
# High-Speed Rail Versus Short-Haul Flights: The Factors That Influence Travel Choices

A case study of the Rotterdam-Paris and Rotterdam-Berlin routes using choice experiments

Master Thesis: Urban, Port & Transport Economics

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Date Final Version: 15-07-2022

# Abstract

This research focuses on the decision making of people with a specific focus on young adults (aged 18-25) when it comes to travelling short distances either by aeroplane or high-speed rail (HSR). These two modes of transportation are competing, so understanding how people make travel decisions can help operators and governments understand what business strategies or policies would be effective. To understand these behaviours, the route between Rotterdam and Paris is analysed and compared with the route between Rotterdam and Berlin. Analysis of the results of the survey conducted in this research can help HSR companies increase their competitiveness and allow governments to see what policies can encourage travellers to travel by high-speed rail, as it is beneficial to society from an environmental perspective.

This research found that total travel time and price are the two most important factors when it comes to picking travel methods. Controlling those factors can help make high-speed rail travel more competitive with aeroplane travel. Governments that want to encourage HSR travel should subsidise the production, provide incentives to passengers to travel on HSR, and discourage people from flying on routes where a high-speed rail alternative exists. Education on the benefits of HSR is also essential to promote as this research has found that those who have travelled by HSR before are likely to do it again.

# Acknowledgements

I would like to thank my parents and siblings for all their support throughout my academic career and in particular their support throughout the thesis writing process. I also want to thank my friends for supporting me throughout this journey and making the master program very enjoyable overall. Thank you to all my professors this year who have taught me so much and a very special thank you to Giuliano Mingardo who coached me while working on this thesis, gave me great pointers on how to execute my research, and gave me the freedom to study the subjects that I found interesting.

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# 1. Introduction

How consumers make decisions when it comes to travel is very important to understand; it allows transport companies to support business decisions and it helps policymakers establish policies that support environmental and sustainability goals. With short-haul flight bans being put in place by certain governments and some companies not allowing employees to travel by plane  if the distance is below a certain threshold, it would be beneficial to see how people, especially the younger generation who tends to be the most price-sensitive, prefer to travel over these routes (BBC News, 2021). As the Paris Agreement has set climate standards and goals that need to be reached by 2050, governments aim to increase the amount of rail travel and lower the use of short-haul flights (The Paris Agreement, 2016), in an attempt to reduce the global carbon footprint. Germany is currently looking to invest in high-speed rail for the about 600 km journey from Amsterdam to Berlin, which will have a maximum speed of 230 kph and it is expected to be completed in 2024 (Spoorpro, 2020).With business travel not returning to the levels it was before the COVID-19 pandemic, and projections showing that full-scale business travel may not return to pre-COVID levels until 2025, it is important to study why people, especially the age group of 18-24 year olds, who travel often for leisure, make certain travel decisions (Association, 2021).

The aim of this research is to better understand what factors contribute to people's decisions such as people's backgrounds and previous travel experiences when choosing travel options this research will attempt to answer these questions by studying the routes Rotterdam-Paris and Rotterdam-Berlin by surveying people and asking choice experiment questions, willingness to pay questions, as well as people's travel preferences, travel experience and background. Background literature will be explored in section 2, the methodology of the experiment is further explained in section 3, the results will be discussed in section 4, and the results will be analysed as well as policy advice and further research will be discussed in section 5.

### 1.1 Why Study Rotterdam-Paris and Rotterdam-Berlin?

The route between Rotterdam and Paris is being studied and compared with the route between Rotterdam and Berlin for a few specific reasons. Firstly, these are popular routes connecting two major cities that are all economically connected within the EU. Both the cities of Berlin and Paris are seen as popular travel destinations and vacation spots, especially among Dutch tourists. The two most visited countries by Dutch tourists are France and Germany, and these destinations are both their capital cities (CBS, 2017). Another important reason these routes were chosen is that flight times are about the same for both routes (within 10-15 minutes). The distances for these routes are quite different though: Rotterdam to Paris is 373 km while Rotterdam to Berlin is 612 km. The Rotterdam-Paris route currently has a direct high-speed rail line that only stops in Antwerp and Brussels and will get one to the city centre in under three hours. The fastest one can get from Rotterdam to Berlin by train is 6 hours and 35 minutes with two transfers which is more than double the time it takes to get to Paris. The Berlin route is on trains that stop often and not all sections are high-speed rail. This study can look at the positives and negatives of both routes to help improve their respective products. Furthermore, according to most research, high-speed rail is best suited for journeys of about 150 km-800 km, which means non-stop journeys of about 1-4.5 hours (Hagler & Todorovich, 2009). Both of these routes are within this category as it pertains to distance. High-speed rail can be seen as a competitor to commercial air travel if the high-speed rail trip is under 4.5 hours as the total travel times of each travel method is similar (Hagler & Todorovich 2009). Currently, the Rotterdam-Berlin line is not under this time limit but it is within the distance and has the possibility of time reduction pending a direct HSR line. Furthermore, these two journeys are representative examples of options consumers in general will need to decide between.

# 2. Literature Review

Policymakers can learn from behavioural sciences how to better understand how people make the decisions that they make for many aspects of society including travel decisions. The following information will be useful to use in changing consumer behaviour.

## 2.1 Behavioural Change

### 2.1.1 Social norms

The first aspect of this research is the “social norm” theory, especially the difference in social norms between the United States and Europe. *Social norms* refer to the socially accepted behaviour by society or the behavioural exceptions or rules within a group (Hechter & Opp, 2001) (Minguardo, 2021). The social norms theory is then used with the aim to understand the environmental, societal, and other external influences in order to change behaviour (Berkowitz & Perkins, 1986). The social norms theory is important to consider in this research as people in the USA tend to travel by plane a lot more frequently and quicker than people in Europe as there is just far less rail travel available, especially high-speed rail. Furthermore, rail travel is overall less popular in the USA compared to most western European countries (Feigenbaum, 2013). These social norms can then influence people’s behaviour when they make a quick decision on impulse (“system one”). A *system one* decision-making can cause what they call a "blind spots” (Bazerman, 2011). The other type of decision-making would be slow and well-thought-out which is referred to as “system two” (Minguardo, 2021).

### 2.1.2 System 1 and 2

In most decisions, people are in their “system one” state, or “hot state,” where they rely on emotion, habit, and impulse and are prone to forgetting simple, important, and relevant facts (Fehr, Kamm, & Jäger, 2014). An example where *system one* decision making is often used is when someone needs to book a last-minute ticket to Paris from Rotterdam. People will tend to book on impulse in the travel method that they are used to and if one flies more often than taking the train then this person will more likely book the flight and not look at other options even if

taking the train is overall the better option. Policymakers can try to affect this decision process through effective communication and education. People can also make decisions in their system two state when making travel decisions as they then evaluate actions and their consequences thoroughly (Daniel Kahneman, 2011). This is the state individuals must be in if policymakers want to see a change in overall travel behaviour (Fehr, Kamm, & Jäger, 2014). An example of someone *system two* mode of thinking who needs to book a ticket to Paris from Rotterdam would look at all different factors that they care about from price to travel time to overall convenience among other things before booking their ticket on either the plane or the train. In their system two state they would look significantly more at reviews from others as well and do their own research about each method online.

### 2.1.3 Behavioural Change Matrix

According to Fehr, Kamm & Jäger (2014) and further analysed by Fokker (2021) there are a few effective ways to change people's behaviour, some short-term and some long-term. Strengthening willingness and awareness is essential to inspire behavioural change and the following methods as explained by Fehr, Kamm & Jäger (2014) will indicate which one it is strengthening as well as an example of how this could apply in practicality:

- *Communication and education:* Strengthens awareness of certain issues such as people may not be aware of the negative externalities that come with flying such as air and noise pollution.
- *Negative incentives and control:* Increases willingness for people to change if they are financially punished for taking a certain travel method.
- *Positive incentives and enablers:* Increases willingness for people to take a certain travel method if there are increased benefits such as a reward program or a positive increase of any other factor that people take into account when people make travel decisions.
- *Belief management:* Increases willingness by providing a desired norm attempting to get people to genuinely believe that making a behavioural switch is a net positive.
- *Preference management:* positively affects both awareness and willingness as there is a stress on prioritising customers allowing them to decide the way they communicate with

an organisation through their own channels such as receiving promotions through the channel they prefer (Iyer, 2022).

- *Attention shifting:* influence willingness subliminally with subtle nudges such as cookies on a computer that release subtle advertisements to encourage certain travel methods if one is looking into booking their vacation.

The most important aspect from the behavioural change matrix is that when awareness and willingness are low, change can occur since social norms take a longer time to evolve (Fehr, Kamm, & Jäger, 2014). When willingness and awareness are higher, short-term behavioural change is possible as "nudges" are effective to get people to change behaviour but they will not transform people as the nudges only give signs to encourage behavioural change given the situation (Fehr, Kamm, & Jäger, 2014).

### 2.1.4 Relevance to Travel Behaviour

People's awareness will be measured in this research in the form of their previous experiences with different travel methods and people's willingness will be measured in the form of a choice experiment. Since the goal for governments is long-term change, education, when willingness and awareness are low, is the best way to change travellers' behaviour (Fehr, Kamm & Jäger 2014). Policymakers will also need to take this into consideration when thinking of methods to change people's travel behaviour. The awareness that certain travel methods exist and their past experiences with those methods will likely have a huge influence on the outcome of what the survey participants answer. People's willingness to choose options will be asked in the survey in the form of the choice experiment questions and their willingness to pay. With this information from the survey, policymakers can figure out which demographics they can target to cause behavioural change. Two differing demographics that will be looked at in this study are Americans and Europeans. The European demographic will be the one affected as a result of this research and potential policy changes moving forward. This can be compared to the American demographic, which is a developed country that has almost no high-speed rail but has intentions to build HSR lines and thus little awareness of the HSR system (Fernandez, 2019). The implications of these behavioural concepts will be discussed in more detail in the methodology section.

A traveller is likely to repeat the same method of travel if they have had a good experience with it the first time. People tend to repeat their normal behaviour if personal norms regarding the behaviour are weak (Chandon, 2011). If one has no experience with something they are significantly less likely to choose something that they have not tried out before. If a person has only flown but not taken the train it is believed that they are more likely to choose the plane and vice versa. The main train provider in the USA is Amtrak and it has very limited routes. Because of this many people tend to drive or fly instead. The United States drives significantly more on average per capita compared to most other countries in Europe (Kopestinsky, 2021). Because of this, the following hypothesis is formed.

***Hypothesis 1:*** *Those who have little to no experience with trains (most likely people who live in the USA) will choose the flying options more often than those who have more experience travelling by train.*

### 2.2 Stakeholders

There are different stakeholders impacting the future of travel with the most relevant being airports, governments, rail companies, airlines, and passengers. These stakeholders also have a vested interest in studies like this because the outcome can greatly affect their profitability. The expansion of high-speed rail and the increase in flight bans set forth by some companies and governments influence a lot of different companies and institutions.

#### 2.2.1 Airports

The major airports that are stakeholders in this research are Schiphol International Airport, Paris Charles de Gaulle (CDG), and Berlin Brandenburg as the flights would be leaving from Schiphol on these routes and landing at either CDG or Berlin Brandenburg Airport. Despite only these two routes being studied, broader research can be considered and studied at a variety of different airports all around the world that are similar distances apart and have a similar amount of through traffic. Airports have different objectives which depend mainly on the structure of ownership of the airport. There are several different business models and ownership

structures that exist with the most prominent ones being multi-level government ownership, fully public corporatized, mixed ownership, and private ownership (De Haan & Kerkemezos, 2021). With people transitioning to HSR as an alternative to flying, airports may look into different methods of revenue to appease shareholders.

### 2.2.2 Governments

Governments have been involved with transportation for as long as air travel and travelling by rail have been around. Airlines have been regulated at times by governments and have gone through a deregulation process, the most notable of which is the airline deregulation act in the United States in 1978 (De Haan & Kerkemezos, 2021). Today, many of the airlines that fly are not owned by governments and are companies traded on the stock exchange. Many rail companies are often owned by or partially owned by the state. (DB-Konzern, 2008). Government interference in these markets often occurs to help with the negative externalities that come with the short-distance travel industry.

