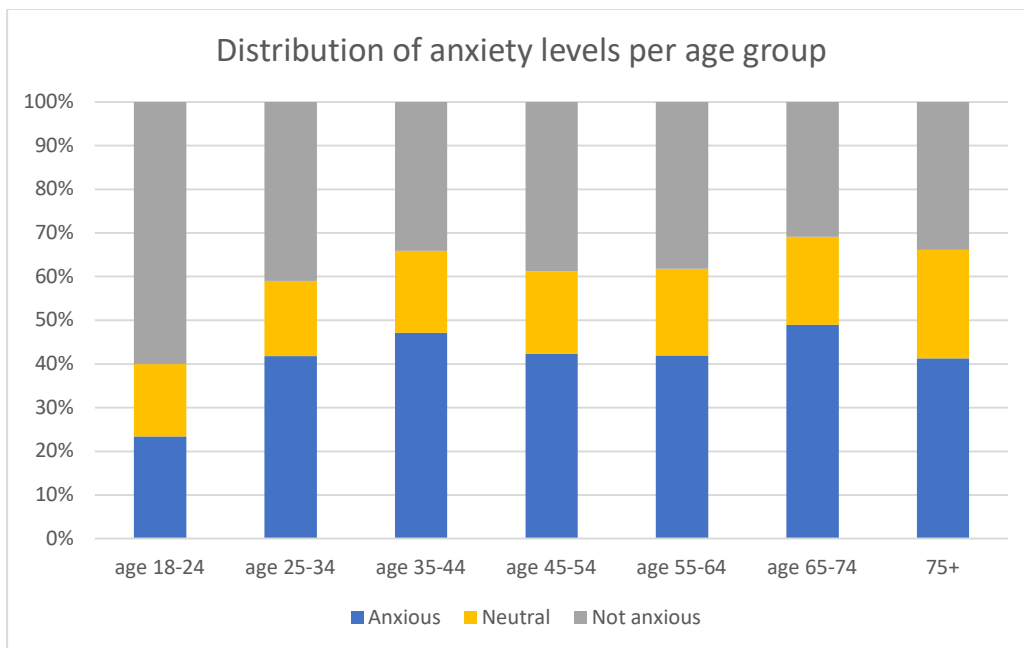

Figure 8 Distribution of anxiety levels per age group

In order to test if there is a significant relationship between age and anxiety level, a chi-square test is performed using SPSS. The chi-square test resulted in a significant result for all of the five samples, where the p-value was between 0.000 and 0.001, as seen in table 1. Therefore, it can be concluded with a 99.9% confidence that the relationship of at least one of the combinations of age group and anxiety level is significant.

A classification tree analysis is performed to test which age groups are different. To prevent overfitting when using the whole sample of the survey, the tree is pruned. Figure 9 shows the classification tree. The figure shows that the age groups are split by taking the 18-24 age group out as they are more

likely to not be anxious. This means that age groups can be split into two categories, where the youngest are more likely to not be anxious, and all other age groups are more likely to be anxious.

Finally, the Cramer's V coefficient is computed. The coefficient for age group and anxiety level is between 0.12 and 0.18 with an average of 0.162 and a standard deviation of 0.024, as seen in table 1. Therefore, it can be concluded that the association between age group and anxiety level is significant but low.

Table 1 summary of statistics for age groups

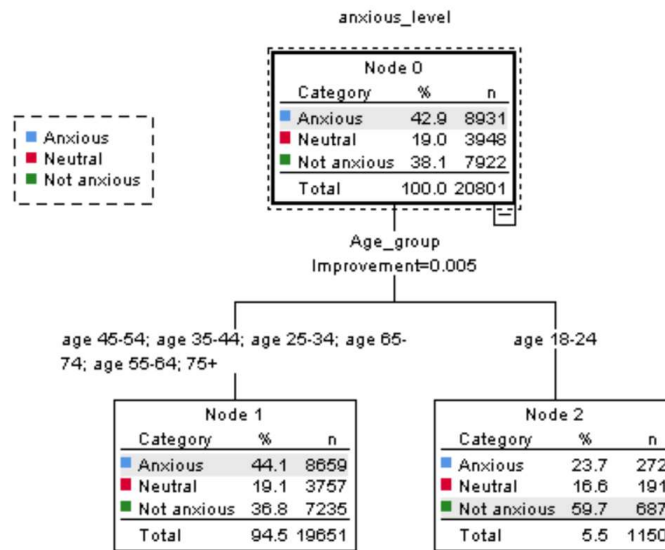|	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	71.753	69.131	31.953	68.117	73.833
p-value	0.000	0.000	0.001	0.000	0.000
Cramer's V coefficient	0.180	0.172	0.120	0.166	0.172

Figure 9 Classification tree results of age groups

Gender

The next characteristic that was investigated was gender. As mentioned in section 2, the research by Kassaw and Pandey (2021) resulted in that female public transport users were more likely to experience anxiety than male public transport users. Gender was also the second most important variable for anxiety level from the classification tree analysis performed in section 4.1 above (figure 2).

Figure 10 shows the percentage of gender for each anxiety level from the survey of April 2021. The figure shows that 46% of females are anxious while only 38% of males are anxious.
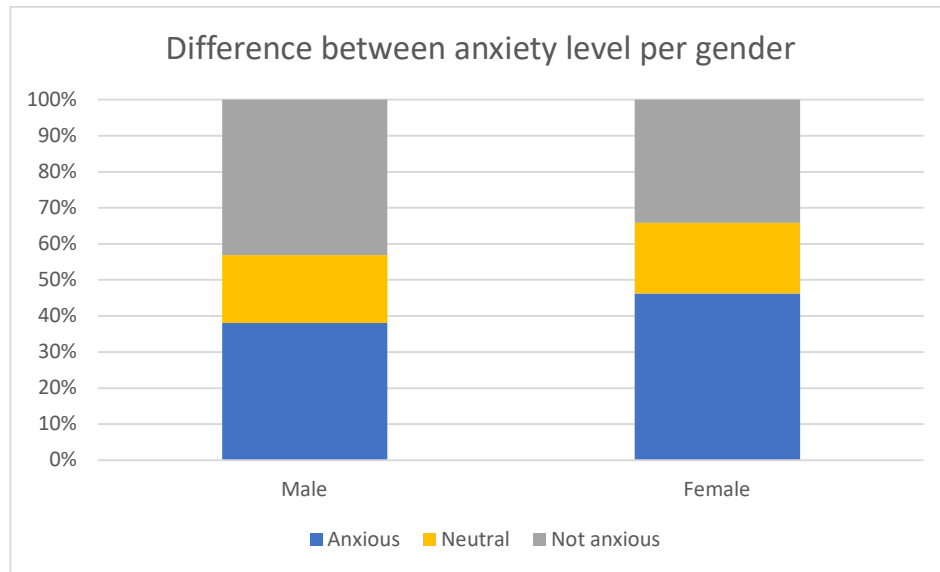
Figure 10 Difference between gender and anxiety level

Figure 10 indicates that females might be more likely to be anxious than men. However, they do not show if the difference between gender and anxiety levels is significant. In order to test if there is a statistical difference between gender and anxiety level, a chi-square test is performed using SPSS. Four out of the five samples tested resulted in a significant result, with a p-value between 0.000 and 0.014, as seen in table 2. However, one of the samples resulted in an insignificant result, with a p-value of 0.675. This could be a Type II error, where we would fail to reject the null hypothesis while it should be rejected. Therefore, it can be concluded that there is a significant relationship between at least one combination of gender and anxiety level, at a 99% confidence interval.

Because there are multiple categories in each variable, a post-hoc test is performed to find which combinations are significant. The post-hoc test was performed on each sample and on the total number participants in the survey. There were some differences in what groups are significant for each sample. However, every combination was significant most of the time, and every combination was significant in the post-hoc test for the total survey. Therefore, the differences are most likely due to coincidences, and it can be concluded that every combination of anxiety level and gender is significant. Additionally, a classification tree analysis was performed using SPSS. The analysis resulted in that females are more likely to be anxious then males.

