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Full-Scale Socio-Economic

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Prediction of hyperloop track usage

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Abstract

This research focuses on predicting the use and utilisation of the Hyperloop, an innovative transport technology. The Hyperloop is based on the concept of vacuum tubes and magnetic levitation systems. Passenger capsules travel at high speed through a tube, which minimises friction and allows impressive travel speeds of up to 1,200 km/h to be achieved. The challenge is that the Hyperloop has not yet been developed and realised for passenger or freight transport, and the concept is still in its early phases. The aim is to predict the capacity utilisation of an Hyperloop route connection between Zurich and Paris. Various factors such as travel times, potential travel needs, and ticket prices are to be analysed. This should enable a reliable assessment of the profitability and potential of the connection and the innovative transport system. A methodology was defined for the development of this research project. Initially, the basics of the Hyperloop, the various means of transportation and the basis for decision-making are to be researched. In addition, a survey with ten questions is part of the methodology. Furthermore, two personas are to be created from the information from the research and the survey results. Moreover, the CO2 emissions of the Hyperloop connection from Zurich to Paris are to be estimated to take green technologies into account. The results show that there is acceptance for a Hyperloop system and that people would use the Hyperloop. The main factors to be considered are safety and cost-effectiveness. For the future, the aspects of low costs, safety and efficient or short travel times apply to a general mode of transportation. These factors are consistent with the Hyperloop technology, whereby long journeys can be shortened, traffic can be relieved and energy consumption can be significantly reduced compared to conventional forms of transportation. By choosing the Hyperloop instead of the aeroplane from Zurich to Paris, it is roughly estimated that 2,279 hot coffees could be brewed.

Statement of Contribution

Name	Affiliated with	Chapter number	Contribution
Laura Egli	HSLU/Swissloop	ALL	Wrote
Simon Züst	HSLU	ALL	Gave advice
Roberto Molinari	Swissloop	ALL	Gave advice, Reworking text

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BIM	Building Information Modelling
CHF	Swiss francs
CO2	Carbon Dioxide
DIY	Do-it-yourself
GJ	Giga Joule
HSLU	Hochschule Luzern
kWh	Kilowatt-hour
UVEK	The Swiss Federal Department of the Environment, Transport, Energy and Communications

1 Introduction

The world is changing dynamically every day and innovative technologies are becoming increasingly important. The dynamic and transformative evolution poses difficult challenges that bring opportunities but also demand sophisticated solutions. Transport is currently a major challenge, as the population continues to grow, and some modes of transportation are reaching their limits in certain areas. In addition, the sustainability aspect has become more and more significant.
This project aims to explore the expected usage of an innovative solution for the future high-speed transport system.

1.1 Aim and Objectives

The aim of this project is to determine the capacity utilisation of a Hyperloop connection from Zurich to Paris. In addition, the viability, potential and efficiency must also be assessed. Thereby it will provide decision-makers in the field of Hyperloop transportation with valuable information for the planning and optimisation of this specific route between Zurich and Paris. Through the analysis of comparative data with competing transportation systems, the potential advantages, and disadvantages of the Hyperloop in terms of efficiency will be highlighted. The results of this research will serve as a basis for future planning decisions and contribute to the development of sustainable and efficient mobility.

1.2 Research questions

As the Hyperloop concept is still in its early stages and has not been realised yet, there are many open questions and challenges. One unresolved aspect concerns the future utilisation and demand from potential customers and passengers. This raises the question of whether such a system is necessary or not. Therefore, the goal of this research is to predict the utilisation of a Hyperloop connection between Zurich and Paris.

There are three important and significant aspects of the research.

1. How resilient is the system of the Hyperloop in the future?
2. Will people change their mode of transportation because of a new Hyperloop connection between Zurich and Paris?
3. By which price would people travel from Zurich to Paris with the Hyperloop?

2 Fundamentals

The basic chapter represents the current state of knowledge on which the work is based and introduces the topic.

2.1 Utilisation of current transportation methods

In this chapter, the current capacity utilisation of the entire transport sector in Switzerland is researched and examined. This allows the current situation to be analysed and the status of the transport system to be assessed. In addition, a deeper understanding of the efficiency and cost-effectiveness of the existing transport system can be determined.
Nowadays, the range of different means of transport is extensive. The progressive transportation was accomplished by the digital transformation and the constant development of technologies. The following modes of transportation are established and well-known by people; Car, taxi, uber, bicycle or e-bike, pedestrian, motorbike or scooter, bus, big bus, tram, metro or subway, train, plan as well cruise ship or ferry.

The Swiss Federal Statistical Office regularly collects important data on the mobility behaviour of the Swiss population. By this analysis of the census on a representation basis of mobility and transportation supports the data basis for decision-making in planning strategy. In addition, identify the observation of transport behaviour as choice and function of the conveyance, daily distance, and travel time. The information of the federal office provides a basis for future strategies. This project focuses on the Swiss statistics for 2021 and 2023 (Mobility and Transport, 2023).
In 2021, every inhabitant in Switzerland travelled an average of 30.0 km per day within the country. Thereby the Swiss population spent 80.2 minutes on the daily basis in traffic. On this, the main purpose of travel was leisure with 41.6 minutes per day. This was followed by work, shopping, education, and other things (Mobilitätsverhalten der Bevölkerung, 2021).
Moreover, it was also analysed that passenger transport was growing faster than the population by 2019. This development is depicted in Figure 1. From 2005 to 2020 the utilisation of transportation has increased in all sectors. In the period 2020 to 2022, there was a decline in demand of transportation and the mobility, which was affected because of the Corona pandemic. However, in the meantime the situation has changed, and the usage has modified.

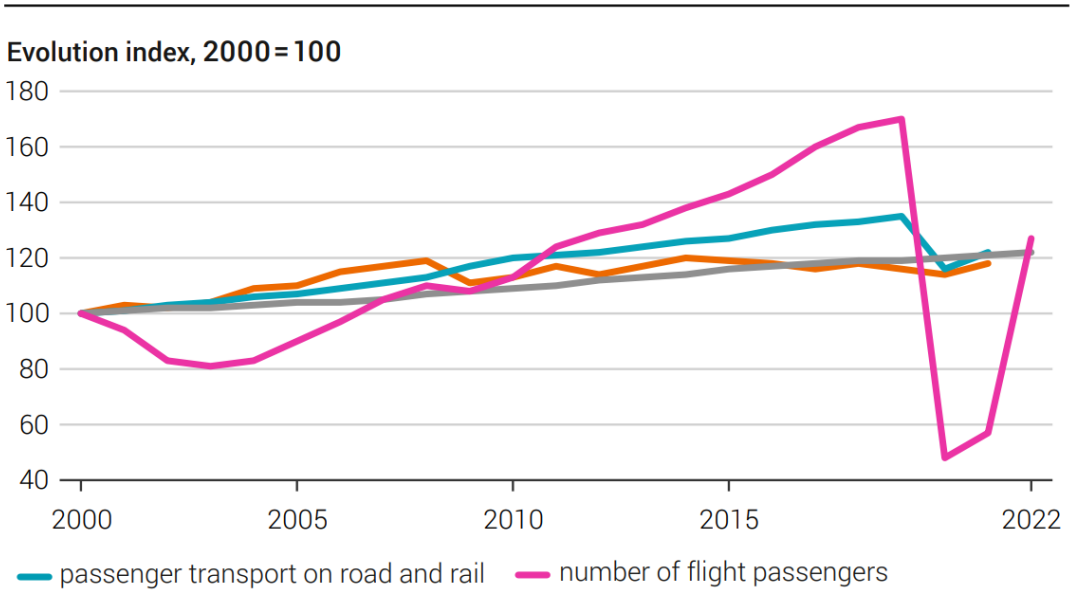


Figure 1: Change in transportation usage from 2000 to 2022 (Mobility and Transport, 2023).

It was further noted that transport infrastructure covers an area more than 1.5 times the size of Lake Geneva. According to the 2013 and 2018 data collection, roads and highways require the most space for all infrastructure, what can be observed in Figure 2. Conforming to data from the Swiss Federal Statistical Office, the network of roads for cars had in 2022 a length of 84,675 km. The network of the railway has since the last update a length of 5,317 km. Switzerland has a highly developed public transport infrastructure. The railways, buses and trams have a total of 24,752 stops and stations.

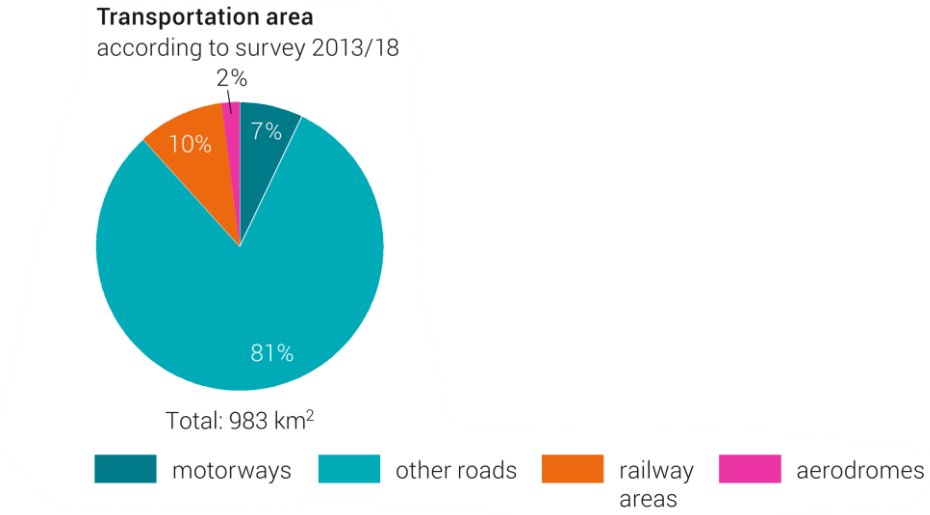


Figure 2: Division of the transport infrastructure (Mobility and Transport, 2023).

Another topic that was analysed in the research is which means of transportation is used the most. Passenger cars covered the highest shares of means of transport in the person-kilometres, which is shown in Figure 3. The automobile is the most used method of transportation. In 2021, there were more than 6.6 million motor vehicles on the roads in Switzerland. Of the total passenger kilometres travelled, 74% were done by motor vehicle, 11% by rail and 5% by bicycle.