Airports also come with plenty of negative externalities that governments try to minimise. One of those is the noise that tends to happen around an airport from all the operations to the planes taking off and landing. An introduction of high-speed rail as a substitute would cause the overall noise pollution from airports and aircrafts to decrease (Wang, Xia, Zhang, & Zhang, 2018). The second externality that governments have a hand in minimising is environmental pollution. The Paris Agreement has set climate standards and goals that need to be reached by 2050, it would be desirable for governments to increase the number of rail travellers on these alternative rail routes lowering the demand for short-haul flights (The Paris Agreement, 2016). According to Janic (2003) as well as many other studies, rail travel is significantly better for the environment than air travel. The French government has passed a bill to combat climate change by banning short-haul domestic flights where train alternatives exist. This means the alternative must be a train ride that takes less than two and a half hours (BBC News, 2021). Other governments can be expected to follow as this is a good way to reduce carbon emissions in this sector of travel. If governments want this to be a long-term solution that can apply to many different routes there will need to be a mass investment into high-speed rail in addition to the 23.7 billion euro co-funding from the EU alone to support high-speed rail infrastructure

investments since 2000 (Special Report: A European High-Speed Rail Network, 2018). This research will look into the factors that influence travel behaviour so governments can step in effectively with certain policies and limit deadweight loss, economic downturn, etc.

### 2.2.3 Rail Companies

Building high-speed rail requires huge investments and takes years to complete but may be well worth it in the end (Fernandez, 2019). Since this research will be interviewing Americans and Europeans both rail networks will be looked at, but more focus will be placed on European rail, as this is the rail that is being studied in this research and in all likelihood will improve sooner than the USA rail network (Fernandez, 2019). Amtrak, the biggest rail company in the USA, has plans to expand its rail network as well as its high-speed rail network, but a lot of the proposals are having difficulty making it pass congress (Fernandez, 2019). For instance, in 2020 there were many talks among elected officials in the American government to build a high-speed rail along the coast of California which would cost an estimated $80 billion or $154 million per mile or about 235.8 million euros per kilometre (Poole, 2020) (The Guardian, 2022). These insufficient rail lines and unfinished plans have effectively left many Americans to have no real good access to trains. It should be noted that the European rail system is significantly more advanced despite there being sections in the USA where building more rail makes logical sense as major cities are within the 150-800 km sweet spot. The European Union has committed to long-term rail investments saying back in 2011 that the 4th goal of the White Paper stated “By 2050, complete a European high-speed rail network. Triple the length of the existing high-speed network by 2030 and maintain a dense railway network in all Member States. By 2050, the majority of medium-distance passenger transport should go by rail” (TRANSFORuM, 2015). Rail can be significant in emission saving (Eurostar, 2022) and this is one of the main motivations for the European Commission to build a connected railway all throughout Europe averaging 200-250 km an hour (European Commission, 2010). Since the rail market was liberated in 2010, many international rail carriers can easily compete on international train routes encouraging more train travel such as Eurostar and the Thalys (Fokker, 2021) (European Commission, 2010).

All these plans will only be beneficial for the public good of course if there is demand. The demand for high-speed rail travel in the future is expected to go up, especially if governments are imposing laws to force people to do so. Making it illegal to fly on certain routes in certain circumstances will most definitely increase demand for train travel. Secondly, other institutions, such as Erasmus University, are requiring employees to take the train if the trip can be under eight hours by rail for environmental reasons (Carbon Footprint, 2021). The purpose of this study is to see what the demand would be for people, especially the young generation and to see what young people value currently. There is an increase in the number of people who are environmentally conscious, which is expected to increase the demand for rail travel in the future (Chen, Huang, & Lin, 2019). Short-haul flight bans can increase the demand for future rail travel as well (Wang, Xia, Zhang, & Zhang, 2018).

There are also alternative modes of transportation that this study does not look at but rail companies need to be serious in considering all transport methods as competitors when transitioning in the future. Those other alternatives are buses, such as short and medium-haul carriers such as FlixBus as well as the classic car. Both of these methods are highly susceptible to traffic and the total price of the trip can vary on the cost of gas. Rail travel is usually faster, more comfortable, and more frequent than travel with a company such as FlixBus, but FlixBus tends to be a lot cheaper (Thalys, 2007) (Flixbus, 2021). Both travel methods can be viable alternatives on these routes and rail companies need to be aware of these.

Train companies often such as Société Nationale des Chemins de Fer Français which owns 70% of the Thalys, the train that connects the cities of Rotterdam and Paris via high-speed rail, is a state-owned enterprise (Thalys, 2007) (Stothard, 2016). The other 30% of the Thalys is owned by the National Railway Company of Belgium which is a government autonomous company (Thalys, 2007) (Andrei, 2020). Deutsche Bahn is the train company that operates the route from Rotterdam to Berlin and this is owned by the Federal Republic of Germany as their single shareholder (DB-Konzern, 2008). Both of these rail companies having massive government influence and ownership would want to see their respective do well and become profitable in the future. The Thalys is considered a high-speed rail as its maximum operating speed is 300km/hr (Thalys, 2007). This makes a huge difference as if there were no high-speed connection between Rotterdam and Paris the total travel time would take much longer and could possibly require more transfers. The current Deutsche Bahn route from Rotterdam to Berlin

requires passengers to begin on an NS or dutch train and then transfer to a Deutsche Bahn train in Utrecht, Amersfoort, or a few other locations. Only part of this route is done on high-speed rail, depending on where the transfers are, with some connections offering it to be partially done on the German ICE which is considered high-speed rail. Despite this, the fastest one can get from Rotterdam to Berlin is 6 hours and 35 minutes travel time which is more than twice the time it takes to get from Rotterdam to Paris despite it being 239 km longer (Trainline, 2022). There are talks of building a direct HSR connection between Amsterdam and Berlin that would take 4.5 hours which would likely change the current travel dynamic completely (Spoorpro, 2020). This research can help rail developers see what qualities this HSR would need for it to be successful as it can be compared to the HSR from Rotterdam to Paris. It would be beneficial to know at what price and travel time among other factors the new HSR will be competitive with flying as will be discussed more in the passengers' section.

### 2.2.4 Airlines

The airline industry works with some of the thinnest margins compared to almost any other industry so the price cannot vary that much (Wensveen, 2016). This is because if a competitor drops the price below the rest on a certain route, customers will most likely use that service, as the service quality and time travelled rarely vary all that much. Certain routes are highly competitive with multiple airlines and high-speed rail on the same route all competing for passengers. These airlines look at what the rest are charging and airlines attempt to have the lowest possible price but still remain profitable. On some routes, airlines may take a loss so they can acquire customers to be profitable on other routes (De Haan & Kerkemezos, 2021). A large difference between airlines and certain trains is fuel costs. Fuel costs represent 15-20 percent of total costs for airlines and the price of fuel constantly varies, which influences ticket prices (Bureau of Transport Statistics, 2019). The long-term survival of airlines must adopt a hub and spoke model to stay competitive with HSR as this can encourage passengers to fly if they need to get to a hub instead of relying on HSR (Logan, 2021) (Jiang & Zhang, 2016).

With wide-scale adoption of HSR in China, and to a lesser extent South Korea and Japan, European airlines can learn from Chinese airlines in how they were affected on certain routes. With an HSR entry into a market, airlines in China would immediately lower the number of

flights in markets under 500 km as the HSR is now competitive on this route and stealing potential airline customers (Wan, Ha, Yoshida, & Zhang, 2016). In Korea and Japan, when there was an introduction of HSR on routes under 500km it took a few years before airlines began to lessen the capacity of flights, and yet they did not lessen it as much as Chinese carriers on similar distance routes when HSR came in to compete. Wan, Ha, Yoshida, & Zhang (2016) and Zhang, Johnson, Zhao, & Nash (2019) found specifically that the route's frequency decreased by 60% when HSR exists on a route within China. Chinese high-speed rail is also some of the fastest and most efficient in the world so these results may not carry over exactly but can be a good indicator of what the future holds in Europe (Lawrence, Bullock, & Liu, 2019). Full-service carriers who operate with a hub and spoke model can benefit from rail connections to nearby cities to a major hub. The hub airport can be extended to host a train station which will then encourage train travel to and from the airport for international travel (Albalate, Bel, & Fageda, 2015) (Flokker, 2021). Cooperation between rail companies and airlines can be beneficial for both parties and can prevent a large reduction in total volume if air travel and rail travel can cooperate on certain routes (Xia & Zhang, 2017). The European Commission has recognized this and their plan of action is to encourage cooperation on certain routes (European Commission, 2010).

### 2.2.5 Passengers

Passengers will experience major changes in the total travel experience for mid-distance trips with the introduction of high-speed rail. The following characteristics: total travel time, environmental concerns, comfort/service quality, service quality, and convenience will be asked in the survey so they will be analysed.

**Price:** People tend to want to travel for the cheapest price option, assuming that the quality of all the alternatives is about the same (Goodwin, Cairns, Dargay, Hanly, Parkhurst, Stokes, & Vythoulkas, 2004). With the future moving towards less air travel for short distances and more towards rail travel, the main thing rail companies and governments need to focus on is bringing the price point down if they want full-scale adoption from passengers. For example, currently at the time of writing, if one wants to book a ticket from Schiphol to Paris for two weeks out it would cost 61 euros for the cheapest ticket and the Thalys train would cost 88 euros

for the cheapest (Google flights, 2022) (Trainline, 2022). This is backed by an IATA study that found that train tickets tend to be more expensive than planes (IATA, 2015).

**Total Travel Time:** In general, assuming all else is equal, people prefer to take the quickest travel method from point A to point B (Small, 2021). If high-speed rail gets developed between cities that fall into the distance sweet spot, then people's travel habits will be severely affected. The quickest way historically has been flying on many routes, but this competitor of HSR can have an extremely important and competitive market presence. Human beings tend to value their time quite highly and take this very much into consideration when it comes to making travel decisions (Small, 2021). When flying, travelling to and from the airport to the city centres, and going through security all takes time, but when one looks at flights to book online they only see the actual flight time. When travelling by train, the total train travel time is shown on a website such as The Train Line but there is very little check-in time and the stations are already in the city centre, which is often where the traveller's final destination is (Google flights, 2022) (Trainline, 2022).

With travel time being important to people, especially if there are alternative travel methods that may take less time, people will be willing to pay more the more time they save in general has been seen as a trend. Many studies back this up but one significant one by Lascelles (2008) found that among a sample of college students, their willingness to pay was significantly higher when saving on travel time. People's willingness to pay to save on an hour of travel is also higher than the wages that they earn thus showing the important value people place on time-saving while travelling (Lascelles, 2008). Another study by Qin, Chen, Cu, & Wang (2014) has shown that people prefer an alternative travel method with the shortest travel time when all other factors are comparable. This is based on the idea that people have a willingness to pay with time that is a maximum of 24 hours in a day. People are willing to save that time if they can and put it to better use if possible such as productive working or relaxing. With all this other research previously done in mind, the following two hypotheses are formed.

***Hypothesis 2:*** *More people will be willing to choose the train on the Rotterdam-Paris route than the Rotterdam-Berlin route in general.*

***Hypothesis 3:*** *Willingness to pay increases the more time one saves*

**Environmental concerns:** People who are cautious of the environment can cite it as an issue that influences them in making travel decisions. Some people do take this into consideration when it comes to making travel decisions. According to a study done by Hares, Dickinson, & Wilkes, (2010) many people recognized that climate change is affected partially by flying and the survey participants understand that, but it does not feature in most of their travel decisions when it comes to planning a holiday. Those who are concerned with their personal CO2 output can see what the carbon emissions are for certain flights which may influence their decision on which flight they book (Google flights, 2022). Despite all this, there are also many travellers that do not take environmental concerns into account when flying according to a study done by Schwirplies, Dütschke, Schleich, & Ziegler (2019). Many participants in this survey sighted that they would rather offset their carbon emissions on their bus travels than on their aeroplane travels. This can potentially be due to the fact that marketing for years has shown people that road vehicles are bad for overall emissions but people have only recently begun being told that aeroplane emissions are very bad for the environment.

Environmental Countiality is more intertwined in the everyday lives of Europeans and the assumption is it will be no different when it comes to travel behaviour. “The average American produces triple the amount of CO2 emissions as the average person living in France (Rosenthal, 2009). “Per capita, CO2 emissions in the U.S. were 19.78 tons according to the Union of Concerned Scientists, which used 2006 data, compared to 9.6 tons in the U.K., 8.05 tons in Italy, and 6.6 tons in France” (Rosenthal, 2009).

**Comfort/Service quality:** Leg room, quality of seats, luggage room and the overall feel of comfort in that cabin plays a factor in the decision-making for travel. The cabin of a plane or train can be quiet and may have entertainment devices which may lead to people making a decision to travel with that service based on overall comfort. This factor is more about personal preference than any one feature of the experience.