Finally, the Cramer's V coefficient is computed. For anxiety level and gender, the Cramer's V coefficient ranged between 0.1 and 0.2 for all the samples, as can be seen in table 2. This means that there is a significant association between gender and anxiety level, but the association is low.

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	80.922	0.787	8.482	12.270	15.100
p-value	0.000	0.675	0.014	0.002	0.001
Cramer's V coefficient	0.272	0.026	0.088	0.101	0.111

Vaccination status

In the survey conducted in April 2021, participants were asked about their vaccination status against Covid-19. Vaccination status was also the third important factor for anxiety level from the classification tree analysis shown in figure 2 on page 12. Also, the number of anxious people decreased a lot between April 2021 and September 2021 which is the time where most people got vaccinated, as seen in figure 6 on page 15. Therefore, it is interesting to see the effects of vaccination status on anxiety levels.

Figure 11 shows the difference in anxiety levels per vaccination status from the April 2021 survey. The figure shows that the vaccination status that has the highest share of anxious people are people that are partly vaccinated and those that are planning to get vaccinated. The groups that have the least share of anxious people and the highest share of not anxious people are those that are fully vaccinated or are not planning to get vaccinated.
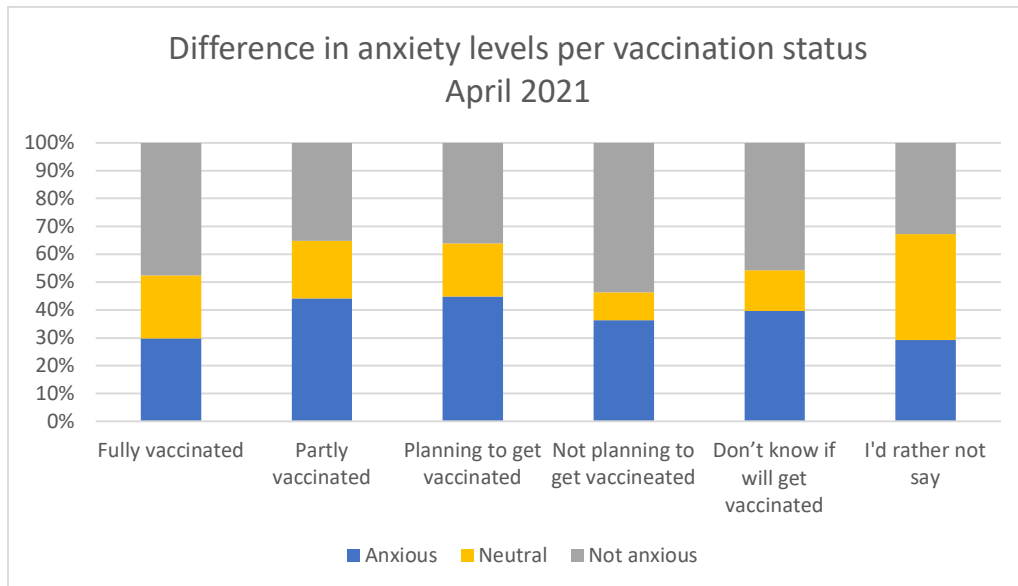

Figure 11 Difference in anxiety levels per vaccination status in April 2021

In April 2021, not everyone had gotten the chance to get vaccinated, which means that many people are in the group of planning to get vaccinated or partly vaccinated. By the end of April 2021, about 1.2 million people in the Netherlands were fully vaccinated and about 3.2 million people were partially vaccinated, as seen in figure 6, while in the beginning of October 2021, 11.7 million people in the Netherlands were fully vaccinated and 1.2 million people partially vaccinated (Rijksoverheid, 2021).

Due to this rapid change in vaccination status nationwide, the data from the latest survey (September 2021) is also considered.

Figure 12 shows the difference in vaccination status per anxiety level from the September 2021 survey. In September 2021, 90% of train travellers were fully vaccinated. The figure shows that majority is not anxious in all groups of vaccination status. But the group of those that are not vaccinated has the highest share of people that are still anxious.
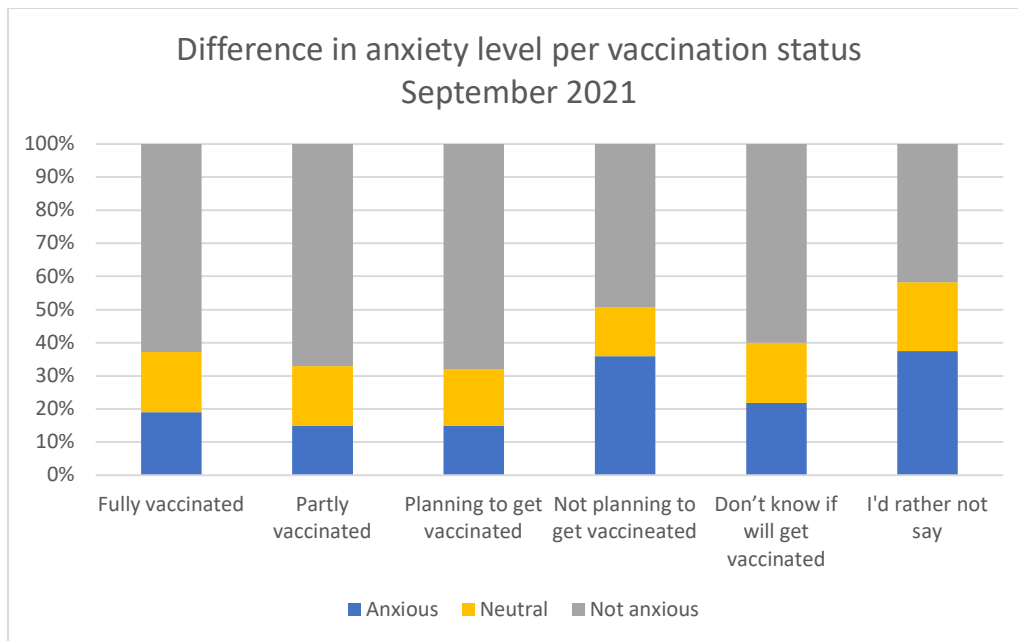

Figure 12 Difference in anxiety level per vaccination status in September 2021

Another interesting topic is the relationship between vaccination status and the anxiety level over time. To determine the change in anxiety levels over time, the participants that participated in all three surveys of December 2020, April 2021, and September 2021 were taken separately out of the data and investigated further. The change in vaccination status was investigated and grouped in appropriate groups as seen in figure 13. Those that were still partially vaccinated in September are included in the "other" category along with those that preferred not to say and still don't know if they will get vaccinated. Then, the anxiety levels for each participant were investigated. If the anxiety level decreased from before vaccination until after vaccination, they were grouped in the "decrease in anxiety" group. Similarly, those that had an increase in anxiety level after being vaccinated were grouped in the "increase in anxiety" group. Those that had the same anxiety level in all three surveys were grouped in the "same" anxiety level group. Some participants, however, showed a change in anxiety level between December and April and then changed back to the same anxiety level in September as they chose in December. Those were grouped into one group called "other" along with those that would rather not say regarding their vaccination status, because in those cases it was not known if their vaccination status changed or not.