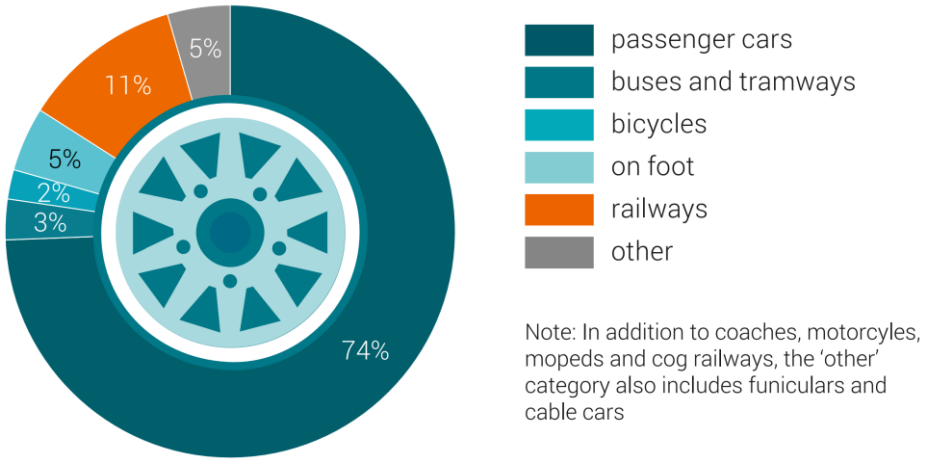


Figure 3: Shares of means of transport in the person-kilometres (Mobility and Transport, 2023).

In Switzerland, the automobile exhibits the highest modal share in the transportation sector when compared to other modes of mobility. This observation is consistently evident across all member states of the European Union. The automobile represents the most frequently utilised means of

transportation, with Switzerland having the lowest share at 74%. In contrast, Lithuania and Portugal report automobile usage shares exceeding 90%. The average value for the automobile in the European Union stands at 87.2%. Furthermore, the infrastructure and utilisation of trains in Switzerland surpass those of other European Union member states. Following Switzerland, Austria, France, the Czech Republic, the Netherlands, and Sweden exhibit notable performance in this regard. The average share of these states in the total transportation load attributed to trains amounts to approximately 7.8% (Palm, 2022).

In the field of logistics, the transport network changed considerably. The volume of transported goods has increased significantly, almost doubling between 1980 and 2021. A substantial allotment of this goods transportation, approximately 63%, occurred through road transport, while the remaining 37% was attributed to rail transport. Within the area of road transport, domestic transportation clearly prevails, representing approximately 66% of the total tonne-kilometres. Similarly, in the domain of rail transport, transit transportation dominated with a share of approximately 66% of the overall domestic transport volume (Passenger transport performance, 2022). The comparison between domestic road traffic and transit rail traffic is depicted in Figure 4.

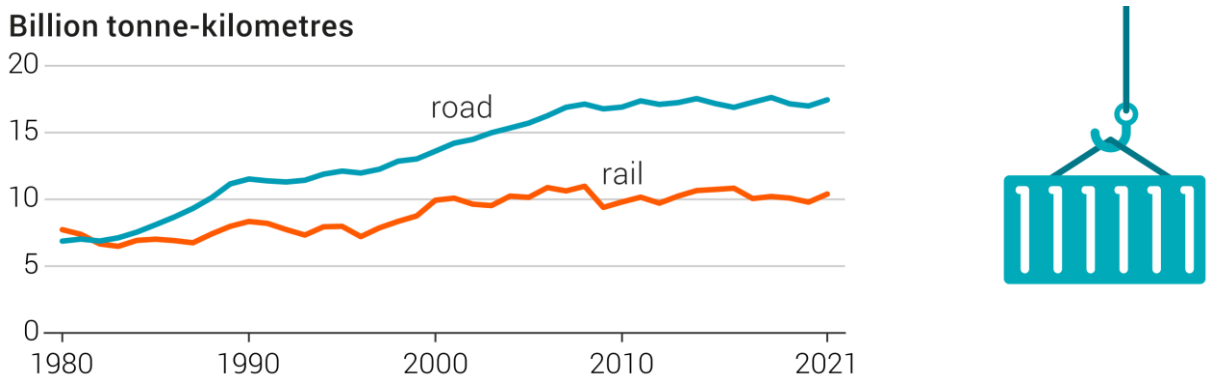


Figure 4: Comparison of Domestic Traffic and Transit Traffic (Mobility and Transport, 2023).

The safety of the various means of transportation was also reviewed and has as well an influence on road users and the choice of transport. The aeroplane is the safest mode of transportation. This is followed by the ship, train, bus, car, bicycle, pedestrian, and the most dangerous means of transport is the motorbike.
In another study, the different countries in Europe were compared against each other. In the year 2020, Romania reported the highest fatality rate in road accidents among the European Union Member States, with 85 deaths per one million inhabitants. Conversely, the lowest fatality rates were documented in Malta (23 deaths per million inhabitants) and Sweden (20 deaths per million inhabitants). Most of the EU Member States saw a reduction in the fatality rates from road accidents in 2020 when compared to 2019. Notable exceptions to this trend were observed in Estonia, Luxembourg, Latvia, Finland, and Ireland. It is worth noting that the trend in the number of fatal road accidents can exhibit considerable volatility, especially in the case of smaller countries. Switzerland also performs well in this regard, ranking fourth lowest in terms of traffic fatalities. This underscores the presence of a generally secure transportation network in Switzerland (Kelly, 2022).

Energy consumption and CO2 emissions have also gained attention. Proportionally, transport causes the most emissions in Switzerland. Transport is responsible for 39 percent of all greenhouse gas emissions in Switzerland. Moreover, mass transport contaminated the health due to fine dust and noise emissions. A reason for this is that 2/3 of the Swiss population travels by car and cannot relinquish. Unfortunately, there has been little progress in the transport sector in terms of sustainability (Sustainable Switzerland, 2023).

To get a better estimate of the emissions, here is a comparison. An aeroplane consumes an average of 223.9 kg of CO2 per Person for the route between Zurich and Paris with average occupancy (Rundfunk, 2023). A car needs half as much for the same distance and a train 46 times less than an aeroplane, amounting to 4.9 kg of CO2 per Person. The aviation sector has been the largest emitter of greenhouse gases in Switzerland since 2015, ahead of all other mobility. Swiss citizens fly twice as much as citizens of neighbouring countries (Mein Klimaschutz, 2020).

The costs of the entire transport sector are also researched and compared. This is part of the assessment of economic viability and further feasibility. The consideration of costs is essential. In 2019, Switzerland incurred total transportation costs of 96.3 billion Swiss Francs, which is depicted in Figure 5. Of this amount, 80% was attributed to road-based passenger transportation, 12.5% to rail transportation, and 7.5% to air transportation. It is important to note, however, that this study did not consider the costs associated with maritime transport, road usage by pedestrians and cyclists, as well as air transportation (excluding General Aviation).

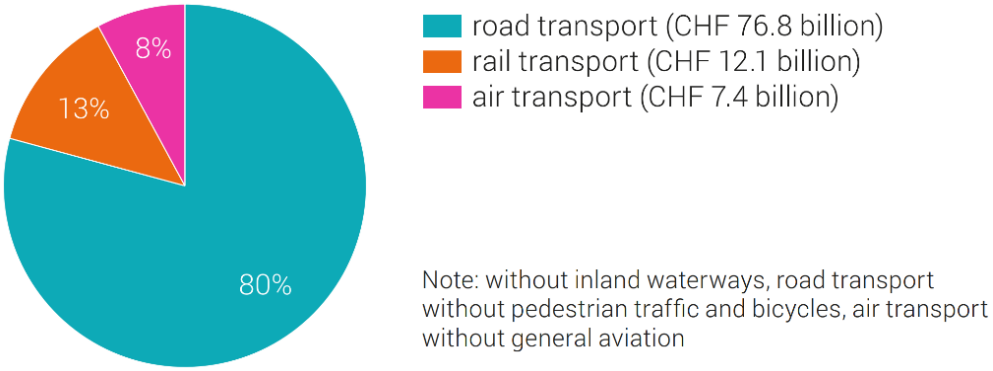


Figure 5: Breakdown of costs in the transportation sector in 2019 (Mobility and Transport, 2023).

In a further step, commuter behaviour was examined. In 2021, there were 3.5 million commuting workers, indicating that eight out of ten individuals left their place of residence to go to work. However, this dynamic has undergone some changes due to the COVID-19 pandemic and the resulting mandatory work-from-home arrangements. Nevertheless, updated data on this matter are not yet available. In 2021, slightly more than half of the commuters, 53% to be precise, primarily used the car as their mode of transportation for the journey to work, while 27% relied on public transport, and 18% walked or used bicycles. On average, these commuting workers covered a distance of 14 kilometres for a one-way trip to work, taking 29 minutes to do so.
The commuter flows were also analysed and recorded. Zurich saw the highest volume of commuter flows, followed by Bern, Basel, Geneva, Lausanne, and St. Gallen (Office, 2021). These data are also evident in Figure 6 and it illustrates the main commuter flows of the municipalities in 2018.

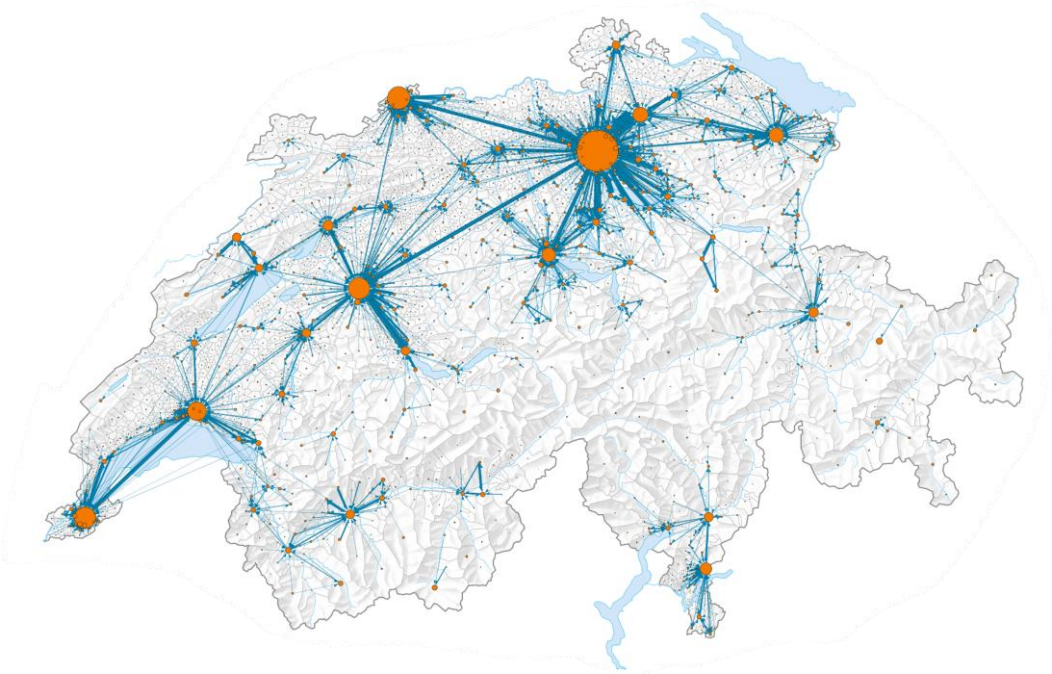


Figure 6: Main commuter flows between municipalities (Office, 2021).