**Convenience:** Passengers often take the number of transfers into account when booking a ticket. According to sources, the more frequent and convenient time options that exist for travel, the more people are willing to travel with that service (Chowdhury, 2015) (Carlos Martín, Román, & Espino, 2008). This means that it would be strategic for airlines to offer many flights

at convenient times with as few transfers as possible to stay competitive with rail companies who need to attempt to do the same thing. Secondly, flexibility to change trips would encourage people to take the service more than if people do not have that flexibility and feel locked in (Carlos Martín, Román, & Espino, 2008). Furthermore, travellers are less willing to make more transfers without any sort of compensation. People, for the most part, will only take a transfer if the opportunity cost outweighs the extra time, or effort it may take to do the transfer. People are only willing to transfer if they save some time or money (Lascelles, 2008) (Chowdhury, 2015). Because of all of these previous studies this thesis hypothesis is as follows:

***Hypothesis 4:*** *People are willing to transfer more if it means they are saving on their total travel time*

Considering all the factors being studied, the point of this research is to find the factors that most influence people's decision making. When it comes to the younger age group they tend to make less money than people that are older, such as being in their fifties for example. Because this age group tends to have the lowest income, they in turn have the lowest disposable income. The prediction is that most people will rate the question as to which is most important to be price. People surveyed are also predicted to choose the lowest price when deciding between two options most of the time. According to a study done in Beijing, people tend to prefer the alternative with the lowest costs if the alternative's overall quality of the trip is comparable (Qin, Chen, Cu, & Wang, 2014). It is most common for the plane ticket to be more affordable than the train ticket. With all these things into account, the hypothesis below is formed.

***Hypothesis 5:*** *Price is the most important factor when it comes to making travel decisions*

### 2.3 Furthering Fokker's Research

A significant amount of this research is based on previous research done by Fokker (2021). Fokker studied the routes Amsterdam-London and Amsterdam-Berlin and studied people's willingness to pay between the train, plane, and bus. This was done by asking participants their willingness to pay for different situations as that information was used to run regressions to see which factors and demographics contribute to the choice of people's willingness to pay for each route on each transport method. Fokker's (2021) research focuses heavily on environmental reasons to encourage the transition to HSR as well as it looks at people who are concerned about the environment responses versus people who are less concerned. While this is studied in this research, it is not as big of a focus as in the research done by Fokker (2021). This research will explore a similar idea with a few minor, but key differences. In Fokker's (2021) research, willingness to pay was asked of participants while there was no price to compare. Survey participants could not base their prices on anything other than experience, thus possibly leading to potentially a wider range of answers. This will be improved in this research by asking willingness to pay questions as an alternative to the other travel option that has a set price as well as a discrete choice experiment. This will better give survey participants an idea of exactly which travel service they are paying for and all its factors with a suggested price. This is done in an attempt to give participants a realistic representation of the choices that are currently available and their current prices. Secondly, the routes in this experiment are different from the routes chosen in Fokker's (2021) research. Thirdly, the city names in the survey in this research remain anonymous in an attempt to eliminate any possible bias of people that have taken these routes, or similar routes before. Fourthly, a few different factors will be studied such as transfers and comfort. This research also will compare the difference in responses from Europeans and Americans. All these factors will be explained in more detail in the methodology section.

# 3. Methodology

## 3.1 Choice of method

For this research, a survey was sent out for people to fill in via text message and social media platforms, with people spreading the survey directly to friends and family. Quantitative research was done for the reasons to quantify the choices people made in travel behaviour. The main goal of this was to generalise what factors influence travel on these short-distance routes from the young adult generation. The exact questions can be found in the appendix.

Online self-administered questionnaires were chosen to get a large amount of data because it is a useful way to allow populations to be assessed and studied (Jones, Baxter & Khaduja, 2013). Because of the use of social media websites such as Instagram and LinkedIn and messaging platforms such as WhatsApp, the survey was expected to be filled out by people all over the world. It is easy to conduct and can have far reach on the internet (Ortiz-Ospina, 2019). This is the best way to reach the two main demographic groups that will be studied, Europeans and Americans, with a high expected number of 18-25 year olds.

## 3.2 Sampling and Research Unit

Throughout history, most people act a certain way when they are young and tend to change and mature their overall behaviour as they get older (Sheldon & Kasser, 2001). Governments, especially in Europe, are trying to encourage people to travel by train if the alternative is flying on short-distance routes up to about 800 km (*TRANSFORuM*, 2015). Questions that this research will attempt to answer will be of use to the European Union and rail companies in this transition. HSR is being encouraged and is looking to be the way of the future so knowing what factors people take into account when they travel would be beneficial to HSR companies and governments. On the other hand, airlines do not want to lose their customer base so they will be interested to look at this data and see this analysis as well. With airlines attempting to transition to more sustainable fuel forms (Amankwah-Amoah, 2020), it will be extremely beneficial for them to see how to stay as profitable as possible during the transition as many predict that sustainable fuels are the way mankind will be flying in the future (Uppink,

2021). High-speed rail is becoming more advanced in certain parts of the globe with places such as China, Japan, and South Korea being the most prominent (Wan, Y., Ha, H. K., Yoshida, Y., & Zhang, A. 2016).

### 3.2.1 Why Europe vs USA

With Europe attempting to create a high-speed train service all throughout the EU by 2050 (*TRANSFORuM*, 2015) people from Europe were surveyed to attempt to understand what their travel behaviours are now with the limited HSR that is currently in use, measured by the Rotterdam-Paris route, to contrast with a route that does not have much high-speed rail, measured by the Rotterdam-Berlin. People from the USA are surveyed as well to understand their travel behaviour as a contrast to Europe. The USA lacks far behind in rail travel compared to Europe (Fernandez, 2019) so surveying both of these areas in the world which are both about just as evenly developed, can compare attitudes towards rail travel between the two. It can show that the USA is far behind Europe when it comes to an HSR future, or this may show that attitudes towards the type of travel do not really matter and it is more about other factors such as price and total travel time. Either way, the actions taken for policy advice from European governments as well as business strategies will most likely differ from one continent to another due to the behavioural matrix discussed in the previous section.

The sampling for this research was done through chain/snowballing sampling and produced about 184 respondents that were used in the analysis. These were mostly found through social media from friends, ex-colleagues, friends of friends, current and former classmates, etc. and relying on participants to further spread the word about the survey. While most respondents are expected to be in this young adult range of 18-25 years of age, everyone above the age of 18 is allowed to participate in the survey and the results can be analysed against one another to see the preferences of each age group.

### 3.3 Survey Description

To combat biases of people who have not taken these routes or for those who have taken these routes on one transport method the city names have been left out. The travel times, transfers etc. are all the same as they would be if one travelled on this route, however, the route remains anonymous to the survey participant. Most prices were looked at for the questions if one were to book a month from the time of writing the survey. This is to see if the current pricing strategy would encourage one method over another. Some of the prices are hypotheticals to better understand the participant's value of the other factors in each choice. Rotterdam has been replaced by City A, Paris has been replaced by City B, and Berlin has been replaced by City C.

#### 3.3.1 Background and Demographics Questions

The survey starts off by asking where people live as my assumption is that most people that participate either live in Europe or the USA. This then determines if they answer the question of how often they travel by train internationally (Europe) and how often they travel by train for more than two hours (USA west coast/USA central/USA east coast/other). The distinction between the different regions in the USA is done because the east coast of the USA does have a little bit of "higher speed rail" and train travel is more relevant there than other places in the USA as the major cities are closer together so it makes more logical sense. This is then followed by all the different scenarios that the participants can choose from. This question is followed up by asking how often people travel more than two hours by train, for people in the USA, and how often people travel internationally by train, for participants who reside in Europe. Both groups are then asked how often they travel by plane per year. The overall attitude toward trains and planes is asked to everyone on a 5-point Likert scale (1= Extremely Negative and 5= Extremely Positive). The Likert scale is an effective method to generate a composite score of all the answers where the average, mean, and standard deviation can be analysed from the participants' answers (Joshi, Kale, Chandel, & Pal, 2015). A conscientious decision was made to construct this scale as simply as possible. People's prejudices can have an effect on how they answer the rest of the survey so asking about their habits and attitudes to these things is essential for accuracy (Ito, Urland, Willadsen-Jensen, & Correll, 2006). A potential pitfall in using the

Likert scale is that the distance between the ranks cannot be measured. The choices 1-5 are evenly distributed so there may be a basis in people meaning different levels of experience or attitudes but picking the same number. The data is skewed and not normally distributed so the standard parametric test cannot be used (Fokker, 2021).

### 3.3.2 Choice Experiment questions

A choice experiment method was chosen in this research to attempt to eliminate hypothetical bias from a willingness to pay question. This is discussed more in section 3.3.4. The benefit of a choice experiment is that participants are asked to pick a choice with a set of factors that give a more realistic representation of people's preferences as a whole. With a choice experiment, multiple attributes can be valued simultaneously which allows this research to look at multiple influencing factors as an outcome (Van Loo, Caputo, Nayga Jr, Meullenet, & Ricke, 2011). Secondly, they are consistent with the random utility theory and Lancaster's theory of consumer demand (Van Loo, Caputo, Nayga Jr, Meullenet, & Ricke, 2011). Thirdly, a choice experiment is more similar to actual purchasing decisions made by consumers and in theory is less prone to a hypothetical bias (Van Loo, Caputo, Nayga Jr, Meullenet, & Ricke, 2011). The exact choice experiment questions can be seen in appendix 1. Choice experiments are also consistent with the random utilisation theory which assumes that people make rational decisions and will maximise their utility and the Lancasterian consumer theory which states that the utility of a good can be segregated in utilities of different attributes and the consumers make the decisions based on the attributes that they prefer (Gracia, Loureiro, & Nayga, 2009) (McFadden, 1974) (Van Loo, Caputo, Nayga Jr, Meullenet, & Ricke, 2011). The total travel product, in this case, is made up of multiple attributes and survey participants, in theory, will gravitate towards the option that aligns with their preferences for attributes of these goods.

The two travel methods between City A and City B were given and all the different factors were shown for each situation such as total travel time, transfers, etc., and participants were asked to give their preference on which method to take, plane or train, at each given price.

There are three trains being compared to one flight being studied between City A and City C which are all based on real travel times and the number of transfers between Rotterdam and Berlin. These trains are labelled Train X, Train Y, and Train Z. Each participant is asked to

compare two of them at random at certain prices compared to the flight and pick which method they would be willing to choose the most. Participants were given two of the three questions to save overall time on the survey and to attempt to limit the amount of attrition. Secondly, this is to limit bias on people being asked very similar scenarios three different times as answering one scenario may affect the answer on the other scenarios (Sauro, 2016).

### 3.3.3 Comparing Rail Route Questions

A few questions on the survey are designed to compare the different train routes that currently exist between Rotterdam and Berlin. The main point of these questions is to evaluate how participants value transfers. The question comparing trains Y and Z together is strictly designed to see what percentage of people are willing to sacrifice 56 minutes of total travel time to transfer one less time. There is a question analysing if then people are willing to pay significantly more to travel on the fastest train with the least amount of transfers for a significantly higher price. The last few are comparing all the trains with an even quicker flight.

### 3.3.4 Willingness to Pay

Every survey participant will be asked to give their willingness to pay for the flight service that has a longer overall travel time from City A to City B given that a train ticket is 100 euros. Furthermore, from City A to City C given that a flight is 100 euros, participants are asked what is the most they are willing to pay for a train ticket. The train in question here is train X for all participants, the quickest available train currently on this route (Trainline, 2022). Willingness to pay is the maximum amount of money that one would be willing to pay for a certain product or service (Hanemann, 1991). This is not done in a complete direct method as participants have a baseline to compare it to. A direct method would ask people's willingness to pay solely based on the product or service's description (Breidert, Hahsler, & Reutterer, 2006). In the literature review of Harrison and Rutström (2008), evidence was found that 34 of the 39 studies they looked at contained hypothetical bias when asking willingness-to-pay questions to survey participants. The main goal of the willingness to pay questions in this survey is to see how much they value their time from a monetary standpoint. This is not the only thing being measured but it

is one of the biggest differences here between the two travel methods. One of the pitfalls here is that people may choose their willingness to pay on other factors such as environmental concerns or comfort or convenience. A second major pitfall in willingness to pay questions is that people are being asked to look at hypothetical buying situations and they tend to behave differently when the same real buying situation is presented (Chang, Lusk, & Norwood, 2009).