Figure 13 shows if anxiety levels increased (person got more anxious), decreased (person got less anxious), or if anxiety levels stayed the same compared to a change in vaccination status. The figure

shows that many 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 of anxiety in all three surveys.
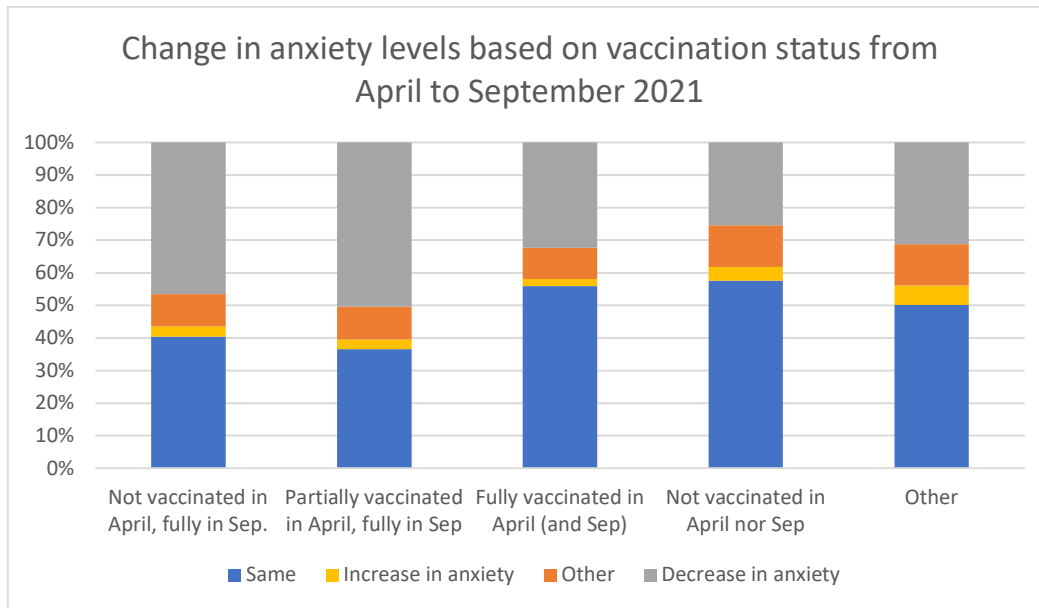

Figure 13 Change in anxiety levels based on vaccination status from April to September 2021

The figures above (figures 11, 12 and 13) indicate that there is a relationship between vaccination status and anxiety level, where those that are fully vaccinated are less anxious and people's anxiety level decreased after they got fully vaccinated.

A chi-square test was performed on the anxiety level and vaccination status for April 2021. The results of all the chi-square tests are significant with p-values of 0.000. It can, therefore, be concluded with a 99.9% confidence that at least one combination of anxiety level and vaccination status in April 2021 has a significant relationship. A chi-square test could not be performed for the September 2021 survey due to low counts in many of the cells.

Classification tree analysis of only anxiety level and vaccination status results show that in April 2021 vaccination status can be split into two categories based on anxiety level, as seen in figure 14. Those that are not planning to get vaccinated, those that are fully vaccinated, and those that don't know of they will get vaccinated are more likely to be not anxious. However, those that would rather not say, those that are planning to get vaccinated, and those that are partially vaccinated are more likely to be anxious. Classification tree analysis from September 2021 did not split into any groups based on vaccination status. This is probably due to that one group makes up more than 90% of the population, which makes it difficult to split the sample.

This analysis indicates that vaccination status does indeed influence anxiety and that getting vaccinated reduces anxiety levels.
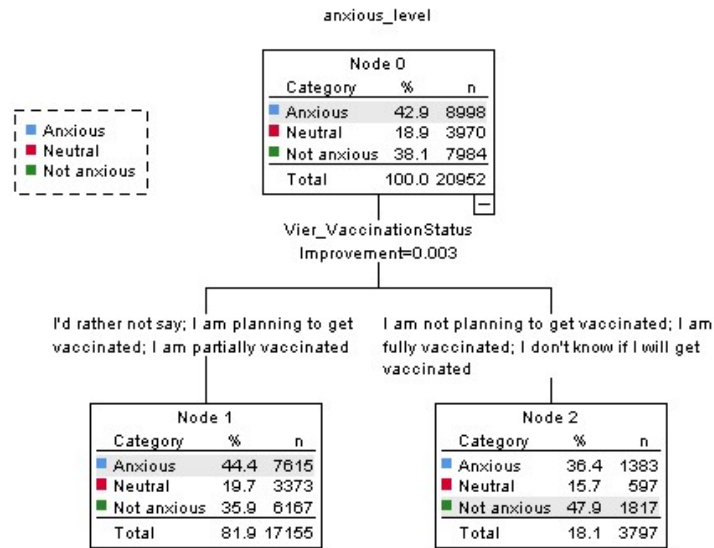
Figure 14 Classification tree results of vaccination status in April 2021

Region of residence

When performing the classification tree analysis in section 4.1, region of residence was not determined to be one of the most important variables for anxiety level. However, it is interesting to test if there is a statistical relationship between regions and anxiety level. This statistical relationship could then be due to correlations between region of residence and age, gender, or vaccination status.

In the dataset, the first 4 numbers of the participants' zip code were recorded, this was then combined into municipalities to see the distribution between municipalities. Due to the many municipalities, a lot of cells had very low values, therefore the data was aggregated further into provinces.

Figure 15 shows the distribution of anxiety levels per province. The figure shows that the distribution is very similar between provinces where there is no province that is drastically different than another. The percent of anxious people per province is between 39 and 49%, where the province with the highest share of anxious people is Groningen and the province with the least share of anxious people is North Holland. When looking at the not anxious groups, the figure shows that North Brabant, North Holland, and South Holland have the highest share of not anxious people, or 41%. Other provinces have a not anxious group of between 29 and 37%, where Flevoland has the lowest percentage of not anxious people.
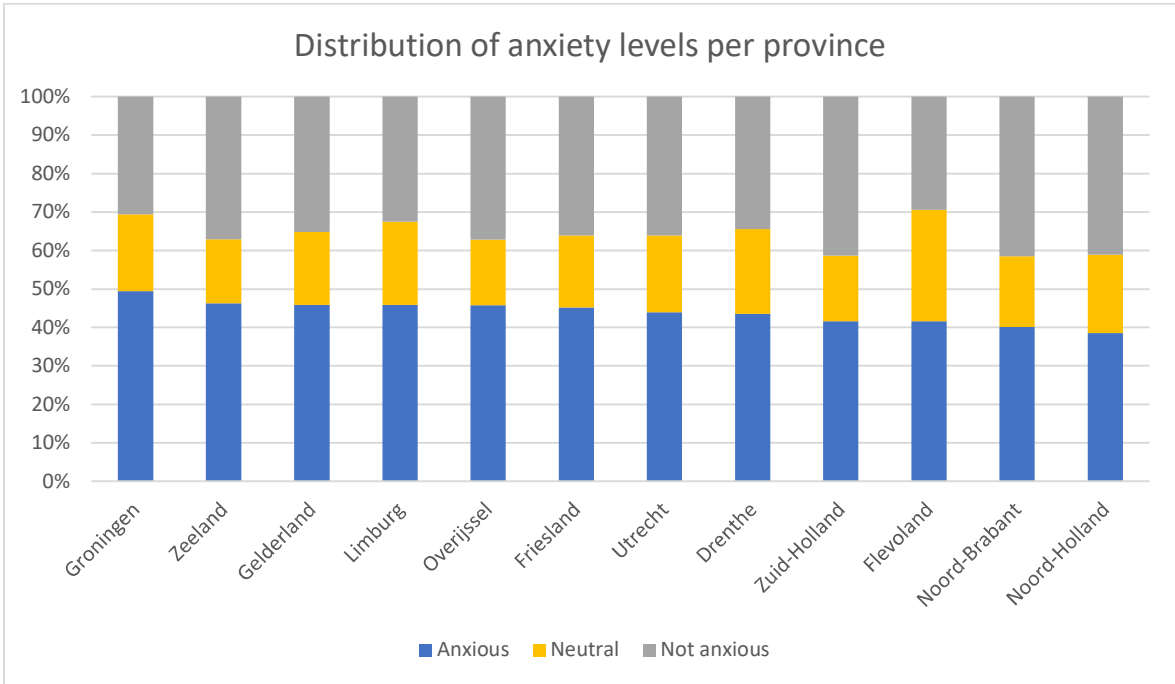
Figure 15 Distribution of anxiety levels per province