There are also many challenges in the transport sector, which are listed in the following step. The challenges at hand encompass the need to curtail the increasing volume of traffic, transition from fossil fuels to renewable energy sources. To stimulate and transform the consumption and travel behaviours of the population and realise cost savings in healthcare through reduced vehicular activity (Commuting, 2023). The Swiss Federal Department of the Environment, Transport, Energy and Communications (UVEK) forecasts a further escalation in traffic levels by 2050, despite a decline in commutes to work. This implies that both passenger and freight transport will continue to surge while commuting distances for workers will decrease.
According to critics, as seen on platforms such as Agenda 2030, enhancing efficiency alone is deemed insufficient. What is imperative is a transformation of our consumption patterns: Favouring smaller automobiles for transportation, covering shorter distances on foot or by bicycle, and opting for public transportation for longer journeys whenever feasible. However, this necessitates the expansion of existing transportation offerings. There is also a call for a general reduction in mobility, as the trend of ever-increasing kilometres travelled per individual must be reversed, especially considering the projected population growth in Switzerland. Each untraveled kilometre yields a positive impact on the climate. Therefore, untapped potential solutions are being sought.

The traffic situation in Paris was also briefly analysed to ensure that all the information could be linked and processed. The traffic situation in Paris differs significantly from that in Switzerland, and this is naturally due to differences in population. Currently, Paris is home to approximately 2.2 million inhabitants, whereas the entire population of Switzerland is around 8.7 million. Furthermore, Paris is an extremely popular tourist destination.

The city of Paris annually accommodates an impressive 308 million passengers in its public transportation system, marking a 20% increase in the last decade. An average of 50’000 passengers per hour travel on the main lines. To handle this volume of commuters, Paris provides train services every 2 minutes during peak hours, with intervals extending to 4 minutes during off-peak times. Additionally,

Paris has a well-developed network of stops, particularly in the case of the Metro. In the French capital, the Metro is unquestionably the fastest and most convenient means of transportation, with a total of 14 lines and approximately 300 stations (ratp.fr, 2017).

2.2 Advantages and disadvantages of the current means of transport

The advantages and disadvantages of different means of transport are briefly outlined in the appendix. This overview assists in the choice and optimization of transport options. By analysing the advantages and challenges of various modes of transport, one can evaluate efficiency, safety, environmental compatibility, and cost-effectiveness. This enables the identification of suitable transport solutions for diverse requirements and the development of measures to enhance existing systems. Additionally, this research supports the planning of more sustainable and effective transport infrastructures.
Each mode of transportation possesses its unique set of advantages and disadvantages. A detailed discussion of these factors is provided in the appendix, facilitating a comprehensive comparison during the analytical phase.

2.3 Basis for decision-making

The transport sector produces the second highest amount of greenhouse gas emissions all over Europe. The transport systems are complex sociotechnical systems. Travel behaviour is however complex and travel-related decisions involve many underlying factors (Bask & Rajahonka, 2017). It is necessary to understand how the decision-making process is realised, which criteria are used and what role environmental sustainability or other decisive factors play in the selection process.
The choice of the means of transportation and the decision-making process is for each person different and it depends on the preferences of every individual. The following decision factors are important to transport users. Costs, safety, flexibility, convenience, reliability, travel time, delays, breakdowns, number of transfers, frequency of service, choice of options, available infrastructure and transport network, access to the means of transportation, weather dependencies, environmental aspects, service, cleanliness, and reason for the travel. The most important quality factors in the choice of transport are safety, travel time, punctuality, flexibility, and travel comfort. In contrast, the recreation factor and use of time are of comparatively less importance. In addition, costs are only of secondary importance (Garcia-Sierra, Miralles-Guasch, Martínez-Melo, & Marquet, 2018), (Eluru, Chakour, & El-Geneidy, 2012).

Other factors are also part of the basis for decision-making. Results show that an increase in household size results in more likelihood to own a car and increasing car ownership results in less usage of public transport, biking, and walking. Additional, income status shows that by increasing the level of income the usage of public transport decreases (Ashraf & Neumann, 2017). Income can restrain the frequency of use and the access to private modes of transport, while demographic variables, such as gender and age, shape the different use of transport means (Weis, et al., 2020), (Tsamboulas & Kapros, 2000). The general consideration is that individuals select a form of transport depending on their opportunities and preferences through scrutiny of the pros and cons of the available alternatives (Collins & Chambers, 2005). **Fehler! Verweisquelle konnte nicht gefunden werden.** and **Fehler! Verweisquelle konnte nicht gefunden werden.** visually represents the various forms of transportation.

The transport-related components of each individual are different. The following aspects have an impact on the choice of transportation. The pattern of conduct and the phase of life which one is living at the moment, the socio-demographic status, the lifestyle and value attitudes, financial resources, the availability of individual means of transportation, external or environmental influences and social networks, habits, culture and religion, level of education, gender and age, state of health and consumer behaviour (Asensio, 2002), (Avila-Palencia, et al., 2018). On the other hand, the individual is exposed to the objective scope for action and situations set by the environment (Laesser, 2001). These situations can be determined by settlement structure and demographics, the offer of transport infrastructures and systems, prices for the transport service, place of residence, place of work or study, working hours and opening hours of public goods. In addition, the destination on holiday with the given means of transportation and options, leisure activities such as hobbies or shopping, but also logistics uses different modes of transportation and selects them with certain factors (Holz-Rau & Scheiner, 2007).

The following facts are related:

- Age: The older a surveyed individual, the higher the probability of driving a car (Fröhlich, Axhausen, Vrtic, Weis, & Erath, 2012).
- Income: The higher the income, the greater the likelihood of driving a car.
- Location Type: Residents of suburban municipalities, isolated towns, and rural communities are more likely to use cars than residents of core cities.
- Many transfer operations reduce the use of public transport. Direct connections are thus preferred.

It is important to note that transport planning decision-makers have other determinants. Many transportation agencies have begun to introduce explicit transportation system performance measures into their policy, planning, and programming activities (Pickrell & Neumann, 2001). This is also because nowadays the possibility to build additional infrastructure is limited. The European Directive 2014/24/EU encourage an extensive use of BIM-based practices in transport infrastructure design. Therefore, a shift from the traditional design approach towards a shared and highly integrated model, capable of including the various design phases along with economic, operational, and environmental concerns, is observed (D'Amico, Calvi, Schiattarella , Di Prete, & Veraldi, 2020). For the planning decision-makers, the following factors are part of the decision-making process. Network-Level Planning, Project Development, Programming, Budgeting, financial planning, federal legislation that affects transportation decision making. It also includes types of transport stimuli, impact categories and types, dimensions of the evaluation, other ways of categorising transport system impacts, and much more. On the one hand, public decision-makers have limited resources that they must use in the best way possible. On the other hand, when choosing among alternative investment projects, the decision-makers reveal their priorities, and these priorities must be perceived as legitimate (Damart & Roy, 2009). It is not only planning for the modes of transportation in demand, but also for infrastructure, stimulating needs, balancing the use of different modes with proposal management, sustainability, and future assessments of leading technology.

2.4 Types of travel

This chapter identifies the activities for which a transportation mode is being used. The modes of travel were researched to find out what a mode of transport is used for. The needs of travellers were also

analysed. As there are many types of travel, a mind map was created to present the information clearly. The reasons for movement have been classified into six main categories. Logistics, leisure, place of work and school, vacations and belonging destinations, medical care, and household obligations. In logistics, a distinction is made between passenger and goods transportation. In passenger transport, individuals are transported, and this belongs to all categories in the following mind map. In freight transportation, letters, parcels, machinery, resources, facilities, and other products are transported.
During the leisure time, various modes of transportation are used for different activities. For example, for visits, shopping, events, going out, parties, hobbies like sports, music, or other matters, diverse leisure activities, or spontaneous trips and excursions (Romão & Bi, 2021).
For commuting to work or school, there are also further subgroups. There is the daily routine, where the user commutes to the workplace or study location every day. There are also business trips or school excursions, as well as study or business trips (Dunning, 2012).
Choosing a mode of transportation for vacations also involves different types of travel and, consequently, different choices of transportation. This strongly depends on each individual and their personal vacation preferences. Costs are also often included and considered. However, this subsection describes the types of holidays. There is the road trip, the package holiday, the beach vacation, the city trip, the weekend break, or the group trip. There are more types of travel, but these are the most common for vacation travel.
In the medical care subgroup, there are various possibilities and reasons to move with the means of transportation. For example, for therapy, to go to the doctor or hospital, to go to physiotherapy or to get a massage. There are other possibilities or reasons, but they are not listed here.
In the sector of household obligations, there are also possibilities where transportation is necessary. For example, to do the shopping or to do laundry outside the home. In household chores, not many tasks require a mode of transportation. It's primarily an in-house activity. Other related activities associated with the household have already been listed in other sections, such as leisure time.

The following Figure 7 shows the mind map with the different types of travel and the purposes for which a mode of transportation is needed and utilised for.