All the information that concerns travel times, flights, and most prices (there are a few manipulated to study other variables such as transfers) are all found on booking websites such as (Skyscanner, 2022) (Trainline, 2022) (Thalys, 2007).

### 3.3.5 Specific Preference Questions

Some final questions were added to the survey in an attempt to rule out a basis or to better understand why people answered the questions a certain way. Knowing people's reasons for picking certain choices in the choice experiment can help better understand the reasoning behind all of these choices. Price, convenience, environmental concerns, service quality, comfort, and total travel time are looked at and participants are asked to rank them in order of importance. This is done to force participants to pick the most important one which is a good way to give each factor individual value and this can then be analysed quantitatively (Finch, 2021). By understanding why participants chose the answers to the choice experiment, policymakers and others utilising this research can understand what factors this sample finds to be most important when it comes to making travel decisions as well as some of the hypotheses mentioned earlier rely on this preference ranking.

### 3.3.6 Demographics

The survey ends with a few demographic questions. The first of which is age, which is divided into five separate categories. The first one is 18-25 years old, as this is the group that is expected to respond to the survey the most, and then age categories in 15-year increments ending with a 71 and older category. Gender and employment status are also asked to better understand the background of survey participants and preferences can be analysed to these specific demographics.

### 3.4 Statistical Analysis of Survey Data

#### 3.4.1 Interpreting Data and Processing Data

When it comes to the interpretation of the data most of it was looked at in the computer program Qualtrics and certain interpretations can be made by looking at the results of the different questions. The data did need to be processed in the computer program R studio to create one long data set with all the available choices the participants could make. This was done so analysis could be carried out on all the variables that went into making the choice of either taking the train or the plane in the choice experiment questions. The factors that were put into this final data set that could be analysed are: plane price, plane total travel time, the plane ride time (exclusively flying), train price, train total travel time, the train ride time (exclusively travelling on the rails), number of train transfers, the time difference between the two options, and the price difference between the two options.

#### 3.4.2 Logistic Regression

A binomial regression model was used to estimate the effect of each factor on the final choice made. Logit models are efficient when organising a whole choice set together as is done here (Rambonilaza & Dachary-Bernard, 2007).

A logistic regression is expressed as follows (Hosmer & Lemeshow, 2013):

$\log(odds) = c + \beta 1x1 + \cdots + \beta kxk$

Where: c = constant

βi (i = number) = coefficient

xi (i = number) = independent variable

log(odds) = log of odds ratio

$Odds\ Ratio = \frac{\pi}{1-\pi}$

$\pi$ = probability that people pick the train

The odds ratio is the chance the binary variable is one divided by the chance that the variable is zero. The log(odds) which is the choice variable in the data set is binary with plane=0 and train=1. To interpret the results, or the coefficient of $\beta 1$ the odds ratio can be calculated by multiplying the odds ratio by $e^{\beta 1}$. The greater the value of this is the greater the odds of picking

the train are. Thus if $e^{\beta 1}$ is higher than 1, the odds ratio increases and if $e^{\beta 1}$ is lower than 1 the odds ratio decreases.

To find the odds it can be said "if we change our independent variable by 1 (unit), we'd expect the odds of our dependent variable being 1 to change by $100 \cdot (e^{\beta 1}\text{-}1)$ percent" This is how the results will ultimately be interpreted.

The three variables that are ultimately being looked at are the difference in price between the plane and the train, the difference in travel time between the plane and the train, and the total amount of transfers for the train. The rest of the variables being tested could not be defined because of singularities meaning that two or more of the predictor values in the regression have a perfect linear relationship or the variable's p-value was not low enough, thus deeming it insignificant. The difference in price is defined as plane price minus train price and the difference in time is defined as plane travel time minus train travel time.
So for this research, the final logarithmic regression is:
$\log(odds) = c + \beta 1 * \text{difference in price} * \beta 2 * \text{difference in travel time} * \beta 3 * \text{total train transfers} + \varepsilon$

### 3.4.3 OLS Regression

To analyse the willingness to pay for certain travel alternatives and the drivers behind the decisions people made a regression is performed. All six of the factors participants could rank are put into this equation in an attempt to understand which factors had the biggest influence on people's choices for choosing their Willingness to Pay. The regression is as follows:

Willingness to Pay = $c + \beta 1 *$ Importance Travel Time + $\beta 2 *$ *Importance Price*+ $\beta 3 *$ *Importance* convenience $\beta 4 *$ *Importance environment* + $\beta 5 *$ Importance comfort + $\beta 6 *$ Importance service quality + $\varepsilon$.

By doing this the regression can be interpreted as follows:

An increase in rank of the Importance of travel time by one rank is associated with in a $\beta 1$ dollar increase in willingness to pay holding all else constant. An increase in rank of the

Importance of Price by one rank is associated with in a $\beta 1$ dollar increase in willingness to pay holding all else constant.

Furthermore, this regression was also run with all the factors at each individual rank (1-6) so the effect of each different choice point could be compared to 1 of that individual factor. For example, the coefficient of Importance comfort 4 is the effect it has on WTP as compared to Importance comfort 1. These results did not give much more information than the standard regression so it was left out of the results.

It is important to note that when a participant ranked a factor one that means it was the most important factor to them and when they ranked a factor six it is the least important factor to them.

### 3.4.4 Willingness to Pay Calculation

In order to understand people's willingness to pay for certain alternatives to the standard, more popular, travel method, willingness to pay was calculated by asking participants their willingness to pay compared to a faster 100 euro travel method and will be referred to the standard route. All people who would have chosen the standard route instead of the cheaper alternative were omitted from these calculations, due to them possibly prioritising other issues other than price or travel time such as environmental reasons, comfort, or the unfamiliarity of the travel methods. These participants could have also simply skipped this question so no further analysis can be done on those participants who refrained from answering this question as the reasons why are unclear. The willingness to pay estimation is compared to an alternative choice on both the routes and the value of money on time is calculated as follows:

The difference of the medians medAB and medAC was calculated to find the median amount of money people would be willing to save on each route.

Median amount of euros saved on route AB = 100-medAB
Median amount of euros saved on route AC = 100-medAC

Furthermore, the percentage of extra time travelled calculation is shown below. This is done for both questions, one on route AB and one on route AC. The results are shown in section 4.3.

$$\frac{(standard\ route\ travel\ time - alternative\ route\ travel\ time)}{standard\ route\ travel\ time} * 100 = \text{percent extra travel time}$$

### 3.5 Descriptive Statistics

In total there were 277 respondents to start the survey but only 185 finished the survey but due to one participant not being American or European 184 respondents will be analysed in this research. Of the 184 fully completed surveys, 97 of the participants said they lived in the USA with 90 saying they live on the west coast (48.91%) 3 participants said they live on the east coast (1.63%) and 4 participants said they live in the central USA (2.17%). This is compared with 87 participants that said they live in Europe (47.28%) and 1 person saying they lived somewhere else (0.54%). The person living in an "other" location is dropped from this analysis as it is only one respondent and a lot of analysis focuses on comparing the two regions. The official total number for analysis is 184 (N=184). Gender is quite evenly distributed with 88 of the respondents being male (47.83%) and 95 of the respondents being female (51.63%) and 1 respondent answering "other" (0.54%). As expected, the majority of the respondents were in the 18-25 age group with 144 (78.26%) of respondents checking this option. There were 5 respondents aged 26-40 (2.72%), 23 between 41-55 (12.50%), 11 between 56-70 (5.98%) and 1 aged 71 and above (0.54%). The final data set with all the possible factors from the choice experiment questions contains 2208 observations and 35 variables.

**Table 1:**

| **Place of Residence** | **Percentage of Respondents** |
|---|---|
| USA East Coast | 1.63% |
| USA Central | 2.17% |
| USA West Coast | 48.91% |
| Europe | 47.28% |

**Table 2:**

| **Age** | **Percentage of Respondents** |
|---|---|
| 18-25 | 78.26% |
| 26-40 | 2.72% |
| 41-55 | 12.50% |
| 56-70 | 5.98% |
| 71 | 0.51% |

# 4. Results

The following Charts are the different travel methods given to participants. They will be referred to frequently in the results. More details of the exact survey are in the appendix:

**Situation 1:** *City A (Rotterdam) to City B (Paris)*

| Transport Method | Plane | Train |
|---|---|---|
| Departure Area | City A Airport | City A Train Station |
| Arrival Area | City B Airport | City B Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 2:37 |
| Airport to Centre Travel Time | 45 minutes | 0 |
| Total Time | 3:50 | 2:52 |

**Situation 2***:* *City A (Rotterdam) to City C (Berlin)*

| Transport Method | Plane | Train X |
|---|---|---|
| Departure Zone | City A Airport | City A Train Station |
| Arrival Zone | City C Airport | City C Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 6:35 |
| Airport to Centre travel time | 55 minutes | 0 |
| Total Time | 4 hours | 6:50 |
| Number of Transfers | 0 | 2 |

**Situation 3:** *City A (Rotterdam) to City C (Berlin)*

| Transport Method | Plane | Train Y |
|---|---|---|
| Departure Zone | City A Airport | City A Train Station |
| Arrival Zone | City C Airport | City C Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 7:56 |
| Airport to Centre travel time | 55 minutes | 0 |
| Total Time | 4 hours | 8:11 |
| Number of Transfers | 0 | 3 |

**Situation 4:** *City A (Rotterdam) to City C (Berlin)*

| Transport Method | Plane | Train Z |
|---|---|---|
| Departure Zone | City A Airport | City A Train Station |
| Arrival Zone | City C Airport | City C Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 7 hours |
| Airport to Centre travel time | 55 minutes | 0 |
| Total Time | 4 hours | 7:15 |
| Number of Transfers | 0 | 4 |

## 4.1 Hypothesis 1

***Hypothesis 1:*** *Those who have little to no experience with trains (most likely people who live in the USA) will choose the flying options more often than those who have more experience travelling by train*

As stated in section 2.2.5, people who have had experience with certain travel methods are expected to be more likely to choose those travel methods than those who have no experience with them at all. In this particular survey, it is expected that Americans are expected to be less favourable towards train travel compared to Europeans. The only respondents that got the question about their overall attitude towards train travel were the participants that said they had travelled by train before. Almost twice as many Europeans had travelled by train before 65 participants (75.5%) compared to 33 participants (34%) that were Americans. This alone can indicate the difference in the relevance of train travel between the two continents. However, those who did have experience travelling by train had almost equally positive attitudes towards them with the mean for Europeans being 4.00 and the mean for Americans being 3.94 on a 1-5 Likert scale.

**Table 1:** *Europeans*

| Field | Minimum | Maximum | Mean | Std Deviation | Variance | Count |
|---|---|---|---|---|---|---|
| Overall Attitude towards travelling by train | 2.00 | 5.00 | 4.00 | 0.78 | 0.61 | 66 |

**Table 2:** *Americans*

| Field | Minimum | Maximum | Mean | Std Deviation | Variance | Count |
|---|---|---|---|---|---|---|
| Overall Attitude towards travelling by train | 2.00 | 5.00 | 3.94 | 0.98 | 0.97 | 33 |

In this sample, it can be seen that Europeans have more experience with trains than Americans when the question is asked directly, further analysis of the choice method problem can further support this hypothesis. When the train was the faster option (scenario 1 in the appendix) at the three price points given, Americans chose the plane on average 27.15% of the

time as opposed to Europeans who chose the plane on average 19.92% of the time. This notable difference in the data without taking any other factors into consideration shows that there can be a bias that correlates with the place of residence of the survey participants.

When survey participants were asked to choose their preferred method of travel between City A and City C with all three train options as well as an artificially faster flying option 64.95% of Americans chose the flying option at the higher price option and when the flying price was lowered 77.32% of Americans chose to fly. This is in contrast with the Europeans who saw only 49.43% of people choose to fly for the higher plane ticket price compared to all train options as well as 68.97% of Europeans choose flying price was lowered. These results indicate that Europeans are more likely to travel by train.

Furthermore, after running the binomial regression model from the choice experiment it was found that there is no effect on how people answered the question on their attitude about how they felt towards trains and the outcome. When the data is separated into data between participants from the USA and Europe, it can be inferred that people from the USA are significantly less likely to take the train compared to Europeans as there is a negative coefficient, thus concluding that someone from the USA has 48.6% reduced odds of picking the train as compared to people from Europe.