From figure 15, it would also be interesting to investigate if there is a difference in the distribution of anxiety levels between large cities such as Amsterdam, Rotterdam, Den Haag, and Utrecht, other cities with a population over 100.000, and the countryside, which are places with population less than 100.000. This difference is shown in figure 16. The figure shows that people in smaller cities, in the countryside and Utrecht tend to be more anxious than people in the large cities such as Amsterdam and Den Haag.
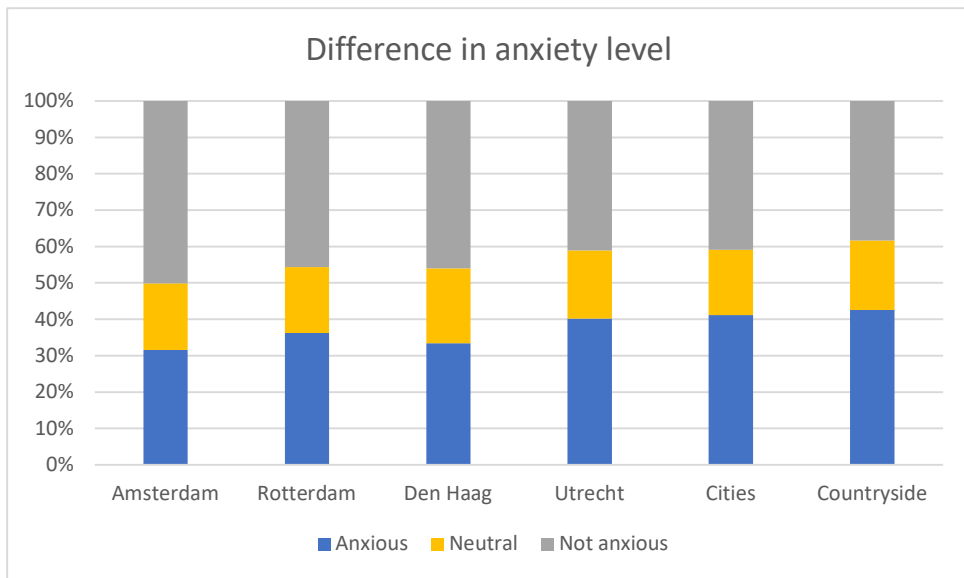

Figure 16 Difference in anxiety levels between the 4 largest cities, cities with population over 100000 and the countryside

A chi-square test was performed using SPSS for all five samples. All samples resulted in a significant relationship, where the p-values were between 0.000 and 0.002, as can be seen in table 3. Therefore, it can be concluded with a 99% confidence that at least one combination of place of residence and anxiety level is significant.

Figure 17 shows the results of a classification tree analysis for anxiety level and place of residence. The tree is pruned to avoid overfitting. The figure shows that residence can be split into three categories, where residents of Rotterdam and Amsterdam are more likely to not be anxious, cities are more likely to be anxious and the countryside and Utrecht are most likely to be anxious.

Finally, the Cramer's V statistic was computed. As seen in table 3, the coefficient is between 0.12 and 0.21, which means that there is an association between place of residence and anxiety level, but it is low.

The reason why region of residence might not be included in the classification tree in figure 2 on page 12 but shows a statistically significant relationship with anxiety level could be because of correlation effects. In order to see if the differences found in anxiety and region of residence are due to correlations, a simple crosstabulation was performed. This resulted in that Utrecht, Cities, and Countryside had a higher percentage of young people than other regions. The percentages of those that are planning to get vaccinated or are partially vaccinated (in April 2021) was highest in Utrecht and lowest in Rotterdam. These differences in the percentage of these variables could have an effect on the significance of the relationship of region of residence and anxiety level and therefore the chi-square tests show a significant relationship, but region of residence does not come up as a factor that influences anxiety because of the correlations with age and vaccination status.

Table 3 Summary of statistics for region of residence

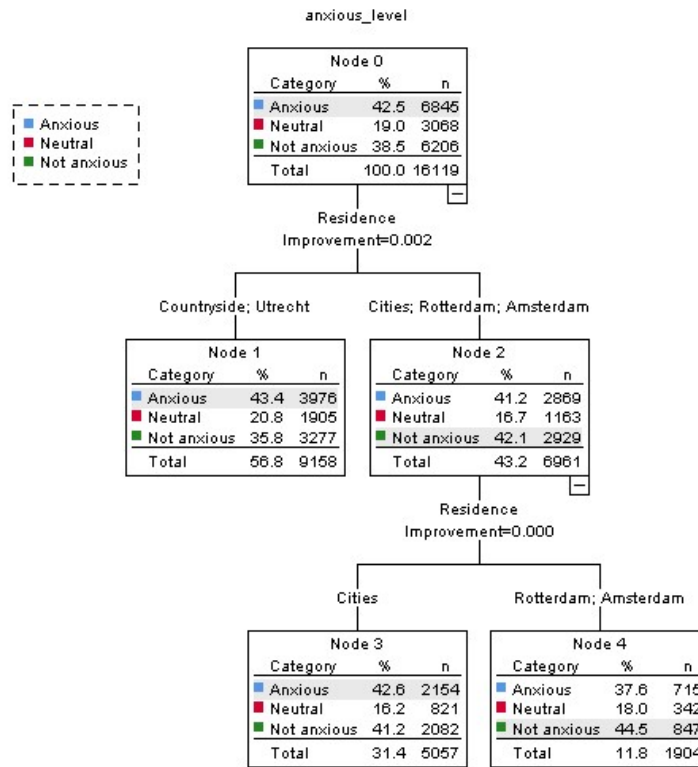|	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	58.744	87.195	28.354	46.407	81.624
p-value	0.000	0.000	0.002	0.000	0.000
Cramer's V coefficient	0.186	0.215	0.126	0.154	0.198

Figure 17 Classification tree for place of residence for anxiety level

Trip purpose

Another variable that is interesting to investigate with respect to anxiety level is usual trip purpose before Covid-19. Figure 18 shows how each trip purpose is split up between the anxiety levels. The figure shows that those that used to mainly travel for leisure or recreation purposes have the highest share of anxious people and those that mainly travelled for education purposes have the least share of anxious people. These results are also influenced by age, as trip purpose and age are correlated. Those that travel for educational purposes are younger and that group is more likely to be not anxious, as shown in the analysis above in section 4.3 with age groups and anxiety. When adding trip purpose to the classification tree that is shown in figure 2 on page 10, trip purpose is placed below age, gender, and vaccination status. Therefore, age is more important than trip purpose when it comes to anxiety levels.
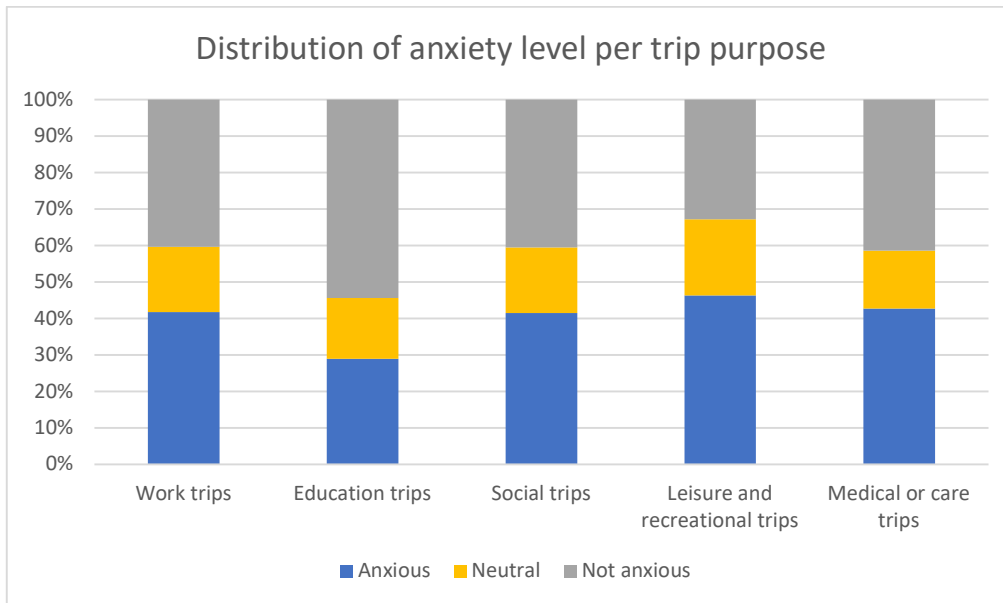
Figure 18 Distribution of anxiety levels per trip purpose

A chi-square test was performed using SPSS to investigate if there is a significant relationship between trip purpose before Covid-19 and anxiety level. All samples show a significant result, with p-values of 0.000 (table 4) which indicates that there is at least one combination of travel purpose and anxiety level that has a significant relationship, at a 99.9% confidence interval.