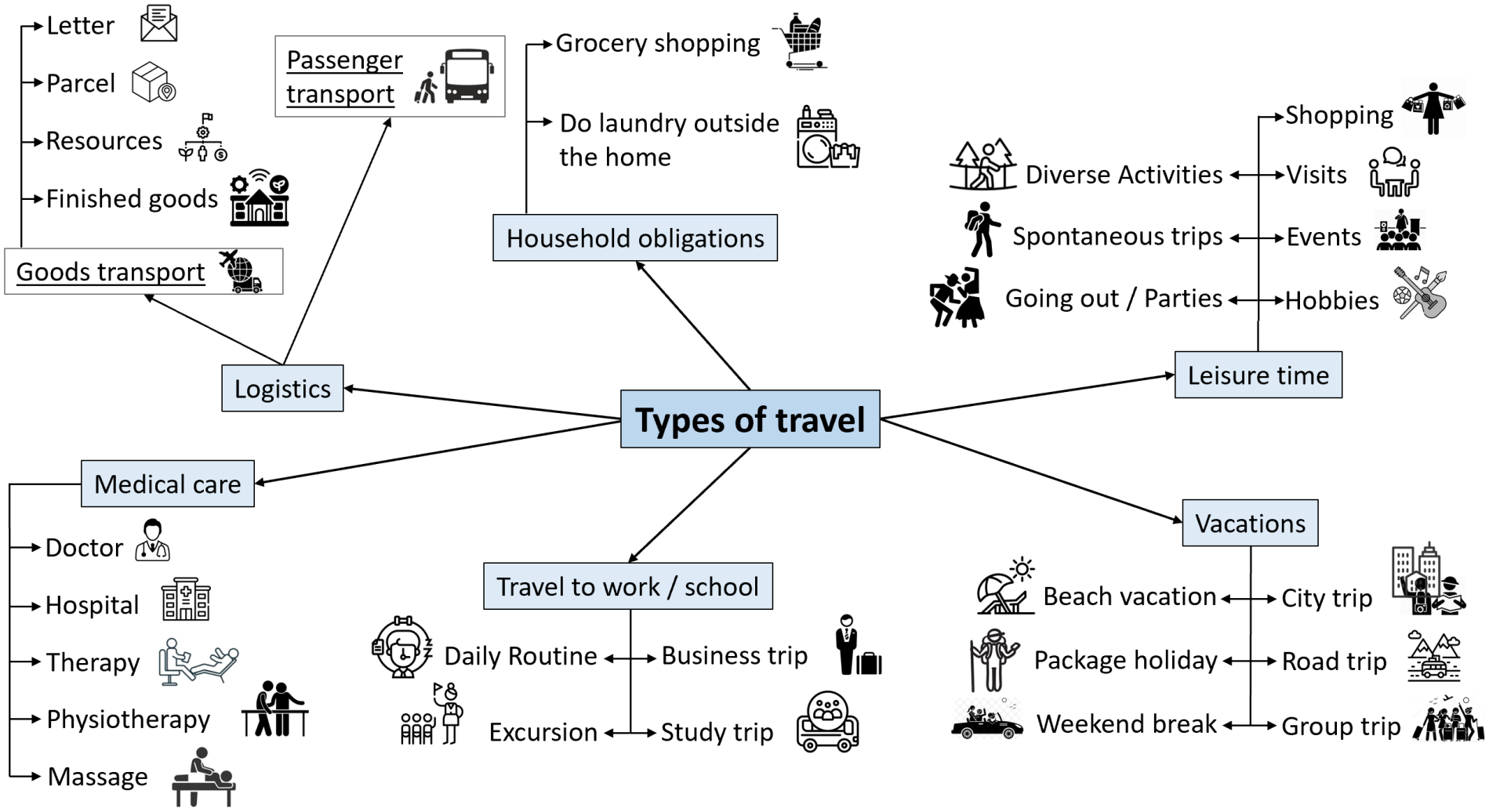


Figure 7: Mind map with different types of travel.

2.5 Utilisation between Zurich and Paris

In this subchapter, it is determined how many people travel from Zurich to Paris. At what price, with which means of transportation and with what time. This research enables a better understanding of the demand for this transport section. By analysing the capacity utilisation, it is possible to identify patterns and pave the way for more efficient transport solutions. The research also provides insights into the environmental impact of different modes of transport and thus promotes more sustainable options. In addition, research helps to understand the changing needs and preferences of travellers, which in turn enables the adaptation of services and offers.

Every year, more than 2.5 million people travel from Zurich to Paris. This is highly dependent on the economic situation, and available means of transportation and the individual travelling needs of each person. Table 1 below provides the travel time, costs and CO2 emissions of airplane, train, and car.

Table 1: Overview of the different modes of transportation for the route from Zurich to Paris.

Means of transportation	Travel time	Costs	CO2 emission
Airplane	1 h 30 min	84 – 317 CHF	approx. 144 - 224 kg CO2 per person
Train	4 h 4 min	49 - 160 CHF	approx. 5 – 8 kg CO2 per person
Car	6 h 40 min	120 - 175 CHF	approx. 84 - 114 kg CO2 per person

Figure 8 depicts the different routes with the corresponding modes of transportation. Each mode of transportation utilises a different route (Google Maps, 2022). The following figure displays the fastest route from Zurich to Paris for each respective mode of transportation. Blue represents travel by plane, orange by car and bus, and red by train.

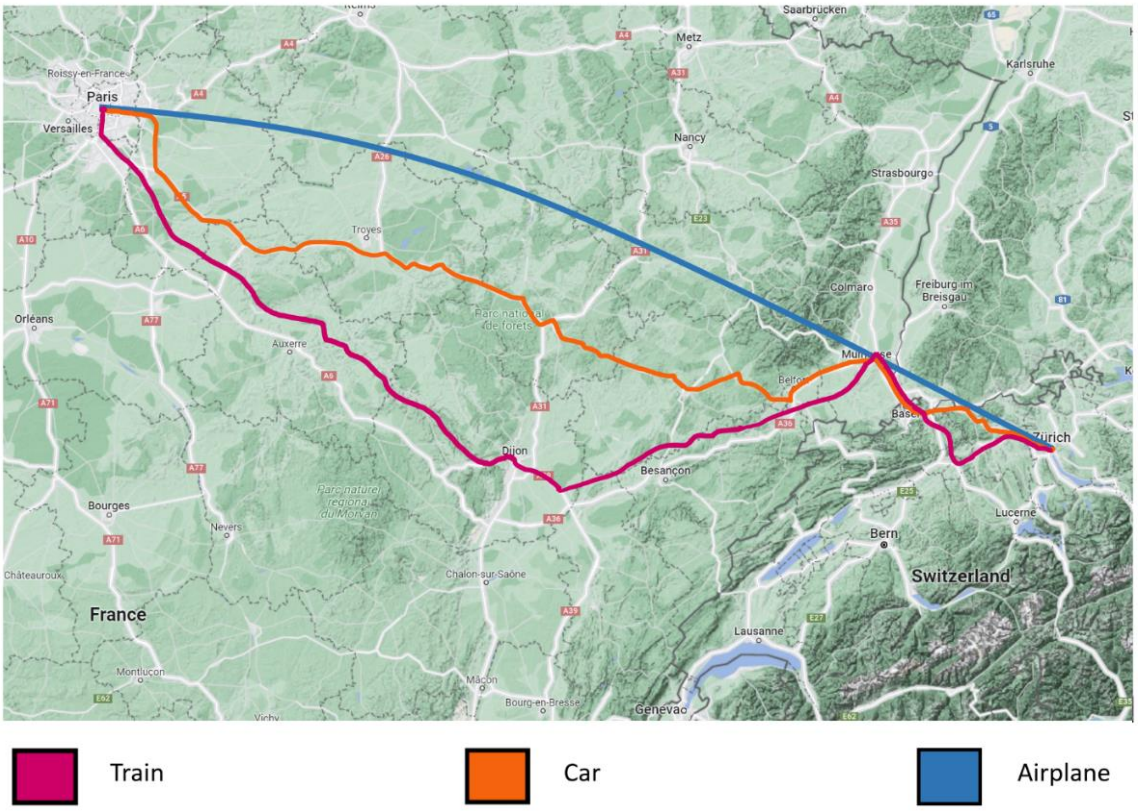


Figure 8: The different routes for various means of transportation.

2.5.1 Usage by airplane

In 2019, 1.681 million passengers travelled by plane from Switzerland to France (Linien- und Charterverkehr, 2023). 758,242 individuals flew from Zurich to Paris, while the rest departed from Geneva to Paris (Schneeberger, 2023). As Paris has a total of five airports, it is difficult to determine how many passengers travelled from Zurich to each airport. The travel time by plane from Zurich to Paris is approximately 1 hour and 30 minutes (Swiss International Air Lines, 2023) for a distance about 488 km. The airline Swiss offers 27 flights per week on this route. However, a total of around 315 planes flies from Zurich to Paris each week (Paris Orly Airport, 2023). The price range for a journey for this route by plane is approximately 84 to 317 Swiss francs in the economy category. Additionally, the aircraft emits an average of 144 to 224 kg of CO2 emissions per person on this route, depending on how fully booked the airplane is (Baumeister, 2022).

2.5.2 Usage by train:

In 2019, approximately 1.9 million passengers travelled by train from Zurich to Paris. With the expansion of train services and the introduction of new double-decker trains, the TGV Lyria company will be able to transport up to 5 million passengers per year between Geneva, Lausanne, and Zurich to Paris (Manhart, 2019). The exact number of passengers may vary from year to year and depends on various factors, including economic conditions, the availability of transportation, the season, and other influencing factors. The fastest train connection from Zurich to Paris takes 4 hours and 4 minutes, which is provided by the direct TGV train (sncf-connect, 2023). The average travel time is 4 hours and 51 minutes. There are 18 daily trips available from Zurich to Paris, with the TGV running 6 times a day directly. The costs for this route vary between 49 to 160 Swiss Francs for a second-class ticket (TGV Lyria, 2023). This depends on the train's schedule, occupancy, operating rail companies, class, peak seasons, and holiday time. The price is therefore dynamic between this range. The train covers a distance which approximately 686 kilometres on the route between Zurich to Paris and emits five to eight kilograms of CO2 per person (Tschudy, 2021). As the pricing, the CO2 emissions depend on train occupancy and weather conditions, with considerations for heating in winter and cooling in summer.

2.5.3 Usage by car

By car, the travel time for the fastest route is 6 hours and 40 minutes (Google Maps, 2022). However, this highly depends on traffic and can vary. The distance covered is 655 kilometres. There are two other routes, both longer, resulting in a longer travel time of up to 7 hours and 55 minutes. For the journey from Zurich to Paris produces CO2 emissions of around 84 to 114 kg per person (Hellinger, 2023). This is highly dependent on the type of car, the age of the car, and the type of fuel and consumption. In addition, the emissions per person decrease when multiple individuals are traveling in the same car. The provided value is for a single person traveling alone from Zurich to Paris. Furthermore, an electric car emits only 46 kg of CO2 for the same journey (Nussbaumer, 2022). In comparison, this is nearly half of what a gasoline-powered car emits. The cost of the journey from Zurich to Paris is approximately 110 to 135 Swiss Francs. This also depends on the type of car, fuel consumption, the current fuel price, the insurance chosen for the car, and the selected route with associated toll fees.

In comparison to a car, a bus emits 24 kg of CO2 per person. This depends on whether the bus is full or not. The travel time is slightly longer, taking 9 hours and 40 minutes. The lowest price for a bus ticket is 26 Swiss Francs. Additionally, the exact number of passengers using a car or bus from Zurich to Paris is not known. The estimate ranges from around 1,000 to 40,000 travellers per year.

Figure 9 below shows the various CO2 emissions of the different modes of transport for the route from Zurich to Paris. The values apply per kg of CO2 emissions per person. The aeroplane requires the most CO2 for this route and is therefore the most harmful to the environment. This is followed by the car, the bus and then the train. The train is the most environmentally friendly.