**Table 3:** *Americans*

| Coefficients | Estimate | Std. Error | Z-value | P-value |
|---|---|---|---|---|
| (Intercept) | 1.136080 | 0.121959 | 9.315 | < 2e-16 |
| Plane-Train Time Difference | 0.009587 | 0.00169 | 8.202 | 2.37e-16 |
| Plane-Train Price Difference | 0.028854 | 0.002081 | 13.863 | < 2e-16 |
| Train Transfers | -0.301573 | 0.088362 | -3.413 | 0.000643 |
| Americans | -0.665986 | 0.116838 | -5.700 | 1.20e-08 |

**Table 4:** *Americans That Have Previously Taken The Train*

| Coefficients | Estimate | Std. Error | Z-value | P-value |
|---|---|---|---|---|
| (Intercept) | 0.380670 | 0.146808 | 2.593 | 0.00951 |
| Plane-Train Time Difference | 0.010136 | 0.001668 | 6.076 | 1.23e-09 |
| Plane-Train Price Difference | 0.027715 | 0.002909 | 9.527 | < 2e-16 |
| Train Transfers | -0.289330 | 0.126058 | -2.295 | 0.02172 |
| Americans That Have Previously Taken The Train | 0.498120 | 0.168622 | 2.954 | 0.00314 |

**Table 5:** *Europeans That Have Previously Taken The Train*

| Coefficients | Estimate | Std. Error | Z-value | Pr(>\|z\|) |
|---|---|---|---|---|
| (Intercept) | 0.488275 | 0.202753 | 2.408 | 0.016030 |
| Plane-Train Time Difference | 0.009133 | 0.001680 | 5.437 | 5.41e-08 |
| Plane-Train Price Difference | 0.031580 | 0.003099 | 10.189 | < 2e-16 |
| Train Transfers | -0.339836 | 0.127326 | -2.669 | 0.007607 |
| Europeans That Have Previously Taken The Train | 0.758736 | 0.197847 | 3.835 | 0.000126 |

Americans have 64.66% more odds of taking the train if they have taken the train before compared to having never taken the train before and Europeans have 113.56% more odds of taking the train if they have taken it before compared to having never taken the train before holding all else constant. This is significant at the 1% level. Because of all this data hypothesis 1 is not rejected.

### 4.2 Hypothesis 2

***Hypothesis 2:*** *More people will be willing to choose the train on the Rotterdam-Paris route than the Rotterdam-Berlin route in general.*

The difference in total travel time of the train compared to the plane on the route Rotterdam-Paris is that the train is about 58 minutes quicker. When the choice experiment was asked, 84.24% of respondents indicated that they would be willing to take the quicker train over the plane, even though it was 10% more expensive. 51.63% indicated they would take the train even if it was 20 euros or about 38% more expensive. This is indicating that on this particular route with these travel times and prices, the majority of people would choose the train over the plane.

For the Rotterdam Berlin route, 3 separate trains were analysed all with different travel times and transfers but the prices were the same for all situations. When the plane was three times as expensive as the train 77.24% of participants chose the plane even though the plane was only a 2 hour and 50 minute difference in total travel time and the train had 2 total transfers. Even at a 50 (2.25 times) euro price difference 52.85% of people still chose the train. When the plane was only 15 (1.3 times or 30%) euros more expensive than the train, the majority chose the plane at a percentage of 78.05%. With the two other trains that took even longer and required 3 and 4 transfers, the percentage of the people willing to take the train at the largest price difference (the plane being about 3 times more expensive) it came down even more dramatically with Train Y being chosen 51.41% and Train Z 60.48%. In section 4.5 tables 10,11,12,13 show all these data results. At both other price points, the plane was the preferred travel method by a significant margin. Based on these results, it can be concluded that not always the cheapest option gets chosen and that people value total travel time relatively high which will be analysed further in section 4.3. Hence, hypothesis 2 is not rejected.

### 4.3 Hypothesis 3

***Hypothesis 3:*** *Willingness to pay increases the more time one saves.*

As previously stated, willingness to pay to save time on travel goes up the more time one saves according to studies done by Qin, P., Chen, Y., Cu, J., & Wang, L. (2014) and Lascelles (2008). In the survey question where participants were asked to rank the factors they find most important when it comes to travelling, the most important factor was price but the second most important factor is travel time with 29.35% ranking it number one and 37.50% ranking it as the number two most important travel factor.

When an OLS regression was performed on the willingness to pay for the slower alternative from city A to city B the importance of environmental concerns was significant at a 5% level and the importance of service quality was significant at a 1% level. If participants ranked something "1" that was what they felt is the most important factor. For this particular route, as shown in table 6, an increase in the rank of environmental concerns (environmental concerns becomes less important) with one rank is associated with a 1.92 euro increase in willingness to pay holding all else constant. Furthermore, an increase in one rank of importance of service quality (service quality becomes less important) is associated with a 3.45 euro decrease in willingness to pay holding all else constant. The willingness to pay in this case was asking how much one was willing to pay for a plane ticket (the exact question can be found in the appendix). The importance of travel time could not be defined because of singularities.

**Table 6**

| **City A - City B** | Estimate | Standard Error | T-value | P-value |
|---|---|---|---|---|
| (Intercept) | 72.5005 | 15.1503 | 4.785 | 1.84e-06 |
| Importance Price | 0.7920 | 0.7678 | 1.031 | 0.30246 |
| Importance Convenience | -0.1357 | 0.7240 | -0.187 | 0.85130 |
| Importance Environment | 1.9178 | 0.7853 | 2.442 | 0.01470 |
| Importance Comfort | 1.2803 | 1.1186 | 1.145 | 0.25256 |
| Importance Service Quality | -3.4521 | 1.2649 | -2.729 | 0.00641 |

For the route from city A - city C the results can be seen in table 7. An increase in the rank of environmental concerns (environmental concerns becomes less important) with one rank is associated with a 9.15 euro decrease in willingness to pay holding all else constant. An increase in one rank of the importance of comfort (comfort becomes less important) is associated with an 8.53 euro decrease in willingness to pay holding all else constant. Furthermore, an increase in one rank of importance of service quality (service quality becomes less important) is associated with a 5.84 euro decrease in willingness to pay holding all else constant. These are all significant at the 1% level. The willingness to pay in this case was asking how much one was willing to pay for a train ticket (the exact question can be found in the appendix). The importance of travel time could not be defined because of singularities.

**Table 7**

| **City A - City C** | Estimate | Standard Error | T-value | P-value |
|---|---|---|---|---|
| (Intercept) | 166.13343 | 10.22322 | 16.251 | < 2e-16 |
| Importance Price | 0.92609 | 0.61707 | 1.501 | 0.134 |
| Importance Convenience | 0.08744 | 0.60073 | 0.146 | 0.884 |
| Importance Environment | -9.14681 | 0.55076 | -16.607 | < 2e-16 |
| Importance Comfort | -8.52700 | 0.73477 | -11.605 | < 2e-16 |
| Importance Service Quality | -5.84235 | 0.90459 | -6.459 | 1.33e-10 |

**Figure 1**

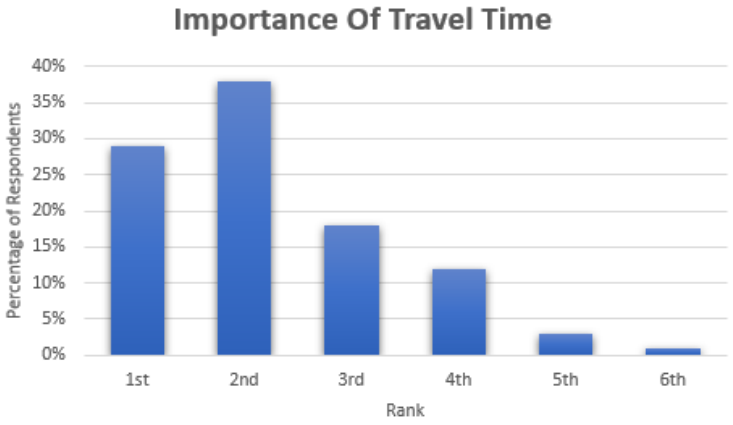


**Figure 2**


People's willingness to pay for the slower alternative was asked in comparison to a 100 euro ticket for the quicker travel situation. The results of these two willingness to pay questions are analysed to attempt to put a monetary value on time. People may have taken other factors into account when answering this question but it can be inferred that price and travel time were the biggest factors as participants were asked for their willingness to pay and the main difference was travel time between the two questions. Secondly, the overwhelming majority of participants valued price and travel time as their two most important factors when it comes to making travel decisions, thus it can be inferred that these two factors are what participants are looking at when it comes to answering the willingness to pay questions. The alternative train route for the city A to C route is what is referred to as train X in this research so it also has two additional transfers.

People who are willing to fly (alternative route) from city A to city B are willing to pay an average of 68.47 euros and a median of 72 euros if the standard method is the 100 euro train ticket from A to B saving them 58 minutes of travel time. People who are willing to take the train (alternative route) from city A to city C pay an average of 57.55 euros with a median of 60 euros when the standard method is a 100 euro plane ticket saving 2 hours and 50 minutes of travel time.

A-B (median): For 58 minutes extra travel time (33.72%) people are willing to pay 28% less.
A-C (median): For 170 minutes extra travel time (70.83%) people are willing to pay 40% less.

**Table 8**

| Variable | Observations | Mean | Median | Standard Deviation |
|---|---|---|---|---|
| WTP City A-B | 141 | 68.47518 | 72 | 25.60987 |

**Table 9**

| Variable | Observations | Mean | Median | Standard Deviation |
|---|---|---|---|---|
| WTP City A-C | 141 | 57.5461 | 60 | 25.16871 |

The majority of people did answer this willingness to pay question (141 out of 184) thus inferring that people are willing to pay more for the quicker overall travel time but in running the OLS regression showing the other factors that may have an effect on people's willingness to pay. It can be assumed that people are willing to pay more to save time but because many other factors are shown to have an effect on people's willingness to pay and two totally different travel methods are being compared hypothesis 3 is inconclusive.

### 4.4 Hypothesis 4

***Hypothesis 4:*** *People are willing to transfer more if it means they are saving on their total travel time*

In the question asking if people are willing to spend less time on a train but must transfer one time more, 60.33% of the participants chose to transfer once more to save time. This is the only question that directly supports this hypothesis, however. This can be further analysed by the contrast of the different choice experiments offered to each participant randomly as done in section 4.5. Despite the prices being offered, the two trains being compared to the same flight at 3 different price points shows results that participants are more willing to take Train Z (7:15 total travel time with 4 transfers) than Train Y (8:11 total travel time with 3 total transfers). The results here are inconclusive as the participants each chose the train at about the same rate, which can be seen in tables 10, 11, 12, and 13 in section 4.5. There is also a negative effect that shows

from the results of the choice experiment when a transfer is added (implying that people are less likely to choose the train the more transfers there are). From the results of the choice experiment as seen in table 14, for an additional transfer, people are 25.04% less likely to choose the train as a travel method compared to the plane ceteris paribus. This is significant at the 1% level. This is also simultaneously true with the fact that the odds of picking the train increase the more the difference of plane minus train time increases holding all else constant. This goes more in-depth in section 4.5 hypothesis 4: cannot be rejected

### 4.5 Hypothesis 5

| ***Hypothesis 5:*** *Price is the most important factor when it comes to making travel decisions* |
|---|

One of the most important factors people consider for transport is price. When asked which factor was the most important for the 50.54% of respondents chose price as the number one most important and 27.71% had it as their number two option. The second most important factor is travel time with 29.35% ranking it number one and 37.50% ranking it second.

Therefore, it can be expected that people will choose the cheapest travel option presented to them. This can be seen further in the choice experiments. Participants were asked which option they would be more willing to choose between City A and City B between the train and the plane at different prices.

**Table 10:** *City A to City B*

| Price Difference | Train (shorter by 58 minutes) | Plane |
|---|---|---|
| Plane 10 Euros (10%) Cheaper | 84.24% | 15.76% |
| Plane 20 Euros (38%) Cheaper | 51.63% | 48.37% |
| Train 20 Euros (43%) Cheaper | 92.93% | 7.07% |

In the first situation, however, most participants chose to take the train in all three pricing scenarios. The difference is very drastic if the price difference is 10 euros but they save 58 minutes and it is relatively even if people save 20 euros and save 58 minutes.

In the second, third, and fourth situation, analysing between city A and city C all choices given to participants are cheaper for the train but it is a significantly longer travel time. Nobody would logically choose this method if it took longer and was more expensive unless they severely cared about another issue such as environmental concerns, or comfort, or have an extremely negative attitude towards flying.