In order to identify which combinations are insignificant or significant, a post-hoc test is performed. The post-hoc test resulted in that leisure and recreational trips is the only trip purpose that has a significant relationship with all anxiety levels. Additionally, educational trips have a significant relationship with the not anxious anxiety level, which is probably related to the correlation between age and trip purpose.

Finally, the Cramer's V coefficient was found for all samples. For trip purpose and anxiety level the Cramer's V coefficient was between 0.1 and 0.13, as can be seen in table 4. This means that there is an association between the variables, but it is at the minimum value for association and is therefore very low.

Table 4 Summary of statistics for travel purpose

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	31.166	37.863	33.890	24.874	31.166
p-value	0.000	0.000	0.000	0.002	0.000
Cramer's V coefficient	0.122	0.130	0.127	0.102	0.122

Usual time of travel

Additionally, the usual time of travel of participants before Covid-19 is tested with respect to anxiety level. Figure 19 shows how anxiety levels are distributed per travel period. The figure shows that the

distribution of anxiety levels is very similar for all times of travel. The anxious group is slightly higher than the not anxious group, or about 42.5% and 38.5%, respectively.
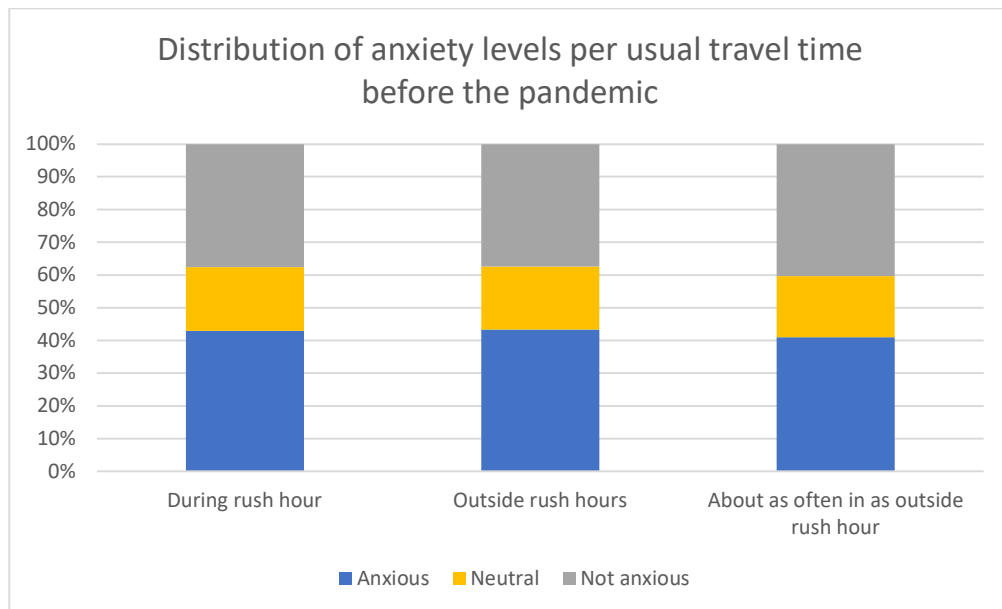

Figure 19 Distribution of anxiety levels per usual travel time before the pandemic

Since there is very little difference between the time of travel and anxiety level, i.e., there is not a larger share of anxious or not anxious people that used to travel during a specific time, it is expected that there is not a significant relationship between anxiety level and usual time of travel.

A chi-square test was performed using SPSS for all five samples. This resulted in that all chi-square tests were significant, with a p-value of 0.000, as seen in table 5. This indicates that there is at least one combination of usual travel time and anxiety level that is significant, at a 99.9% confidence interval.

A post-hoc test was performed to find which combinations were significant or insignificant. This resulted in that for each sample, there was always at least one combination that was significant, leading to a significant chi-square test, but there was no consistency in what combinations were significant. Then a post-hoc test was performed on the whole sample of the survey, which also resulted in some combinations being significant, but many of those were never significant in the samples or only significant in one of the samples. Additionally, a classification tree analysis was performed with these two variables, which resulted in no splits. The results of the post-hoc tests and the chi-square tests were likely due to Type I error, where it is concluded that there is a significant relationship when there is not.

Therefore, the tests lead to an inconclusive result, and it cannot be said if there is a statistical relationship between usual time of travel and anxiety level or not.

Table 5 Summary of statistics for usual time of travel

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	58.955	62.306	72.178	54.748	31.950
p-value	0.000	0.000	0.000	0.000	0.000

4.4 Travelling behaviour and attitude

Attitude towards the train

Another variable that is also interesting to investigate in relation to anxiety levels is the attitude towards the train. As mentioned in the behavioural model section (section 4.1), attitude is one of the elements that influences behaviour, and is influenced by and influences anxiety level.

Figure 20 shows how attitude towards the train is distributed for each anxiety level. The figure shows that those with very negative and negative attitude towards the train are mostly anxious. The opposite can be seen for those with very positive and positive attitude, they are mostly not anxious.
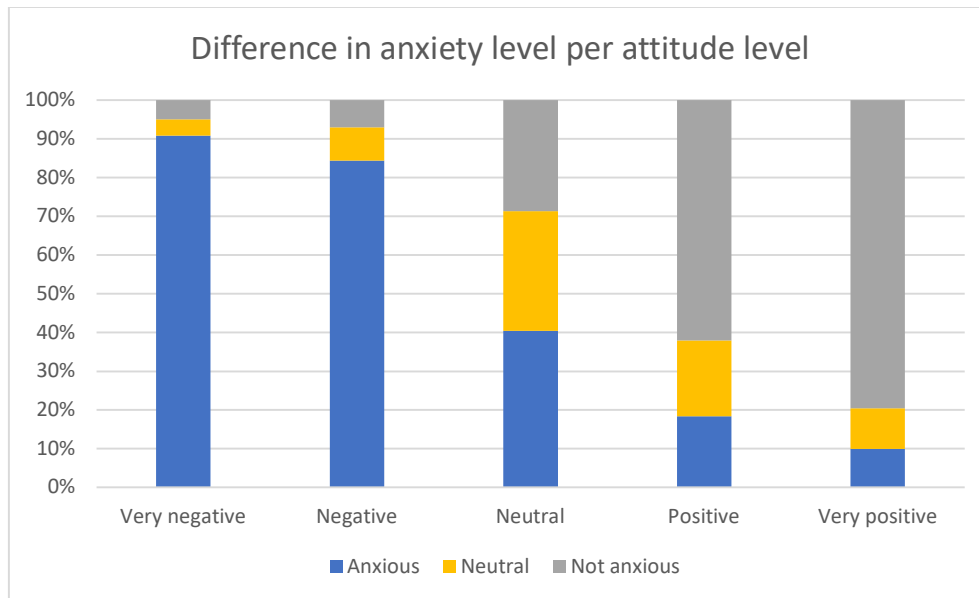

Figure 20 Difference in anxiety levels per attitude level

A chi-square test is performed in SPSS which resulted in all five samples being significant, with a p-values of 0.000, as can be seen in table 6. Therefore, it can be concluded with a 99.9% confidence that the relationship between at least one combination of attitude towards the train and anxiety level is significant.

In order to identify which combinations are significant or insignificant a post-hoc test is performed. The post-hoc test resulted in that all combinations were significant except the combinations of neutral attitude-anxious, positive attitude-neutral anxiety level, and very positive attitude-neutral anxiety level.