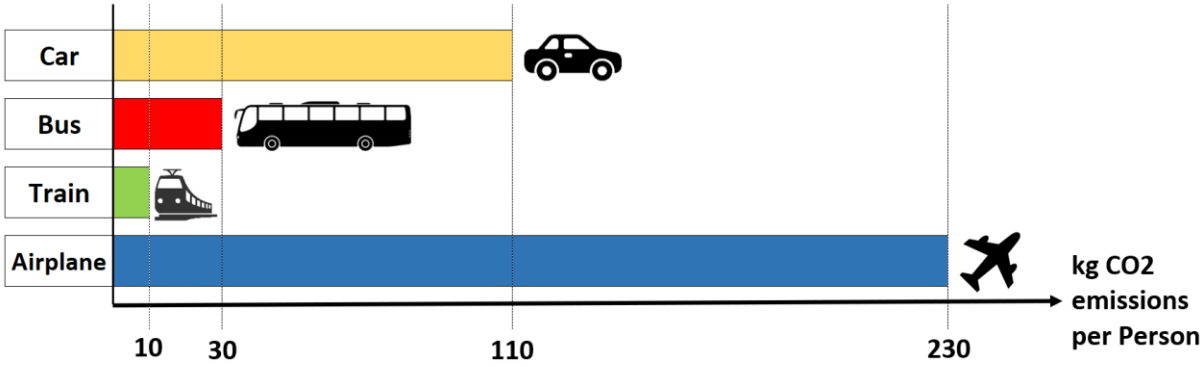


Figure 9: Overview of CO2 emissions for the route from Zurich to Paris.

3 Methodology

In the methodology chapter, a detailed description of the procedures for addressing the research questions is provided, whereby qualitative and quantitative methods are included. The described process ensures the traceability of the structure and the development of the results. An overview of the methodology was created in Figure 10 to analyse the user utilisation of an Hyperloop journey from Zurich to Paris. The aim of the methodology is to demonstrate transparency and reliability and to structure the work with the methods and results.

The following Figure 10 shows the methodology in seven steps. It describes the procedure and the entire methodology.

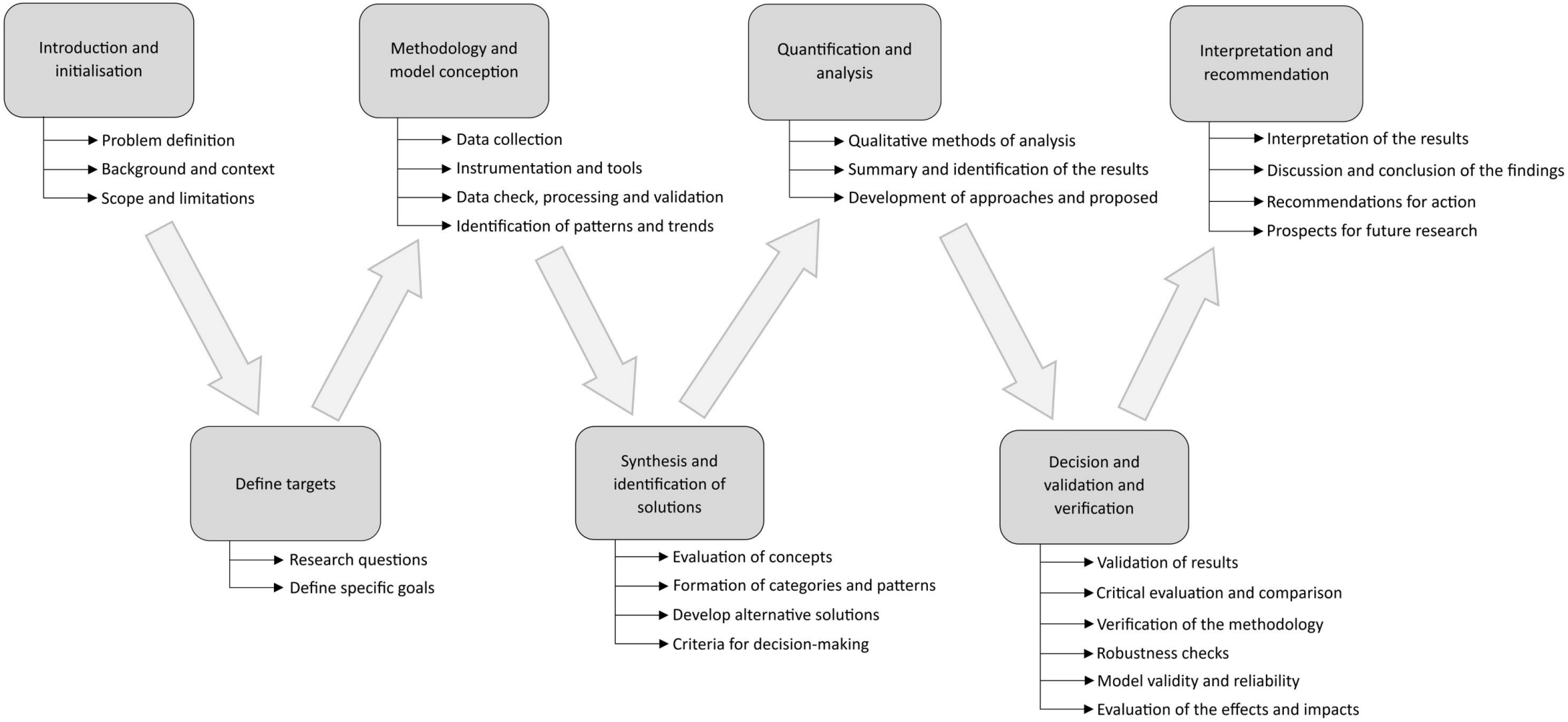


Figure 10: The methodology in seven sequences.

3.1 Definition of the target values

The purpose of this research is to analyse the utilisation of a Hyperloop connection from Zurich to Paris. What would be the future usage of this innovative system and what would the demand from potential passengers look like? For this purpose, there are three research questions. These questions have already been outlined in section 1.2 Research questions. The research questions are listed again to clarify the subject of the study:

1. How resilient is the system of the Hyperloop in the future?
2. Will people change their mode of transportation because of a new Hyperloop connection between Zurich and Paris?
3. By which price would people travel from Zurich to Paris with the Hyperloop?

This research "Prediction of hyperloop track usage," aims to forecast the utilisation of the Hyperloop for the route from Zurich to Paris. How many individuals would use the Hyperloop for this route. The primary focus is to enable a thorough assessment of the profitability, potential, and efficiency of this specific connection. The objective includes a comprehensive investigation, analysing various influencing factors such as travel times, fare prices, geographical conditions, economic considerations, and potential passenger travel needs. The findings are to be integrated into forecasting models to provide accurate assessments of demand and utilisation for the Hyperloop route.

In addition, the project aims to evaluate the profitability, potential, and efficiency of the Hyperloop connection. The results of this evaluation should provide valuable information for decision-makers in the field of Hyperloop transportation. By comparing with competing transportation systems such as airplanes, trains, and cars, potential advantages, and disadvantages of the Hyperloop in terms of efficiency will be identified. The overarching goal is to generate well-founded insights serving as a basis for future planning decisions and contributing to the development of sustainable and efficient mobility in the future.

3.2 Survey

To answer the research questions, primary research was conducted with a survey. The aim of the survey was to predict the potential utilisation of a Hyperloop journey from Zurich to Paris based on the participants responses. The poll was also designed to find out whether the Hyperloop could be a potential future mode of transportation and whether transport habits might change.
In addition, the questioning has the objective to gain insights into the preferences, concerns, and potential user behaviour in the context of the utilisation of a Hyperloop journey from Zurich to Paris and in relation to the innovative transport system in general. As the central instrument for data collection, the survey was specifically selected to gather a broad spectrum of information from potential users. This enables a thorough analysis of the utilisation factors and thus lays the foundation for well-founded research.

The research objectives defined at the beginning and the literature research carried out provided a solid basis for the development of the survey and the targeted formulation of the questions. The canvassing instruments were designed to be as easy and quick as possible for the participants. The questions were designed to gain insights into individual travelling habits and preferences, perceptions of various factors in the transport sector, the influence of travel times and participants' willingness to

pay. In addition, the requirements, and changes to existing behaviour in relation to future means of transportation were to be analysed.
The survey is not focused on a specific target group but was broadly disseminated in the environment of the author of this research. Data collection through the poll was conducted online to enable broad participation and maximise the efficiency of data collection. Attendants were fully informed about the purpose of the survey, and it was ensured that participation was voluntary and anonymous to preserve the integrity of the data collected.

The collected survey data is analysed in detail in Microsoft Excel. Statistical methods are used to identify patterns, trends, and significant correlations. This data analysis serves as a basis for answering the research questions of this thesis and enables an in-depth investigation of the potential utilisation of a Hyperloop system, including the user perspective. The use of Excel as an analysis tool enables a precise and clear evaluation of the survey data.
The survey thus represents an essential basis for answering the research questions of this thesis and enables a detailed investigation of the potential utilisation of a Hyperloop system, considering the user perspective.

3.3 User Persona

In the further methodology, the focus is on the development and description of a future persona. This step requires a synthesis of the findings from the literature analysis, the consideration of the survey results and the integration of relevant assumptions and variables. The aim is to forecast a realistic user perspective for the Hyperloop system, and this provides the basis for findings and recommendations in this research.

Creating a persona is a technique that is used in various areas such as marketing, product design, user experience and to develop the system as closely as possible to the user's needs. A persona is basically a fictitious but detailed representation of an idealised representative of the target group or user. By identifying and characterising potential users of the Hyperloop system, the individual requirements, goals, and challenges could be determined and better recognised. This approach enables the research results to be specifically aligned with the requirements of the actual target group. By combining information from the literature research and the results of the survey, a hypothetical but precise representation of an ideal user is created.
The creation of a persona for the Hyperloop system requires a precise and structured methodology. The persona template from the book "The Design Thinking Toolbox" by Patrick Link is used as a guide (Link, Lewrick, & Leifer, 2020). In a first step, the aim of the persona creation is defined, focussing on creating a representative user to understand the needs and requirements of the Hyperloop system more comprehensively.

To create a solid foundation, a comprehensive literature review is conducted to gain background information on the Hyperloop system. In conjunction with this, the results of a survey are analysed to receive realistic insights into the opinions and needs of potential users. Further assumptions are included to create the persona.

The collected information is integrated into a persona template, which usually contains sections such as name, age, gender, hobbies, a description of the fictional character, goals, needs and solutions. Creating a persona story is a critical step in integrating the information into a real context. This involves

describing the persona's typical routine, their current challenges in the existing means of transportation and how the Hyperloop system could improve their quality of life. Pains, gains, a mood board, influencers, and trends are then added to the persona. Regularly updating the persona ensures that it remains in line with new research findings.