**Table 11:** *City A to City C Train X*

| Price Difference | Train X (2 Transfers) | Plane (shorter by 2:50) |
|---|---|---|
| Train 97 Euros (3 times) Cheaper | 77.24% | 22.76% |
| Train 50 Euros (2.25 times) Cheaper | 52.85% | 47.15% |
| Train 15 Euros (30%) Cheaper | 21.95% | 78.05% |

**Table 12:** *City A to City C Train Y*

| Price Difference | Train Y (3 Transfers) | Plane (shorter by 4:11) |
|---|---|---|
| Train 97 Euros (3 times) Cheaper | 50.41% | 49.59% |
| Train 50 Euros (2.25 times) Cheaper | 29.75% | 70.25% |
| Train 15 Euros (30%) Cheaper | 16.53% | 83.47% |

**Table 13:** *City A to City C Train Z*

| Price Difference | Train Z (4 Transfers) | Plane (shorter by 3:15) |
|---|---|---|
| Train 97 Euros (3 times) Cheaper | 60.48% | 39.52% |
| Train 50 Euros (2.25 times) Cheaper | 31.45% | 68.55% |
| Train 15 Euros (30%) Cheaper | 14.52% | 85.48% |

Above are the results of the choice experiments for the route city A to city C that were randomly assigned to all participants to answer two of the three scenarios. In section 4.3 the perceived monetary value of time was found for both routes.

Looking further into the Logistic regression done to analyse the choice experiments, some statements can be made about the sample.

**Table: 14**

| Coefficients | Estimate | Std. Error | Z-value | P-value |
|---|---|---|---|---|
| Intercept | 0.761569 | 0.099508 | 7.653 | 1.96e-14 |
| Plane-Train Time Difference | 0.009439 | 0.001155 | 8.174 | 2.98e-16 |
| Plane-Train Price Difference | 0.028195 | 0.002049 | 13.760 | < 2e-16 |
| Train Transfers | -0.288176 | 0.087341 | -3.299 | 0.000969 |

On the output above the factors labelled Plane-Train Time Difference and Plane-Train Price Difference are showing the time difference in minutes and price difference in euros respectively as plane minus train. The results of this research indicated that for this sample every euro increase in the difference in price increases the odds of picking the train by 2.86% ceteris paribus. This is compared with every minute increase in the difference in time increases the odds of picking the train by 0.95% ceteris paribus. These are both significant at the 1% level. Furthermore, a 3.01 total minute increase has the same effect as a one euro increase. The results for just the age group 18-25 were looked at separately as well but the results were very similar mainly due to 78.26% of respondents being in this age group. These results indicated that in this sample price is the most important factor of the factors being tested so hypothesis 5: cannot be rejected

**Table 15:**

| **Hypothesis** | **Result** |
|---|---|
| Hypothesis 1: | Not rejected |
| Hypothesis 2: | Not rejected |
| Hypothesis 3: | Inconclusive |
| Hypothesis 4: | Not rejected |
| Hypothesis 5: | Not rejected |

# 5 Conclusions and Discussion

In this research, an analysis was done to find the factors that influence the travel behaviour of people travelling the route Rotterdam-Paris and Rotterdam-Berlin. The respondents being looked at were mostly young people aged 18-25 and the two demographics being researched were Europeans and Americans to see the differences in responses between two developed areas in the world, one with a vastly available rail network and one that is severely lacking behind. The behavioural change matrix can be used for governments to enact policy changes that will help long-term as well as high-speed rail companies to convince travellers to use their services on these routes. The variables that were studied to look at what influences people the most when making travel decisions on these routes were asked to participants in the form of a survey. A discrete choice experiment was used to collect most of the data and it was analysed with a logistic regression as well as some willingness to pay questions that were analysed with an OLS regression that regressed what people's preferences were on how much they were willing to pay for an alternative travel method.

## 5.1 Discussion of Results

The factors that were clearly valued the highest above all other factors were travel-time and price. There was a significant relationship from the data that showed that if the difference in travel time described as plane minus train increased then people were more willing to choose the train holding all else constant and if the difference in price described as plane minus train increased then people were more willing to choose the train as well holding all else constant. It was also found that the more transfers a trip had, the less likely that people were willing to take the train holding all else constant. Furthermore, the percentage of money people were willing to save on each route was found in exchange for a longer travel time. People who have taken the train before were much more likely to take it again than people who have never taken the train, thus it can be inferred people tend to have a good experience with the train. Furthermore, Europeans were more likely to take the train compared to Americans, thus showing that the European market could be much easier to convince people to take the train compared to the

American market and people tend to have an overall good experience with European trains as people are willing to reuse the service.

- *Hypothesis 1 states that those who have little to no experience with trains (most likely people who live in the USA) will choose the flying options more often than those who have more experience travelling by train.* This hypothesis cannot be rejected as the overwhelming majority of people who have taken the train are more likely to do so again than those who have not taken the train before.
- *Hypothesis 2 states that more people will be willing to choose the train on the Rotterdam-Paris route than the Rotterdam-Berlin route in general.* People chose the train more often in situation 1 than in any of the other scenarios so this hypothesis cannot be rejected.
- *Hypothesis 3 states that willingness to pay increases the more time one saves* and this was shown to be inconclusive as there were many factors that had an effect on WTP. The data did show the amount people were willing to pay for the alternative travel route in the two situations which is useful information on these routes but no broad conclusions can be made about this specific hypothesis.
- *Hypothesis 4 stated that people are willing to transfer more if it means they are saving on their total travel time.* This cannot be rejected as the overwhelming majority of participants chose to transfer more for a quicker travel time and people ranked travel time higher than convenience and comfort, however, the more transfers less likely people would be willing to choose the train over the plane holding all else constant. This shows that people do not particularly like to transfer, but if there is an obvious added benefit to transfer they will.
- *Hypothesis 5 states that price is the most important factor when it comes to making travel decisions* and in this set of data this cannot be rejected according to the logistic regression.

## 5.2 Policy advice

The first thing the European governments need to do is educate the public on the benefits of high-speed rail travel. Campaigns run by government programs and non-profits would be beneficial in pointing out the benefits of travelling by high-speed rail. As seen in this study, those who have travelled by rail before are very likely to do it again, thus inferring that it was overall a very positive experience. Benefits of this high-speed rail travel must be conveyed to the public i.e. it drops you off straight in the city centre, it is more convenient, it can be faster for overall travel time compared to the plane etc. The effects of these campaigns will not be seen in the short-term and will only be seen as effective in the long-term as they are attempting to change the social norms according to the behavioural change matrix. The social norm of flying will be easier to change in European countries compared to the USA as seen in this research but depending on the government's success in the coming years the USA government could follow suit with similar policies but this would be predicted to take significantly longer. The train ultimately needs to be cheaper than it is now and the total travel time needs to be comparable to the flying alternative for people to take it.

Incentives to get people to take the train on these routes is essential to change the travel behaviour of people. Price and time were determined as the two most important factors for people, especially the youngest generation, in making travel decisions. Subsidies to bring down rail ticket costs by governments would surely encourage people to take high-speed rail more often. Secondly, a Rotterdam to Berlin high-speed train route that is affordable would be popular if it were to be around 4.5 hours, slightly longer than the total travel time for a flight currently.

## 5.3 Implications for stakeholders

All stakeholders will have major implications with this transition to HSR in the coming years. Other research and literature has shown similar implications for stakeholders in the HSR transition. Airports need to make sure that they are connected to HSR stations as this could replace short-haul domestic flights in the future. This is especially important if rail companies become competitive on the routes with lower prices and equivalent travel times. Airports may then have a stronger focus on the international, long haul flights market as a short leg in the short

hub and spoke model may be replaced by HSR. This research is essential for Airlines as they will be affected by the HSR transition as only low-cost carriers will most likely be able to survive in the coming years for leisure travel, barring any laws banning air travel, if they can keep their prices significantly lower than the HSR competitor which means keeping their profit margins as thin as possible.

Rail operators will most likely see an increase in demand in the coming years if they are operating on a competitive route and can do so at a competitive price and travel time to alternative routes. Because of the increase in demand, it is plausible that competitors will join in on the HSR market, thus forcing rail operators to improve their service according to consumer preferences.

Passengers will be affected by the transition as well as they will have more methods of travel to choose from. Passengers will choose the travel method that satisfies the most factors that they find important. Younger generations will learn from the generations that are travelling now that all these travel alternatives exist and are sufficient enough given the right circumstances.

Governments will ultimately be the ones leading the way when it comes to the HSR transition as they can offer incentives for taking HSR and short-haul flight bans. Governments can use the information in this study to implement policies such as those recommended in section 5.2.

### 5.4 Limitations

Some limitations of this research are that the survey was spread over social media and people were free to take it or refrain from taking it. The survey could have contained participants from the same cohort of people that most likely know each other and possibly have travelled together in the past. Another downside to this research is that it is a relatively small sample of only 184 participants thus making it hard to make an estimate of the overall population. Although it was expected, young people were the majority of respondents which may skew some of the responses when looking at all age groups, as younger people tend to have less income and are willing to pay less for most products and services than older people with a higher income. Furthermore, the order of each question can have a bias on the later questions as all respondents

answered the questions with situation 1 first and then the rest of the situations after. This could lead to one slightly changing their response based on the previous question but this bias is not expected to be instrumental in drastically changing the results.

### 5.5 Further Research

This research was an extension of research done by Fokker (2021). Suggestions to expand upon this research are similar to Fokker's (2021) suggestions such as further research could be looked at other HSR markets other than Rotterdam-Berlin and Rotterdam-Paris as this can possibly lead to different conclusions. Furthermore, the Rotterdam-Berlin line could be compared with the potential new HSR that is expected to be built in an attempt to predict if many passengers would take this over the existing train route and for what exact price. Suggestions for further research that can differ from Fokker's (2021) suggestions could be studying different age groups that may offer different results on these routes. Further research can also look into how much more needs to be done to enact behavioural change and to assess when the citizens of the USA are ready to use HSR as a travel option so it can be a worthy investment for all involved while using the European market as a sample to compare to. Lastly, comparing all different travel methods on these routes can find the true competitiveness of HSR. This can be done by adding buses and cars as transport methods which may offer more accurate results of what factors people value when making travel decisions.

# References


Ahlgren, L. (2022) France's Domestic Flight Ban Will Start Next Month Simple Flying Retrieved from France's Domestic Flight Ban Will Start Next Month (simpleflying.com)

Albalate, D., Bel, G., & Fageda, X. (2015). Competition and cooperation between high-speed rail and air transportation services in Europe. Journal of Transport Geography, 166-174.

Association, G. B. (2021, February 1). *Business Travel: Full Recovery Expected by 2025– GBTA | Blog*. Global Business Travel Association. Retrieved March 1, 2022, from https://www.gbta.org/blog/business-travel-full-recovery-expected-by-2025/

Amankwah-Amoah, J. (2020). Stepping up and stepping out of COVID-19: New challenges for environmental sustainability policies in the global airline industry. *Journal of Cleaner Production*, *271*, 123000.

American Journal of Agricultural Economics, 91 (2) (2009), pp. 518-534., & Pal, D. K. (2015). Likert Scale: Explored and explained. *British journal of applied science & technology*, *7*(4), 396.

Andrei, É. (2020, June 8). *Belgium to give all residents 10 free train journeys to encourage domestic tourism*. Organization: National Railway Company of Belgium — Pendect. https://pendect.com/organizations/National_Railway_Company_of_Belgium

Bazerman, M., & Tenbrunsel, A. (2011). Blind spots: Why we fail to do what's right and what to do about it. Princeton: Princeton University Press.

Berkowitz, AD & Perkins, HW (1986A). Problem Drinking Among College Students: A Review of Recent Research. Journal of American College Health, 35:21-28.

Breidert, C., Hahsler, M., & Reutterer, T. (2006). A Review of Methods for Measuring Willingness-to pay. Innovative Marketing, 1-32.

BBC News. (2021, April 12). *France moves to ban short-haul domestic flights*. https://www.bbc.com/news/world-europe-56716708#:%7E:text=French%20lawmakers%20have%20moved%20to%20ban%20short-haul%20internal,hours.%20Connecting%20flights%20will%20not%20be%20affected%2C%20however.

*Carbon Footprint*. (2021). EUR Sustainability. https://sustainabilityreport.eur.nl/rapporten/sustainability-report-2021/carbon-footprint#highlights-and-achievements-of-2021

Carlos Martín, J., Román, C., & Espino, R. (2008). Willingness to Pay for Airline Service Quality. *Transport Reviews*, *28*(2), 199–217.