Finally, the Cramer's V coefficient was found to be between 0.42 and 0.48, as can be seen in table 6. If the Cramer's V coefficient is larger than 0.5 then there is high association between the two variables (AcaStat, 2015). Therefore, there is a moderate association between attitude towards the train and anxiety level. This high association makes sense since attitude and anxiety levels influence each other.

Table 6 Summary of statistics for attitude towards the train

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	504.476	505.357	396.482	513.148	462.446
p-value	0.000	0.000	0.000	0.000	0.000
Cramer's V coefficient	0.477	0.462	0.421	0.455	0.429

Current train usage

Another variable that could be influenced by anxiety level is current travel behaviour. Participants were asked how often they had travelled by train in the previous week (in April 2021). Figure 21 shows how the anxiety levels are distributed in each option of how often people travelled in the previous week. The figure shows that those that did travel are mostly not anxious. A classification tree analysis also shows this as the current travelling behaviour can be split into two categories, where those that did not travel are more likely to be anxious and others are more likely to be not anxious.
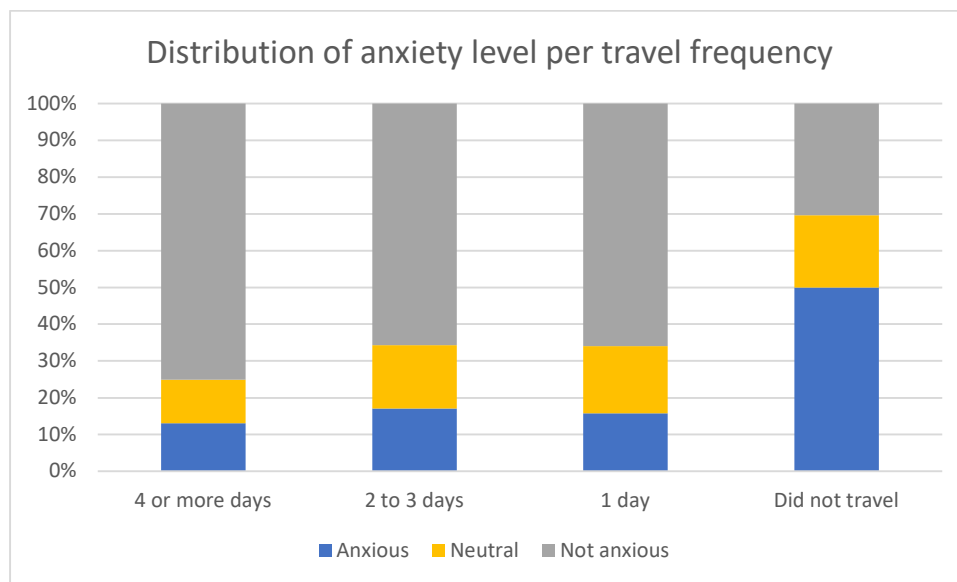

Figure 21 Distribution of anxiety level per travel frequency

A chi-square test is performed using SPSS for all five samples. All tests resulted in a significant result, where the p-values were 0.000, as shown in table 7. It can therefore be concluded that at least one of the combinations of current train travelling behaviour and anxiety level is significant, at a 99.9% confidence interval.

In order to test if there are any combinations that are insignificant, a post-hoc test is performed. The test resulted in that the combinations of those that travelled 1 day and are in the neutral anxiety level

group and those that travelled 2-3 days and are in the neutral anxiety level group are insignificant. All other groups tested as significant. It can therefore be concluded that there is a significant relationship between current travel frequency and anxiety level.

Finally, the Cramer's V coefficient was computed. It resulted in that the coefficient was between 0.167 and 0.335 (table 7) with a mean of 0.25 and a standard deviation of 0.06. This means that there is a low to moderate association between current travel and anxiety level.

Table 7 Summary of statistics for current travel frequency

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	61.881	117.329	250.369	191.910	177.140
p-value	0.000	0.000	0.000	0.000	0.000
Cramer's V coefficient	0.167	0.223	0.335	0.279	0.265

Future train usage

The surveys also included a question asking if participants intended to travel more (or less) by train after the pandemic. Figure 22 shows the distribution of anxiety levels per expected future travel behaviour. Each expected future travel behaviour option is based on how different the participants expect their travelling behaviour to be after the pandemic compared to their behaviour before the pandemic. The figure shows that those that expect to reduce their train usage are mostly anxious.

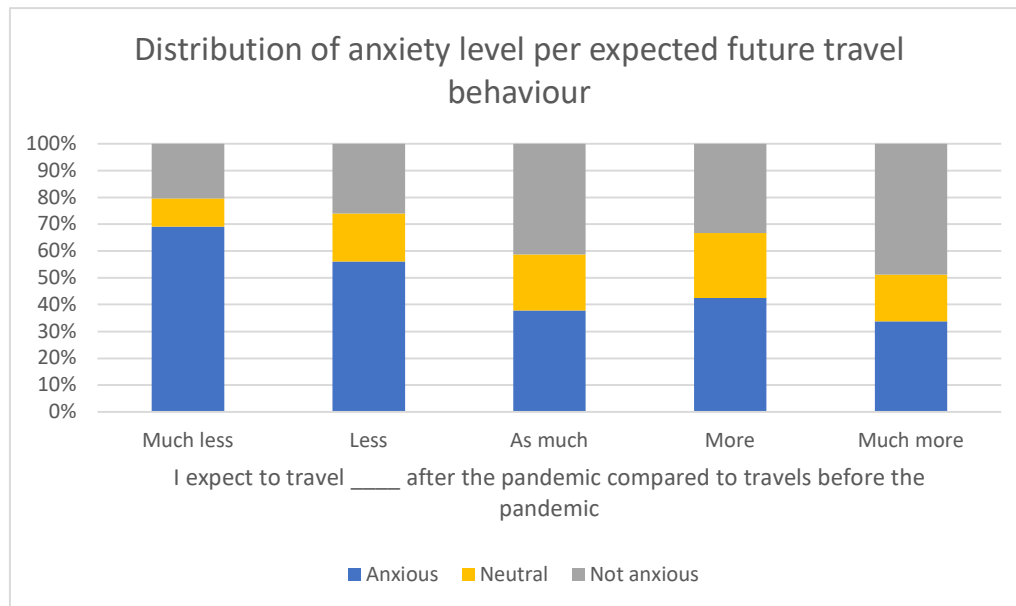*Figure 22 Distribution of anxiety level per expected future travel behaviour*

A chi-square test is performed using SPSS which resulted in that all five samples are significant, with a p-value of 0.000, as shown in table 8. This indicates that there is a significant relationship between at least one of the combinations of change in train usage and anxiety level, with a 99.9% confidence interval.

In order to test if there are any combinations that are insignificant, a post-hoc test is performed. The test shows that those that expect to travel much more is insignificant for all anxiety levels. Those that expect to travel more and for all anxiety levels resulted also in insignificant relationships. Therefore, it can be concluded that there is only a significant relationship between those that plan to travel less and as much and anxiety level.

Classification tree analysis resulted in that those that plan to travel less and much less are most likely to be anxious, those that expect to travel more are likely to be anxious, and those that expect to travel as much and much more are likely to be not anxious.

Finally, the Cramer's V coefficient for these variables was between 0.15 and 0.22 (table 8), indicating that there is an association between expected future travel behaviour and anxiety level, but it is low.

Table 8 Summary of statistics for expected future travel

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Chi-square statistic	46.324	75.754	63.117	37.548	108.939
p-value	0.000	0.000	0.000	0.000	0.000
Cramer's V coefficient	0.157	0.197	0.168	0.143	0.226

4.5 Effects of anxiety on attitude and current and intended future behaviour

The main research question of this project was to investigate the effects of anxiety on behaviour, attitude and intended behaviour. The analysis above has identified which variables characterise the group of anxious train traveller and if attitude, current behaviour, and intended future behaviour are statistically significant to anxiety level.

Even without anxiety, there is a strong relationship between attitude and intention and therefore behaviour, as explained in the behavioural model section above (section 4.1). Hence, it is important to investigate what the additional effects on attitude, behaviour and intended behaviour anxiety has.