3.4 Quantifying the target values with existing modes of transportation

In the pursuit of optimising transportation systems, it becomes imperative to quantify target values associated with existing modes of transportation. This involves a systematic and comprehensive evaluation of key parameters that define the efficiency, effectiveness, and user experience within each mode. By using data analysis methods and predictive models, factors such as travel times, costs, geographic considerations, and other relevant variables across various transportation modes will be precisely measured and analysed. The objective is to derive quantitative insights that facilitate a nuanced understanding of how well each mode meets the diverse needs of users.
This quantitative approach provides a solid foundation for informed decision-making and strategic planning. It allows for a comparative assessment of the strengths and weaknesses of different transportation systems, aiding stakeholders in identifying opportunities for improvement and innovation. Ultimately, quantifying target values contributes to the ongoing discourse on enhancing transportation networks, paving the way for more sustainable, efficient, and user-centric mobility solutions.

3.5 Quantifying the target quantities with the Hyperloop concept

Quantifying the target values associated with the Hyperloop concept is important to enable a robust assessment of the feasibility and efficiency of the transport system. There are several reasons why it is necessary to measure and analyse these key performance indicators. Firstly, quantification enables a realistic assessment of the potential demand for the Hyperloop between Zurich and Paris. By analysing factors such as population density, travel behaviour and existing modes of transportation, the expected usage of the Hyperloop provides an accurate forecast. This data is necessary to ensure that the capacity of the Hyperloop system fulfils the actual needs of passengers and that bottlenecks are avoided.
As a second factor, quantification contributes to the evaluation of the efficiency of the Hyperloop system. By measuring the utilisation and performance, it is possible to identify and optimise weak points in the system. This enables continuous improvement of the Hyperloop system to ensure maximum efficiency and reliability.

To quantify the results, it is necessary to use analytical tools and methods. These tools include data-driven models, surveys to determine target group needs and statistical analyses. By integrating survey results, persona specifications and CO2 emissions data, a comprehensive overview could be created that considers not only the technological performance, but also the environmental and social impact of the Hyperloop system.

Overall, the quantification of the target values serves to enable well-founded decisions and strategic planning in the field of high-speed transport. It is a crucial process to ensure that the Hyperloop is seen not just as a visionary idea, but as a viable and sustainable solution to the challenges of modern transport.

4 Implementation

The following chapter is focussed on describing the analytical and conceptual measures that were conducted to research the issues and solve the industrial challenge. The focus is on the explanation of the survey structure and the development of a comprehensive user profile. These two procedures form the main methods of this research work. These selected methods are not considered as a technological step, but a strategic approach to gaining detailed information on the issues and providing the basis for solving industrial problems. Figure 11 shows the structure and sub-chapters of the implementation.

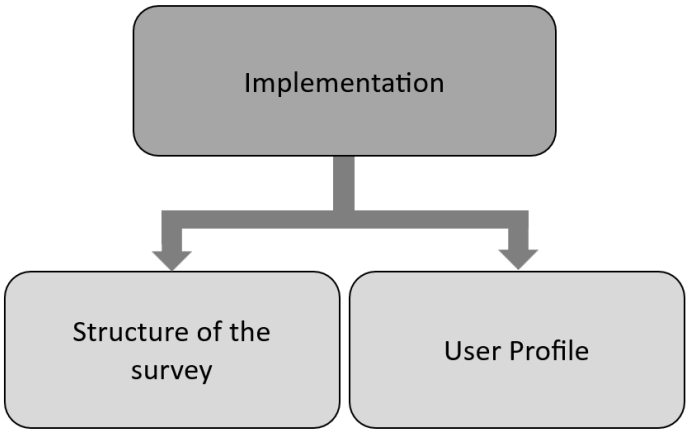


Figure 11: Overview of the implementation chapter.

4.1 Structure of the survey

For this research, a survey was conducted to investigate and analyse the project's objectives and is aimed to create a predictive model. The survey was created and published on the survio platform (survio, 2023). The decision to use the survio platform for the survey was based on positive reviews, which described the tool as extremely user-friendly with a wide range of customisation options. In particular, the numerous available question formats were emphasised, which made it possible to include a diverse range of questions in the questionnaire. Another key aspect was the ability to seamlessly transfer the results to Excel, which was easy to implement with the chosen tool.

There were created two versions, one in German and one in English, which were both sent via an online link. There were 139 participants in the German edition and 30 in the English variation. The average participation time amounted to 5 minutes. The questions were formulated to allow for multiple choice answers, single answers, ordering or ranking based on different preferences and an open-ended question.

Ten questions were posed to the survey participants. Figure 12 shows the sequence of the questions. The initial questions covered age and gender, followed by inquiries about the frequency of using transportation modes more than three times a week and the important aspects of a mode of transport. The questions became more specific with the fifth question, seeking information on which modes of transportation individuals currently use to travel from Zurich to Paris.

Subsequently, general questions about the Hyperloop were presented, assessing whether the survey participants were familiar with the Hyperloop and if they would consider using it for travel between Zurich and Paris. The survey then delved deeper into the Hyperloop, aiming to identify the conditions that participants deemed necessary for choosing the Hyperloop for this route. Additionally, participants were asked about their willingness to pay, specifically the maximum price they would consider for this journey. Finally, respondents were asked which mode of transportation they believed would best meet their future travel requirements.

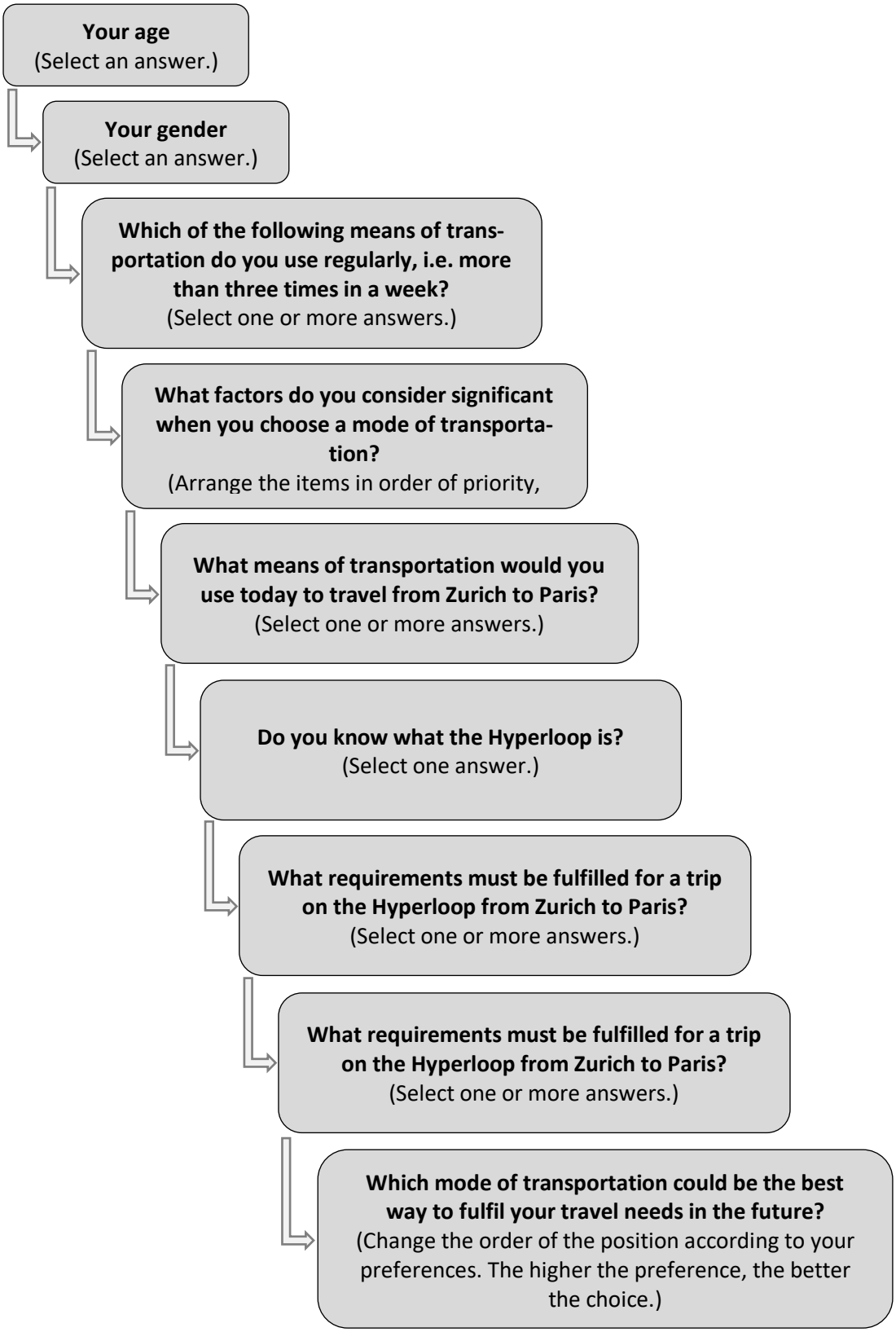


Figure 12: Structure of the survey.

To ensure that a survey provides reliable and statistically significant results, a sufficiently large sample is crucial. For this, it is necessary to have accurate data on the total population that is to represent the target group of the survey (Graglia, 2023). This means that information is required on how many people are considering the Hyperloop as a potential mode of transportation and who specifically would be travelling from Zurich to Paris. One possible basis for this could be the population of Europe and Switzerland. However, it is equally important to consider the age group for which the survey is being conducted. The second step is to determine how representative the sample should be. It should be noted that the closer the sample is to the total population, the more representative the results will be. The required number of survey participants varies according to the desired margin of error and depends heavily on the specific topic and the characteristics of the population.
It is important to note that the survey conducted for this research is not representative. The survey was conducted within the environment of the author of this research paper and involved both personal and professional contacts. Nevertheless, the number of participants is too small for a representative result. To conduct a representative survey, the range of participants would need to be significantly expanded to include people from different cultures and groups and to ensure a more diverse participant base overall. This would inevitably require a significantly larger number of participants.

4.2 User Profile

By creating the user persona, the aim is to gain a more comprehensive insight into the future user. The objective is to learn more about the benefits and potential customers and to develop a detailed understanding of the target group. The tool can be used to create a fictitious but detailed character to create a potential user as a solution. In addition, it enables the visualisation of the goals, wishes, and needs of a typical user to provide a consistent understanding of the target group.
The description of a persona should be as precise as possible. This means that the profile has a name, gender, and basic demographic data such as age, profession, and hobbies. In addition, information on the personality and character details of the persona is documented. On this basis, the goals, needs and fears can be derived. The biography of a persona can also help to draw conclusions about the social environment in relation to purchasing behaviour or user behaviour (Link, Lewrick, & Leifer, 2020).