CBS. (2017, August 2). *Nearly 10 million people on holiday during high season*. https://www.cbs.nl/en-gb/news/2017/29/nearly-10-million-people-on-holiday-during-high-season

Chandon, P., Smith, R. J., Morwitz, V. G., Spangenberg, E. R., & Sprott, D. E. (2011). When Does the Past Repeat Itself? The Interplay of Behavior Prediction and Personal Norms. *Journal of Consumer Research*, *38*(3), 420–430.

Chang, J. B., Lusk, J. L., & Norwood, F. B. (2009). How Closely Do HypotheticalSurveys and Laboratory Experiments Predict Field Behavior? *American Journal of Agricultural Economics*, *91*(2), 518–534.

Cook, G., & Goodwin, J. (2008). Airline Networks: A Comparison of Hub-and-Spoke and Point-to-Point Systems. *Journal of Aviation/Aerospace Education & Research*.

Chen, X., Huang, B., & Lin, C. T. (2019). Environmental awareness and environmental Kuznets curve. *Economic Modelling*, *77*, 2-11.

Chowdhury, S., Ceder, A. A., & Schwalger, B. (2015). The effects of travel time and cost savings on commuters' decision to travel on public transport routes involving transfers. *Journal of Transport Geography*, *43*, 151–159.

*DB-Konzern - Facts & Figures*. (2008). Deutsche Bahn. https://web.archive.org/web/20090426010642/http://www.deutschebahn.com/site/bahn/en/db__group/corporate__group/ata__glance/facts__figures/facts__figures.html

David G., (2016, December 3). *High-Speed Rail Is Killing Short-Haul Air Travel*. Travel Stats Man. https://www.travelstatsman.com/08082016/high-speed-rail-train-plane/

De Haan, F., Kerkemezos, Y (2021). Airports. Lecture conducted from Erasmus University Rotterdam, the Netherlands

Eurostar. (2022). Eurostar. https://www.eurostar.com/nl-nl

European Commission. (2010). High Speed Europe. European Commission.

Fehr, G., Kamm, A., & Jäger, M. (2014). The Behavioral Change Matrix: A tool for evidence-based policy making. Zürich: FehrAdvice & Partners AG.

Feigenbaum, B. (2013). High-speed rail in Europe and Asia: lessons for the United States. *Policy Study*, *418*, 1-39.

Fernandez, J. (2019, June 25). *Global Rail Investment on the Rise but the U.S. Lags Behind – Here's Why*. Trapeze Group. https://www.trapezegroup.com/blog-entry/global-rail-investment-on-the-rise-but-the-us-lags-behind-heres-why

Finch, C. (2021, November 20). *Advantages & Disadvantages of Ranking Scales*. Bizfluent. https://bizfluent.com/list-5966451-advantages-disadvantages-ranking-scales.html

*First Quarter 2019 U.S. Airline Financial Data*. (2019, July 17). Bureau of Transportation

Flixbus (2021 global.fluxbus https://global.flixbus.com/

Fokker, R. (2021, April 17). *High speed rail versus air travel on short haul destinations*. *Business Economics*.

Fu, X., Homsombat, W., & Oum, T. H. (2011). Airport–airline vertical relationships, their effects and regulatory policy implications. *Journal of Air Transport Management*, *17*(6), 347-353.

Goodwin, P., Cairns, S., Dargay, J., Hanly, M., Parkhurst, G., Stokes, G., & Vythoulkas, P. (2004). Changing travel behaviour.

Googleflights (2022) Googleflights. https://www.google.com/travel/flights

Guardian News and Media. (2022, May 29). *Train to nowhere: Can California's high-speed rail project ever get back on track?* The Guardian. Retrieved June 15, 2022, from https://www.theguardian.com/us-news/2022/may/29/california-high-speed-rail-bullet-train

Gracia, A., Loureiro, M. L., & Nayga Jr, R. M. (2009). Consumers' valuation of nutritional information: a choice experiment study. *Food Quality and Preference*, *20*(7), 463-471.

Graham, A. (2009). How important are commercial revenues to today's airports? Journal of Air Transport Management vol. 15, 106-111.

Ghosh, D., & Profile, V. M. C. (2017, October 26). *Bullet train*. Evolving Perceptions. https://evolvingperceptions6.blogspot.com/2017/10/bullet-train.html

Hagler Y., Todorovich P., (2009) Where High-Speed Rail Works Best – America 2050

https://s3.us-east-1.amazonaws.com/rpa-org/pdfs/Where-HSR-Works-Best.pdf#:~:text=The%20competitive%20advantage%20of%20high-speed%20rail%20over%20other,500%20miles%20are%20more%20efficiently%20travelled%20by%20air.

Harrison, G. W., & Rutström, E. E. (2008). Experimental evidence on the existence of hypothetical bias in value elicitation methods. *Handbook of experimental economics results*, *1*, 752-767.

Hanemann, W. (1991). Willingness To Pay and Willingness To Accept: How Much Can They Differ? The American Economic Review vol. 81, 635-647.

Hares, A., Dickinson, J., & Wilkes, K. (2010). Climate change and the air travel decisions of UK tourists. *Journal of Transport Geography*, *18*(3), 466–473. https://doi.org/10.1016/j.jtrangeo.2009.06.018\

Hechter, M., & Opp, K. D. (Eds.). (2001). Social norms.

Hosmer, D., & Lemeshow, S. (2013). *Applied Logistic Regression - Second Edition.* New York: Wiley

IATA. (2015). *Global Passenger Survey 2015*. IATA

Ito, T. A., Urland, G. R., Willadsen-Jensen, E., & Correll, J. (2006). The social neuroscience of stereotyping and prejudice: Using event-related brain potentials to study social perception. *Social neuroscience: People thinking about thinking people*, 189-212.

Iyer, C. (2022, January 14). *Is Consent and Preference Management the Key to Balancing Privacy and Personalization?* CMSWire.Com. https://www.cmswire.com/digital-marketing/is-consent-and-preference-management-the-key-to-balancing-privacy-and-personalization/

Janic, M. (2003). High-speed rail and air passenger transport: a comparison of the operational environmental performance. Journal of Rail and Rapid Transit 217, 259-269.

Jankovec, O (2016) *The Ownership of Europe's Airports.* Airports Council International

Jiang, C., & Zhang, A. (2016). Airline network choice and market coverage under high-speed rail competition. Transportation Research Part A: Policy and Practice vol. 92, 248-260.

Jones, T. L., Baxter, M., & Khanduja, V. (2013). *A quick guide to survey research.* The Annals of The Royal College of Surgeons of England, 95(1), 5-7.

Joshi, A., Kale, S., Chandel, SJ.B. Chang, J.L. Lusk, Norwood F.B.

Kopestinsky, A. (2021). *Average Miles Driven per Year in the USA | Policy Advice*. Policy Advice. https://policyadvice.net/insurance/insights/how-much-do-americans-drive/

*Lack of competitive pressure facilitates high profit margins at airports*. (2016, December 2). YOW. https://yow.ca/en/media-center/cta-review/lack-competitive-pressure-facilitates-high-profit-margins-airports

Lascelles, Ashley, "Alternative Methods Of Eliciting Individual Willingness To Pay For Travel Time Savings: A Pilot Study" (2008). Electronic Theses and Dissertations, 2004-2019. 3540. https://stars.library.ucf.edu/etd/3540

Lawrence, M., Bullock, R., & Liu, Z. (2019). *China's high-speed rail development*. World Bank Publications.

Logan, M. (2021, March 10). The Hub-and-Spoke Model of Air Travel | My American Odyssey. My American Odyssey | Discovering America One Town at a Time. https://myamericanodyssey.com/the-hub-and-spoke-model-of-air-travel/

McFadden, D. (1973). Conditional logit analysis of qualitative choice behavior. pp. 105-142

McKight, P. E., & Najab, J. (2010). Kruskal‐wallis test. *The corsini encyclopedia of psychology*, 1-1.

Minguardo, G (2021). Introduction lecture: course structure + Key concepts in Behavioural Economics Lecture conducted from Erasmus University Rotterdam, the Netherlands

Ortiz-Ospina, E. (2019). *The rise of social media*. Our World in Data. https://ourworldindata.org/rise-of-social-media#:%7E:text=Facebook%2C%20the%20largest%20social%20media%20platform%20in%20the,with%20at%20least%203.5%20billion%20of%20us%20online.

Poole, R. (2020, December 4). *On High-Speed Rail, Look at the Costs and Results Before You Leap*. Reason Foundation. https://reason.org/commentary/on-high-speed-rail-look-at-the-costs-and-results-before-you-leap/

*Press corner*. (2021). European Commission - European Commission. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_364

Rambonilaza, M., & Dachary-Bernard, J. (2007). Land-use planning and public preferences:

What can we learn from choice experiment method?. *Landscape and urban planning*, *83*(4), 318-326.

Rosenthal, E. (2009). *What Makes Europe Greener than the U.S.?* Yale E360. https://e360.yale.edu/features/what_makes_europe_greener_than_the_us

Sauro, J., PhD. (2016). *9 Biases That Affect Survey Responses – MeasuringU*. Measuring U. https://measuringu.com/survey-biases/

Schwirplies, C., Dütschke, E., Schleich, J., & Ziegler, A. (2019). The willingness to offset CO2 emissions from traveling: Findings from discrete choice experiments with different framings. *Ecological Economics*, *165*, 106384.

Sheldon, K. M., & Kasser, T. (2001). Getting older, getting better? Personal strivings and psychological maturity across the life span. *Developmental Psychology, 37*(4), 491–501.

Skyscanner. (2022). Skyscanner. Retrieved from Skyscanner: http://www.skyscanner.nl

Small, K. A. (2012). Valuation of travel time. *Economics of Transportation*, *1*(1–2), 2–14.

*Special report: A European high-speed rail network*. (2018). European Court of Auditors. https://op.europa.eu/webpub/eca/special-reports/high-speed-rail-19-2018/en/

Spoorpro. (2020, February 13). NS: snellere trein Amsterdam Berlijn pas vanaf 2024. Retrieved from Spoorpro: https://www.spoorpro.nl/materieel/2020/01/30/ns-snellere-trein-amsterdamberlijn-pas-vanaf-2024/?gdpr=accept

Statistics. https://www.bts.gov/newsroom/first-quarter-2019-us-airline-financial-data

Stothard, M. (2016, November 13). *France: The politics of state ownership*. Financial Times. https://www.ft.com/content/9be75d5c-a72e-11e6-8898-79a99e2a4de6

Thalys (2007). *Thalys: Thalys : corporate*. https://web.archive.org/web/20071217071047/http://www.thalys.com/be/en/about-thalys/corporate

*The Paris Agreement | UNFCCC*. (2016). United Nations. https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

Trainline (2022) Trainline. Retrieved from Tranline Goedkope trein- en buskaartjes in Nederland en Europa | Trainline (thetrainline.com)

*TRANSFORuM*. (2015, June 11). Transforum-Project.

http://www.transforum-project.eu/high-speed-rail.html#:%7E:text=The%20White%20Paper%20Goals%20High-Speed%20rail%20is%20an,a%20dense%20railway%20network%20in%20all%20Member%20States.

Uppink, L. (2021, July 2). *Sustainable aviation fuel is the key to the future of flying*. World Economic Forum. https://www.weforum.org/agenda/2021/07/the-future-of-flying-is-closer-than-ever-sustainable-fuel-is-the-key/?msclkid=2d31efe0d11f11eca94abcf4ad477c68

Van Loo, E. J., Caputo, V., Nayga Jr, R. M., Meullenet, J. F., & Ricke, S. C. (2011). Consumers' willingness to pay for organic chicken breast: Evidence from choice experiment. *Food quality and preference*, *22*(7), 603-613.

Wan, Y., Ha, H. K., Yoshida, Y., & Zhang, A. (2016). Airlines' reaction to high-speed rail entries: Empirical study of the Northeast Asian market. *Transportation Research Part A: Policy and Practice*, *94*, 532–557.

Wang, K., Xia, W., Zhang, A., & Zhang, Q. (2018). Effects of train speed on airline demand and price: Theory and empirical evidence from a natural experiment. *Transportation Research Part B: Methodological*, *114*, 99-130.

Wensveen, J. G. (2016). The Airline Industry. In *Air Transportation* (pp. 163-194). Routledge.