Figure 23 shows the difference between anxious and not anxious groups in attitude. The yellow bars in the figure show a scenario if all train travellers were not anxious. This would lead to that majority of people have a positive attitude towards the train. The difference that anxiety makes to the attitude is shown in the blue columns in the figure. The figure shows that when people are anxious their attitude towards the train becomes more negative.
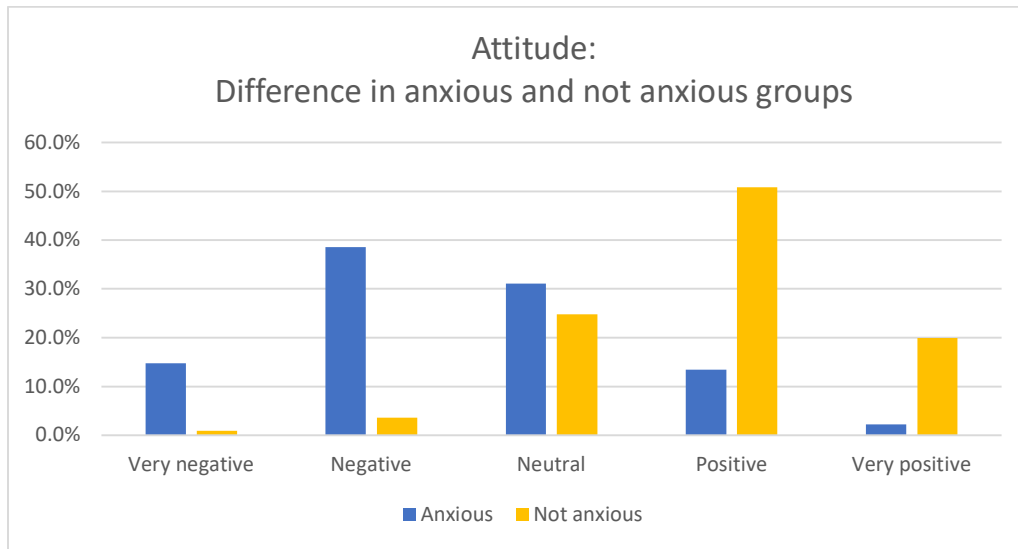
Figure 23 Difference in anxious and not anxious groups in attitude towards the train

Figure 24 shows the difference between anxious and not anxious groups in current travel behaviour, based on the answers from the question how often people travelled in the previous week in April 2021. Like figure 23, the yellow bars show a situation where everyone in the train would be not anxious and the blue columns if everyone would be anxious. The figure shows that when people are anxious, they reduce their trips by train and more people do not travel by train.
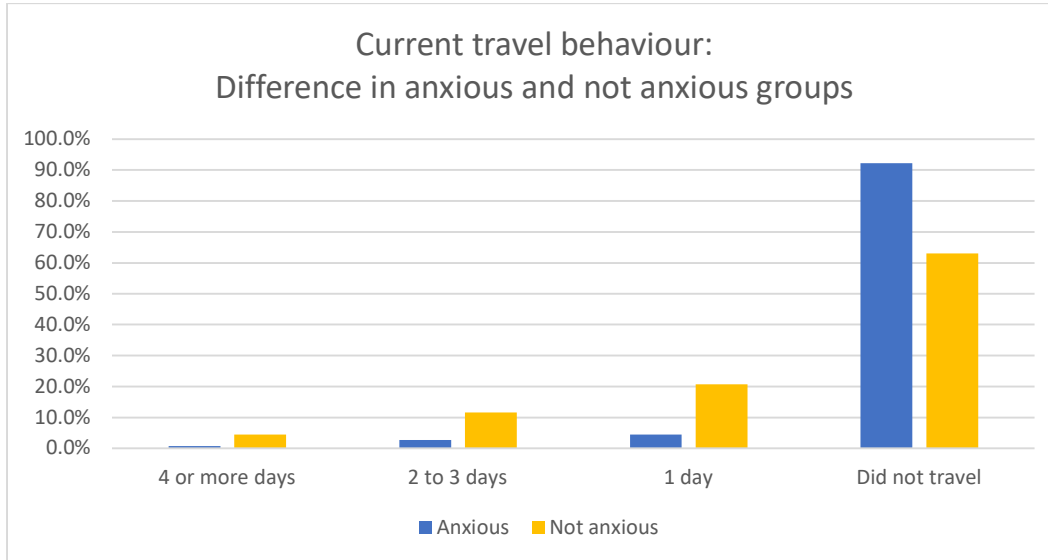
Figure 24 Difference in anxious and not anxious groups in current travel behaviour

Figure 25 shows the difference between anxious and not anxious groups in expected future travel behaviour. Like figures 23 and 24 above, the yellow bars show when everyone in the train is not anxious and the blue when everyone is anxious. The figure shows that when people are anxious, similar percentage of people expect to travel more (4,5% when not anxious and 5% when anxious).

Generally, anxious people expect to travel less than before but majority expect to travel as much as they did before Covid-19.
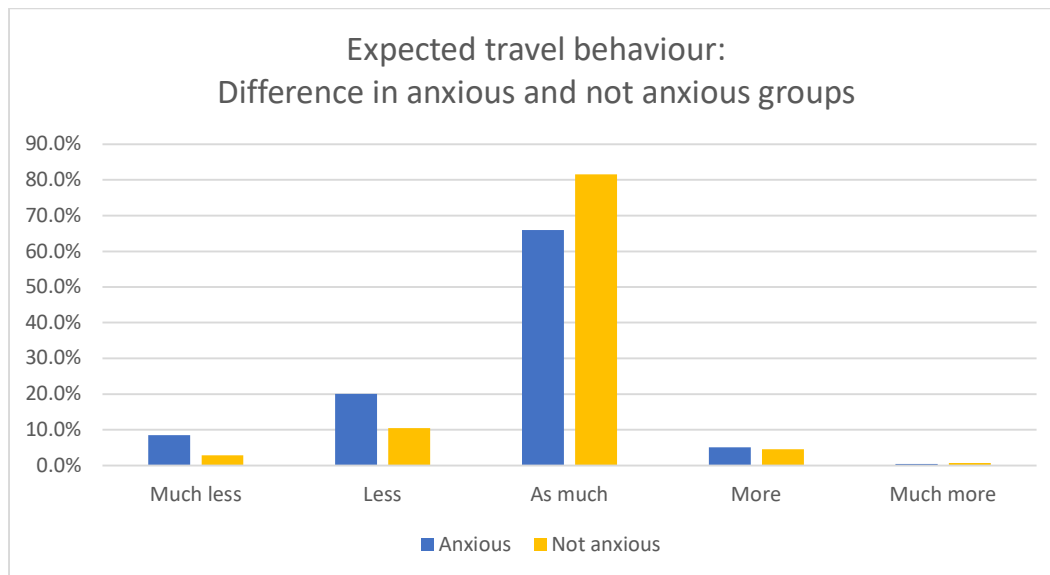

Expected travel behaviour:
Difference in anxious and not anxious groups

Figure 25 Difference in anxious and not anxious groups in expected future travel behaviour

The figures above (figures 23, 24, and 25) show that the effects of anxiety on attitude, current and expected behaviour are negative for train usage. The attitude becomes more negative which leads to less usage. When looking at expected future behaviour, majority of people plan to use the train as much as before, however, 15% expect to travel less than the not anxious group would and only 0.5% expect to travel more compared to the not anxious group.

5. Discussion

The data obtained from the surveys include much information about different behaviour changes and effects that Covid-19 has had on the train travelling population in the Netherlands. This project mainly focuses on one specific group of people out of the thousands of participants of the surveys. This project focuses on anxious train travellers, which were also anxious in general, and uses the not anxious and neutral groups for comparison.