The tool is used according to the following procedure, but the fields can be filled out in any order depending on prior knowledge of the problem. The first step is to describe the persona, specifying a name, gender, and age. Additional attributes such as social environment, family and hobbies can also be added. In the second step, the "job to be done" is described. With the questions of what task does the product fulfil and how can it help the user? In the third phase, the use cases are listed in the context of the problem (Where? What? How?). This involves looking at where and how the customer uses the offer or product and what happens before and after.
In a fourth step, the main difficulties and problems confronting the user are identified. These can be, for example, unresolved problems or challenges that the user experiences with existing products and services. In a further process, the gains, i.e. opportunities and advantages, and pains, i.e. problems and challenges that the user has or could have, are to be listed. In the sixth stage, a sketch is created that visualises the customer. The user profile can also be used here with photos or excerpts from magazines, for example in the form of a mood board. The last part of the template considers how the persona could be influenced. For example, this could be due to the family, children, stakeholders, etc. and it also considers which general trends such as megatrends or market and technology trends could influence the persona.

The persona template is shown in Figure 13. This is done exclusively in German because this is the only language available in this source. In the next chapter, the persona is completed based on the literature research, the results of the survey and interpreted assumptions. Overall, this method should help to strengthen the focus on user needs and adapt the Hyperloop more effectively to the requirements of

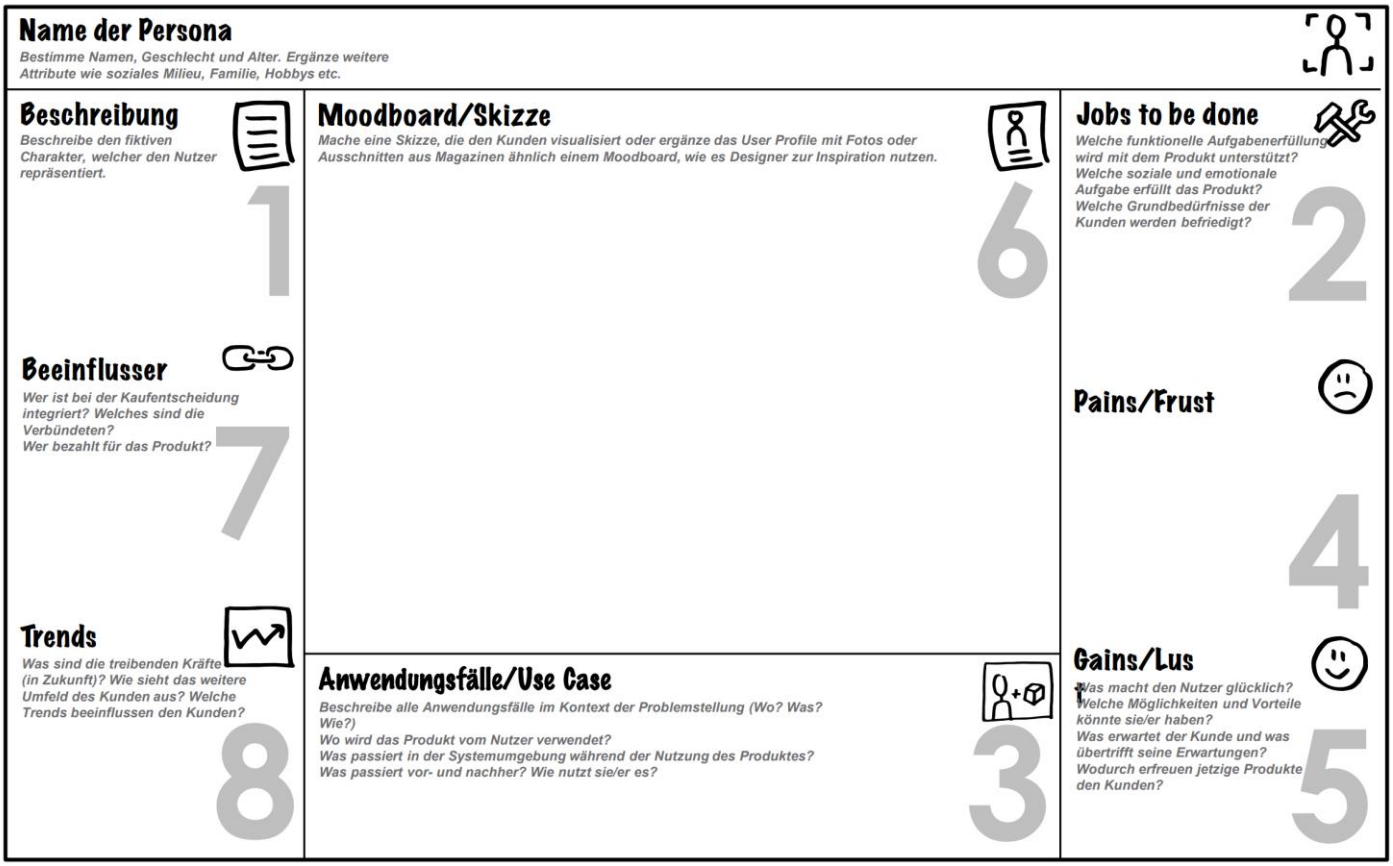


Figure 13: Template of the user profile method.

5 Results and Deliverables

This section describes the results and findings that were achieved as part of this research. Firstly, the general survey responses are analysed, followed by a detailed analysis and comparison of the survey results, whereby various correlations are considered. The survey results and interpretative approaches are then used to develop a persona. The user profile supports the creation of a representative target group and a more specific understanding of customer demands. In a final step, the CO2 savings are to be compared with comparable means of transportation. For this purpose, the CO2 consumption of a Hyperloop journey for the route from Zurich to Paris is calculated. Figure 14 shows the structure and sub-chapters of the results.

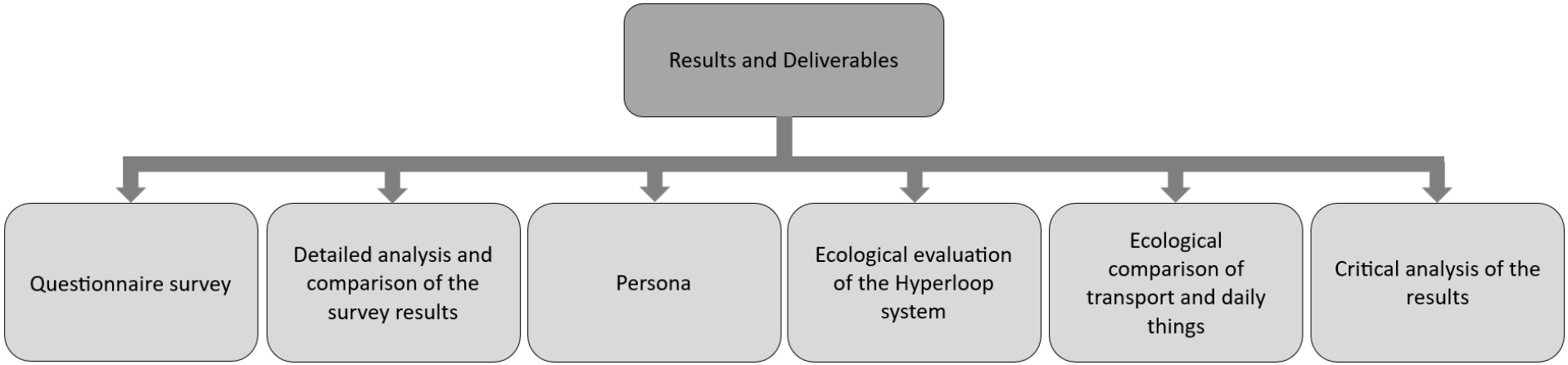


Figure 14: Overview of the results and deliverables chapter.

5.1 Questionnaire survey

The previous sections have already explained how the survey was structured and conducted. The survey will subsequently be analysed. In this subchapter, the first questions are analysed individually to gain detailed insights. By analysing these key questions in a focused approach, the aim is to gain precise insights into the diverse aspects of the participants perspectives and create a basis for further conclusions.

5.1.1 Group of Age

The first question of the survey was the age question. Respondents were asked about their age group. There was a total of 5 age groups: Younger than 18 years, between 18 and 25 years, between 26 and 45 years, between 46 and 60 years, and older than 60 years. The evaluation of the age question is visualised in the chart below in Figure 15.

60.9% of the respondents, which are 103 people, are between 18 and 25 years old. 20.1% or 34 participants are between 26 and 45 years old, 14.2% or 24 attendants are between 46 and 60 years old, 3.6% or six people are older than 60 years, and 1.2%, which are two respondents, are younger than 18 years old.

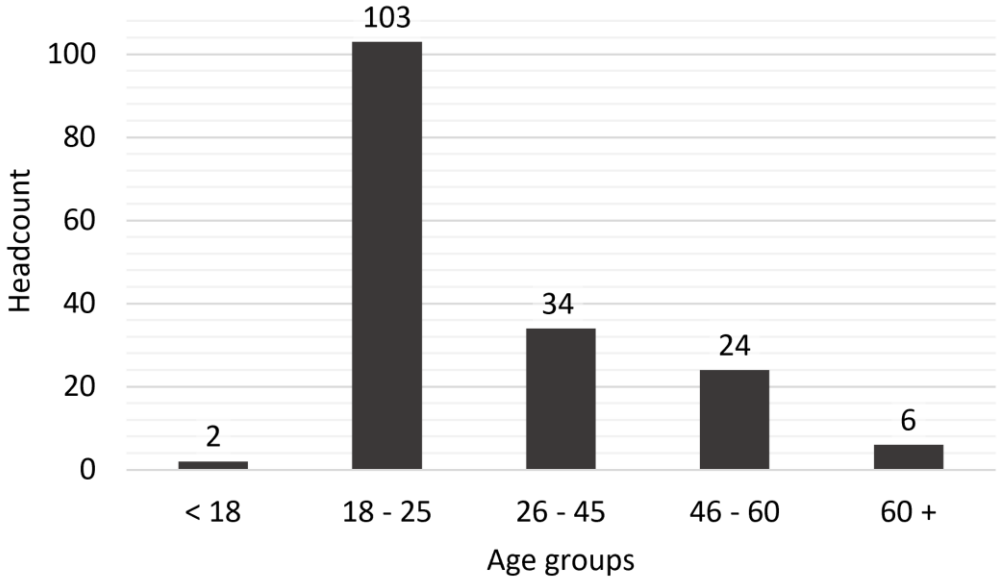


Figure 15: Survey analysis of the age groups.

5.1.2 Gender sense of belonging

In the second survey question, respondents were asked about their gender, with three options available: Female, male, or other. Of the participants, 87 identified as male, while 82 indicated they were female. Therefore, the proportion of male participants was circa 3% higher, but the participation is balanced out. Figure 16 illustrates the gender-specific distribution.