Williams, O. A. (2021, June 30). *Boomers Versus Millennials: Which Generation Is More Environmental?* Forbes. https://www.forbes.com/sites/oliverwilliams1/2020/02/17/boomers-versus-millennials-which-generation-is-more-environmental/?sh=313762c75718

Xia, W., & Zhang, A. (2017). Air and high-speed rail transport integration on profits and welfare: Effects of air-rail connecting time. Journal of Air Transport Management 65, 181-190.

Yang, Y., Wang, C., Liu, W., & Zhou, P. (2018). Understanding the determinants of travel mode choice of residents and its carbon mitigation potential. Energy Policy vol. 115, 486-493

Zach, Z. (2022, March 7). *Kruskal-Wallis Test: Definition, Formula, and Example*. Statology. https://www.statology.org/kruskal-wallis-test/

Zhang, R., Johnson, D., Zhao, W., & Nash, C. (2019). Competition of airline and high-speed rail in terms of price and frequency: Empirical study from China. Transport Policy vol. 78, 8-18.

# Appendix 1: Survey

Below is the survey that was sent to participants:

City A: Rotterdam
City B: Paris
City C: Berlin

Questionnaire Questions:
Welcome, my name is Kees, and thank you for taking the time to participate in this master thesis survey. The following survey will ask questions about your travel behaviour. All responses are anonymous. The survey should take about 5 minutes to complete. This survey will not collect any personal data and the results will only be used for this thesis research and will not be used for commercial purposes.

If you have any questions please email them to 610872kv@eur.nl

By checking the 'I agree' box below you confirm that you are at least 18 years of age and that you understand you have the right to exit this survey at any time.

- I agree

Which describes most accurately where you currently live?

- USA west coast
- USA Central
- USA East Coast
- Europe
- Other

How often do you fly per year assuming there are no COVID restrictions at all in that year (round trip flight = 1)?

- Never
- Less than once a year to 3 times a year
- 4-5 times
- More than 5

(USA AND OTHER) QUESTION

How often do you take the train on trips longer than 2 hours assuming there are no COVID restrictions at all in that year (round trip train=1)?

- Never
- Less than once a year to 3 times a year
- 4-5 times
- More than 5

EUROPE QUESTION

How often do you take the train on trips internationally assuming there are no COVID restrictions at all in that year (round trip train=1)?

- Never
- Less than once a year to 3 times a year
- 4-5 times
- More than 5

IF THEY ANSWER NEVER TO THE QUESTION ABOVE THEY SKIP THE RESPECTIVE QUESTIONS BELOW

What is your overall attitude towards flying in a plane for travel (on a scale of 1-5; 1 being extremely negative and 5 being extremely positive)?

- Extremely negative (1)
- Somewhat negative (2)
- Neither positive nor negative (3)
- Somewhat positive (4)
- Extremely positive (5)

What is your overall attitude towards travelling by train (on a scale of 1-5; 1 being extremely negative and 5 being extremely positive)?

- Extremely negative (1)
- Somewhat negative (2)
- Neither positive nor negative (3)
- Somewhat positive (4)
- Extremely positive (5)

**Situation 1:**

The following questions are hypothetical situations where you will be asked to pick certain trips that you want to take between City A and other cities. Important notes about this situation are:

- All these trips are one-way tickets.
- Assume that you are already at the location of departure and that you can freely choose your time of departure
- Please note that trains and planes are economy class of average service and comfort quality
- Trains have more legroom than planes and no security checks
- You have one piece of luggage with you and the fare shown is everything included
- Assume all train stations are in the city centre which is where your final destination is
- CO2 emissions per passenger are about 80% less by train than by plane.

Please note the following two travel situations:

| Transport Method | Plane | Train |
|---|---|---|
| Departure Area | City A Airport | City A Train Station |
| Arrival Area | City B Airport | City B Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 2:37 |
| Airport to Centre Travel Time | 45 minutes | 0 |
| Total Time | 3:50 | 2:52 |

1. Which of the following travel methods would you choose at the given price?

- Plane 100 Euros
- Train 110 Euros

2. Assuming the same travel situation as above, which of the following travel methods would you choose at the given price?

- Plane 52 Euros
- Train 72 Euros

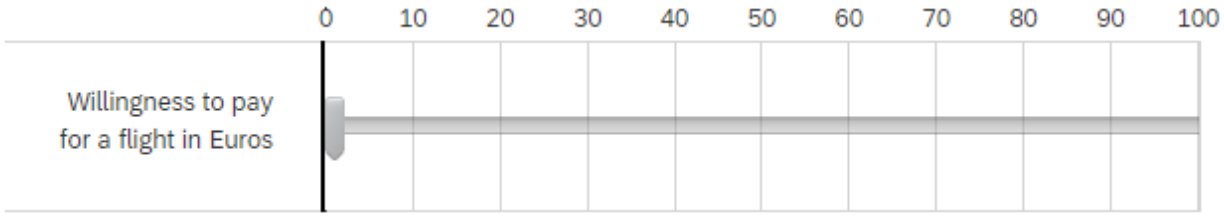
3. Assuming the same travel situation as above, which of the following travel methods would you choose at the given price?

- Plane 67 Euros
- Train 47 Euros

Note the two travel methods below:

| Transport Method | Plane | Train |
|---|---|---|
| Departure Area | City A Airport | City A Train Station |
| Arrival Area | City B Airport | City B Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 2:37 |
| Airport to Centre Travel Time | 45 minutes | 0 |
| Total Time | 3:50 | 2:52 |

Knowing that the train in this case costs 100 euros what is the MOST you are willing to pay for a plane ticket from City A to City B (SKIP if you would rather take the train regardless of price)



PARTICIPANTS WILL RECEIVE TWO OF THE THREE FOLLOWING SITUATIONS

**Situation 2:**

(The bullet points below are repeated for every scenario for your convenience)

- All these trips are one-way tickets
- Assume that you are already at the location of departure and that you can freely choose your time of departure
- Please note that trains and planes are economy class of average service and comfort quality
- Trains have more legroom than planes and no security checks
- You have one piece of luggage with you and the fare shown is everything included
- Assume all train stations are in the city centre which is where your final destination is
- CO2 emissions per passenger are about 80% less by train than by plane

Please note the NEW following two travel situations and the differences in total travel times:

| Transport Method | Plane | Train X |
|---|---|---|
| Departure Zone | City A Airport | City A Train Station |
| Arrival Zone | City C Airport | City C Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 6:35 |
| Airport to Centre travel time | 55 minutes | 0 |
| Total Time | 4 hours | 6:50 |
| Number of Transfers | 0 | 2 |

1. Which of the following travel methods would you choose at the given price?

- Plane 145 Euros
- Train 48 Euros

2. Assuming the same travel situation as above, which of the following travel methods would you choose considering the different options below?

- Plane 90 Euros
- Train 40 Euros

3. Assuming the same travel situation as above, which of the following travel methods would you choose considering the different options below?

- Plane 65 Euros
- Train 50 Euros

**Situation 3:**

(The bullet points below are repeated for every scenario for your convenience)

- All these trips are one-way tickets.
- Assume that you are already at the location of departure and that you can freely choose your time of departure
- Please note that trains and planes are economy class of average service and comfort quality
- Trains have more legroom than planes and no security checks
- You have one piece of luggage with you and the fare shown is everything included
- Assume all train stations are in the city centre which is where your final destination is
- CO2 emissions per passenger are about 80% less by train than by plane.

Please note the NEW following two travel situations and the differences in total travel times:

| Transport Method | Plane | Train Y |
|---|---|---|
| Departure Zone | City A Airport | City A Train Station |
| Arrival Zone | City C Airport | City C Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 7:56 |
| Airport to Centre travel time | 55 minutes | 0 |
| Total Time | 4 hours | 8:11 |
| Number of Transfers | 0 | 3 |

1. Which of the following travel methods would you choose at the given price?

- Plane 145 Euros
- Train 48 Euros

2. Assuming the same travel situation as above, which of the following travel methods would you choose considering the different options below?

- Plane 90 Euros
- Train 40 Euros

3. Assuming the same travel situation as above, which of the following travel methods would you choose considering the different options below?

- Plane 65 Euros
- Train 50 Euros

**Situation 4:**

(The bullet points below are repeated for every scenario for your convenience)

- All these trips are one-way tickets.
- Assume that you are already at the location of departure and that you can freely choose your time of departure
- Please note that trains and planes are economy class of average service and comfort quality
- Trains have more legroom than planes and no security checks
- You have one piece of luggage with you and the fare shown is everything included
- Assume all train stations are in the city centre which is where your final destination is
- CO2 emissions per passenger are about 80% less by train than by plane.

Please note the NEW following two travel situations and the differences in total travel times:

| Transport Method | Plane | Train Z |
|---|---|---|
| Departure Zone | City A Airport | City A Train Station |
| Arrival Zone | City C Airport | City C Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 7 hours |
| Airport to Centre travel time | 55 minutes | 0 |
| Total Time | 4 hours | 7:15 |
| Number of Transfers | 0 | 4 |

1. Which of the following travel methods would you choose at the given price?

- Plane 145 Euros
- Train 48 Euros

2. Assuming the same travel situation as above, which of the following travel methods would you choose considering the different options below?

- Plane 90 Euros
- Train 40 Euros

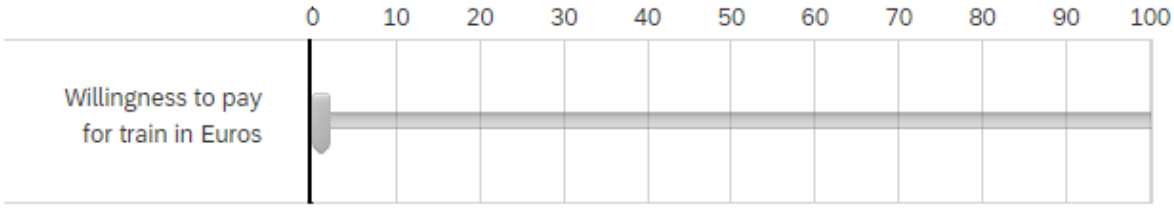
3. Assuming the same travel situation as above, which of the following travel methods would you choose considering the different options below?

- Plane 65 Euros
- Train 50 Euros

Note the two travel methods below:

| Transport Method | Plane | Train |
|---|---|---|
| Departure Zone | City A Airport | City A Train Station |
| Arrival Zone | City C Airport | City C Train Station |
| Check in Process | 1:45 | 15 minutes |
| Travel Time | 1:20 | 6:35 |
| Airport to Centre travel time | 55 minutes | 0 |
| Total Time | 4 hours | 6:50 |
| Number of Transfers | 0 | 2 |

Knowing that the plane in this case costs 100 euros what is the MOST you are willing to pay for the train from City A to City C (SKIP if you would rather take the plane regardless of price)




Let's say you MUST travel by train from City A to City C . Which train trip would you most likely choose?

- Train Y: Total time: 8:11; 3 total transfers; (40 euros)
- Train Z: Total time: 7:15; 4 total transfers; (40 euros)

Let's say you MUST travel by train from City A to City C . Which train trip would you most likely choose?

- Train X: Total time: 6:50; 2 total transfers; (70 euros)
- Train Y: Total time: 8:11; 3 total transfers; (40 euros)
- Train Z: Total time: 7:15; 4 total transfers; (50 euros)

Let's say you need to get from City A to City C by either train or plane. Which method would you want to choose the most?

- Train X: Total time: 6:50; 2 total transfers; (60 euros)
- Train Y: Total time: 8:11; 3 total transfers; (40 euros)
- Train Z: Total time: 7:15; 4 total transfers; (50 euros)
- Flight from City A and public transport from City C airport to City C Centre: Total time 3:00 (88 euros)

Let's say you need to get from City A to City C by either train or plane. Which method would you want to choose the most?

- Train X: Total time: 6:50; 2 total transfers; (40 euros)
- Train Y: Total time: 8:11; 3 total transfers; (48 euros)
- Train Z: Total time: 7:15; 4 total transfers; (55 euros)
- Flight from City A and public transport from City C airport to City C Centre: Total time 3:00 (58 euros)

Sort the characteristics by order of importance when making travel decisions in your opinion (1 being most important and 6 being least important)

- Price
- Convenience
- Environmental concerns
- Total travel time
- Comfort
- Service quality

How old are you?

- 18-25
- 26-40
- 41-55
- 56-70
- 71 and older

What is your gender?

- Male
- Female
- Other
- Prefer not to say

What is your Employment Status?

- Employed part-time
- Employed part-time and student
- Employed full-time
- Unemployed
- Retired
- Student only