Limitations

There are multiple limitations to this research. One limitation is the statistical tests performed. As mentioned in section 3, chi-square tests can result in a statistically significant relationship when it is not significant when working with larger samples. Where the test sees very small differences in the data as significant. To account for this, the data was reduced into five sets of random samples with a size of about 1100, however, these samples could have still been too large for a chi-square test. The size of these samples was chosen because a smaller set would mean that each sample could be further away from the population, and it was wanted to keep the same features in the samples as in the population. This could lead to that the chi-square tests would still result in a significant relationship where it should be insignificant. In this case, it would mean that the analysis would result in that some variables that were not significant would test as significant.

Another limitation is that this project mainly focuses on only one survey (from April 2021). Other surveys might show a different relationship in some cases. Especially the survey of September 2021. This could mean that the results of this project are very specific to the situation from April 2021 and there could be some differences if other surveys were included or investigated further.

Suggestions for future research

For future projects, the following methodology is suggested. It is suggested to investigate further using chi-square test, possibly with smaller sample sizes. Since chi-square tests cannot determine which combinations are significant, it is recommended to look further for a test that grasps that as well. The post-hoc test used in this project did not give very clear results and it is recommended to look into other tests to identify the different groups. The classification tree analysis and Cramer's V coefficient were helpful in identifying different groups and to see how strong the association between the variables was.

Dong et al. (2021) mentioned in their research that people's closeness to the pandemic was also a factor in anxiety levels. There was no question that asked about this in the survey of April 2021. There were, however, questions about this in the first survey (April 2020) and in the latest survey (September 2021) where participants were asked what sector they worked in, where one option was care and another was emergency services. Another question asked if they, or someone they knew had gotten infected with Covid-19. This would be interesting to investigate further with respect to anxiety levels. The reason why this was not included in this project is because it was not in the survey of April 2021 and therefore, it would be more difficult to interpret the conclusions from it based on the anxious group.

It is also suggested to investigate the relationship between the number of anxious people and the trend in the number of cases and hospitalizations of Covid-19. Establishing a relationship between these variables could lead to a better forecasting in train usage which would help with planning, rolling stock purchases and more.

In this research, the characteristics of the anxious group were established, along with the size of the anxious group and the effect that anxiety has on train usage. With this information it is suggested that further research will be done that investigates what measures can be done to get anxious people to go back to travelling by train, at least after the pandemic. Also, it would be interesting to investigate what the issue is. If people are feeling anxious because of crowding in the train, if it is the feeling of being safe in the train, facemask usage, or other things.

Another interesting topic to investigate is looking more into the people that are fully vaccinated but are still anxious. What their characteristics are, and why they are still anxious. Also, to investigate if anxious people are using other modes alternative to the train or using other modes more often. The research by Przybylowski et al. (2021) suggests that a part of the people that reduced their train usage switched to private modes. It would be interesting to investigate if the people that are using other modes more often are anxious train travellers.

In the future, it would also be interesting to investigate whether the importance of vaccination status has changed. In November 2021, the cases have been rising rapidly again but many people are fully vaccinated. This could lead to that people start to get anxious again which would possibly lower the importance of vaccination status to anxiety levels.

Expected situation after Covid-19

The latest survey was conducted in late September 2021. When it was conducted, the number of cases had been very low for a while and most restrictions were removed. This situation was also seen in many other countries in the world at this time. Therefore, it can be assumed that in a world after Covid-19, the number of anxious people in the train might be similar to what was seen in September. 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 people that answered that they were very anxious in September, it is unlikely that their anxiety will change drastically in the near future.

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

6. Conclusions

Covid-19 has had a major impact on mobility and especially on public transportation. The purpose of this project was to investigate the effects of anxiety on train travelling behaviour during and after Covid-19. In order to find these effects, the factors that influenced anxiety in train travellers were found. These factors were age, gender, and vaccination status (in April 2021). These factors are in line with what was found in literature. Kassaw and Pandey (2021); Wilson et al. (2020) mentioned that gender was an important factor for anxiety and that females were more likely to experience anxiety. The research by Kassaw and Pandey (2021) resulted in that people that had families and were daily laborers were more likely to be anxious. This research resulted in that young people were less likely to be anxious and that people over 25 years old were likely to be anxious. This is in line with the research by Kassaw and Pandey (2021) because these age groups are most likely both working and have families.

In addition to the factors that influence anxiety, it was investigated how the percentage of the anxious group developed over time during the pandemic. This resulted in that the percentage of anxious people fluctuates over time, as seen in figure 26. These fluctuations could be due to the different situation in the country at the time. When the number if cases and hospitalizations increase, the media coverage and news about Covid-19 increase and restrictions become stricter, hence the number of anxious people might increase. This reasoning is in line with the research by Dong et al. (2021), where they mention that anxiety level could depend on the person's closeness to the pandemic and that those that are closer to the pandemic pay more detailed attention to the media. In the end of the summer of 2021, most people were fully vaccinated which made a lot of people feel safer, and it shows in the drop in the size of the anxious group in the latest survey (September 2021), as seen in figure 26. The results from this paper show that vaccinations are an important factor that influences anxiety levels, and that a lot of people were less anxious after they got vaccinated. However, currently, in November 2021, cases are rising again, and many people are getting infected with Covid-19, even vaccinated people. Therefore, it would be interesting to see if the effect of vaccinations on anxiety levels will decrease or become less important in the coming months.
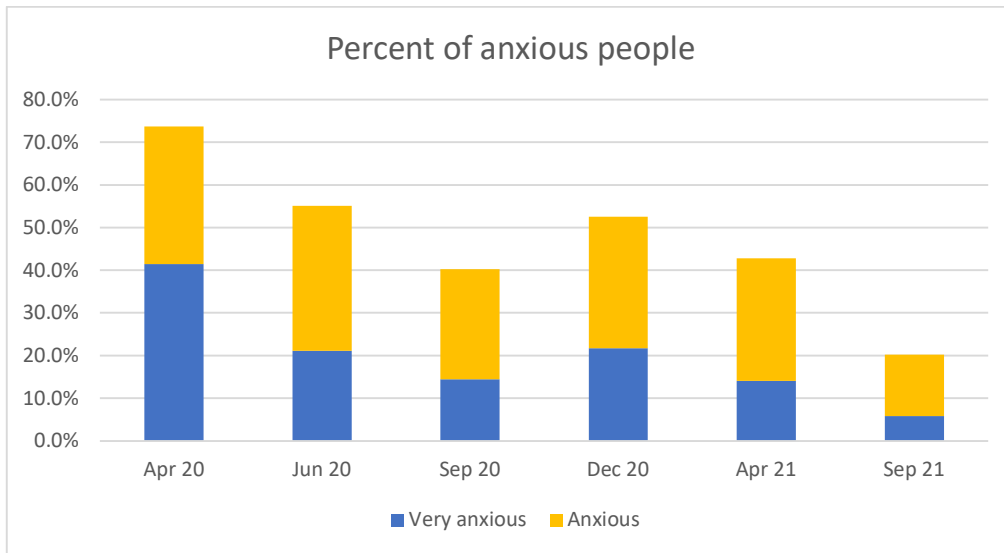
Figure 26 Percentage of anxious train travellers out of the general travelling population

The final aspect to consider before reaching the aim of the project is to investigate the relationship between anxiety and attitude on one hand and anxiety and behaviour on the other hand. As shown in the behavioural model mentioned in section 4.1, anxiety and attitude 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. 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 9. The profile of an anxious person would be female, older than 25 years old, planning to get vaccinated or 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 9 Typical profile of anxious and not anxious persons

	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

The main purpose of this project was to investigate the group of anxious train travellers during Covid-19 and gain more insight into this group, their characteristics, behaviour, and attitude. For at least the first year of the pandemic (April 2020 to April 2021), this group of anxious people has been over and around 40% of train travellers. The results of this paper helped identify this group and established 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. With the information of this paper, it could be investigated if there can be some adjustments done to see if can get those people back, because 15% of anxious people plan to travel less. I would recommend to NS and TU Delft to continue to conduct surveys regularly, until the end of Covid-19, or at least do one more survey to investigate for example the changed effect of vaccinations. I would also recommend NS to look into the reasons why people are anxious and investigate how to adjust those factors.

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