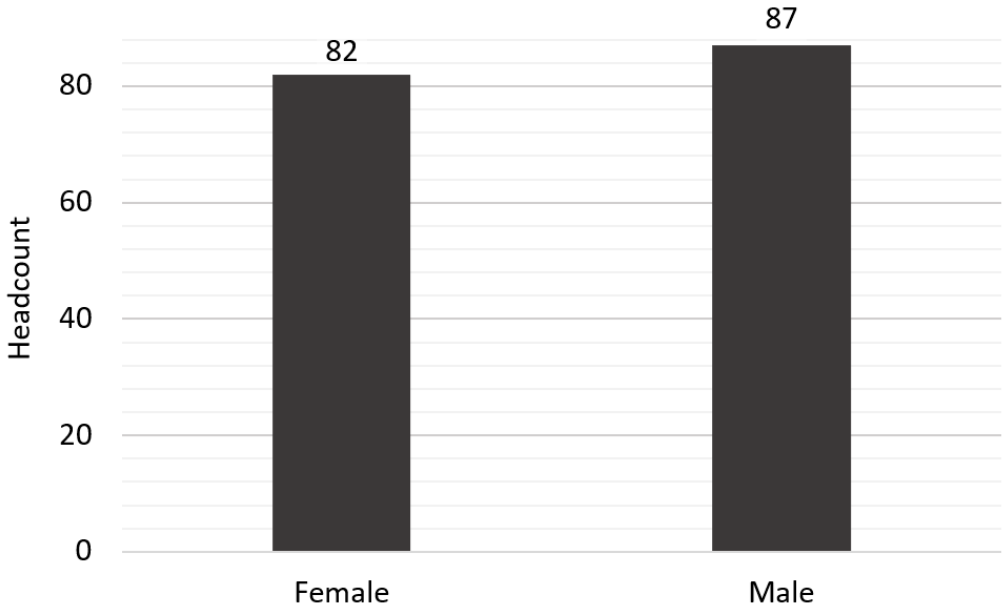
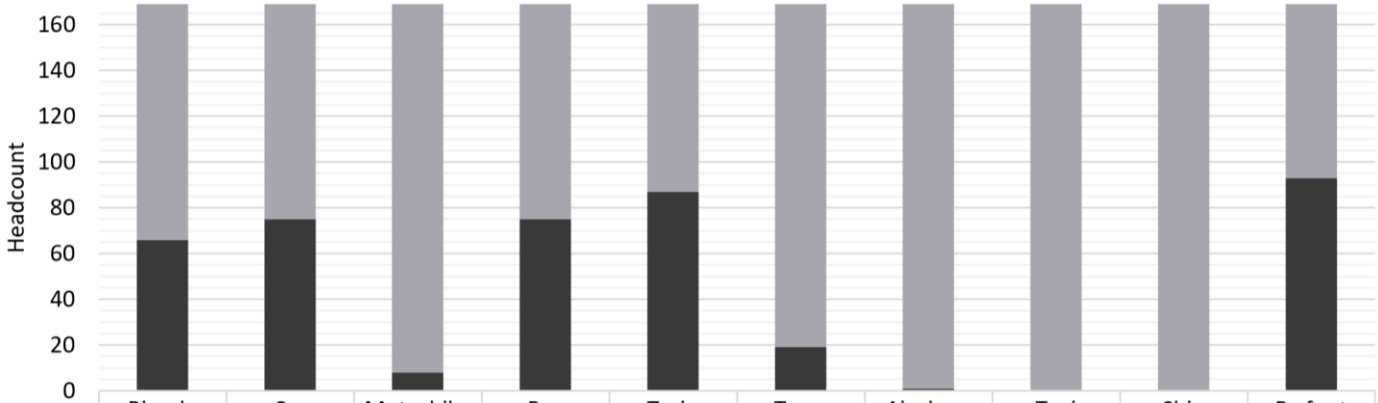


Figure 16: Survey analysis of the gender sense of belonging.

5.1.3 Regular transport habits

The third survey question concerned the transportation habits of the participants. The question was, “Which of the following means of transportation do you use regularly, i.e., more than three times in a week?”. Several answers were available to choose from, whereby the participants could select one or more answers: Bicycle, car, motorbike as well scooter, bus, train, tram as well metro, airplane, taxi, ship, move by foot or other. Figure 17 shows the results of the regular transport habits and the various names of the modes of transportation have been abbreviated. The graph was coloured accordingly, with the dark part of the bar representing agreement or regular use of this mode of transport (i.e. "yes"). The light part of the bar indicates that many survey participants do not use this method of mobility regularly (i.e. "no").

In the case of other means of transportation used more than three times a week, electric scooters were mentioned twice, and skateboards once. Most of the respondents, accurate 93 individuals, primarily move often by foot. The second most common modes of transportation are trains, buses, cars, and bicycles. On average, 19 respondents use the tram or metro more than three times a week. Taxis, uber, ships, or ferries are never used more than three times a week, and airplanes and motorcycles are also rarely used.



	Bicycle	Car	Motorbike	Bus	Train	Tram	Airplane	Taxi	Ship	By foot
No	103	94	161	94	82	150	168	169	169	76
Yes	66	75	8	75	87	19	1	0	0	93

Figure 17: Survey analysis of the regular transport habits.

5.1.4 Preferred transport factors

The following survey question was “What factors do you consider significant when you choose a mode of transportation?”. The following factors were provided for selection: Low costs, safety, comfort, reliability, travel time and sustainability i.e., the environmental aspects. Survey participants were required to rank these factors according to their preferences, with the most important factor assigned the number six and the least important factor assigned the number one.

The results revealed a diverse range of priorities, with each participant emphasizing different factors. For the evaluation of the survey, the average has been calculated in this section. It is important to note that the higher the score, the more preferred the factor. Thus, the reliability is the most important factor for survey participants with an average value of 4.05, closely followed by the low-cost factor, with an average value of 3.82. Then follows travel time, comfort, and safety. These were all rated with an average score between 3.30 and 3.80. Sustainability and the environmental aspect was rated the lowest or least important in this survey. Overall, the average values of the factors show a slight deviation from each other. No distinct value like one or six can be unequivocally assigned to a specific aspect.

Consequently, all values are closely clustered, with each survey participant favouring different factors. Figure 18 shows the results of the preferred transport factors.

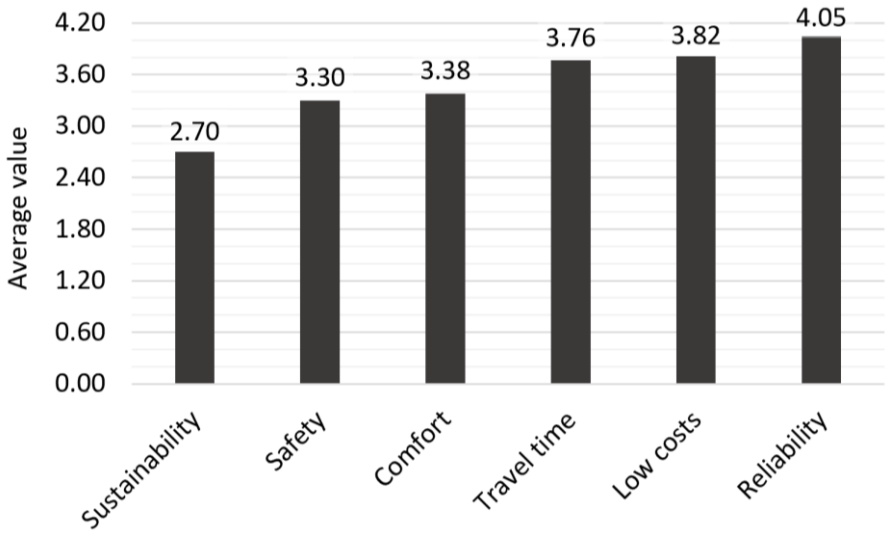
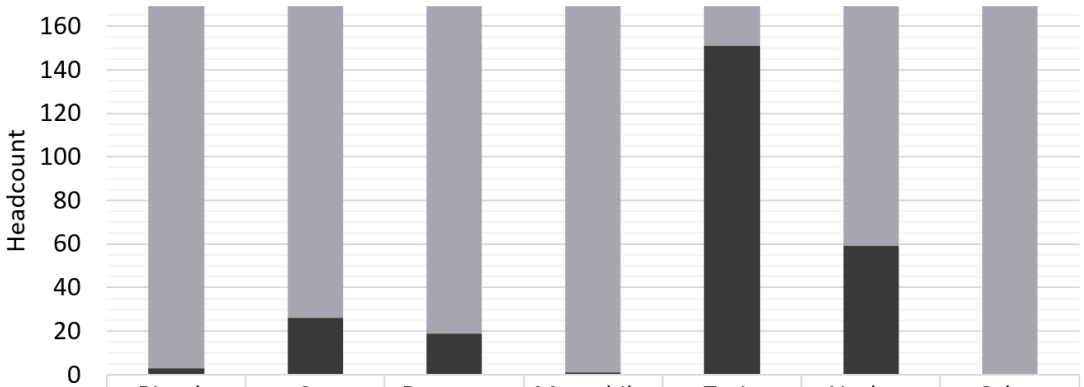


Figure 18: Survey analysis of the preferred transport factors.

5.1.5 Preferable means of transportation for Zurich to Paris

The fifth survey question was: "What means of transportation would you use today to travel from Zurich to Paris?". There were seven options to choose from, whereby the participants could select one or more answers: Bicycle, car, bus tours, motorbike, train, airplane, or other. The following Figure 19 shows the evaluation of the following question. The graph was coloured accordingly, with the dark section of the bar reflecting agreement with the stated journey using this mode of transportation. The light-coloured part of the bar indicates that respondents would not consider this type of transportation for this journey.

The evaluation of this question reveals that the train is the preferred choice, chosen by a total of 151 out of 169 participants for the route from Zurich to Paris. The airplane follows in second place with 59 approvals and 110 rejections. The car and bus tours are more likely to be avoided. 26 respondents would travel from Zurich to Paris by car and 19 out of 169 by bus. Only three individuals would travel the route by bicycle, and one person by motorbike. However, for the majority, the car, bus, bicycle, and the motorbike are not the preferred option for this route. Additionally, no other preferred means of transportation were listed.



	Bicycle	Car	Bus tours	Motorbike	Train	Airplane	Other
No	166	143	150	168	18	110	169
Yes	3	26	19	1	151	59	0

Figure 19: Survey analysis of the preferable means of transportation for Zurich to Paris.

5.1.6 Knowledge about the Hyperloop

This sub-chapter focuses on the survey question, “Do you know what the Hyperloop is?”. The response options were yes or no. Of all survey participants, 83 individuals indicated that they know what the Hyperloop is or have heard of it. In contrast, 86 persons stated that they do not know what the Hyperloop is and have never heard of it. The result is balanced and closely aligned, approximately in the middle. Figure 20 shows the result of this survey question.

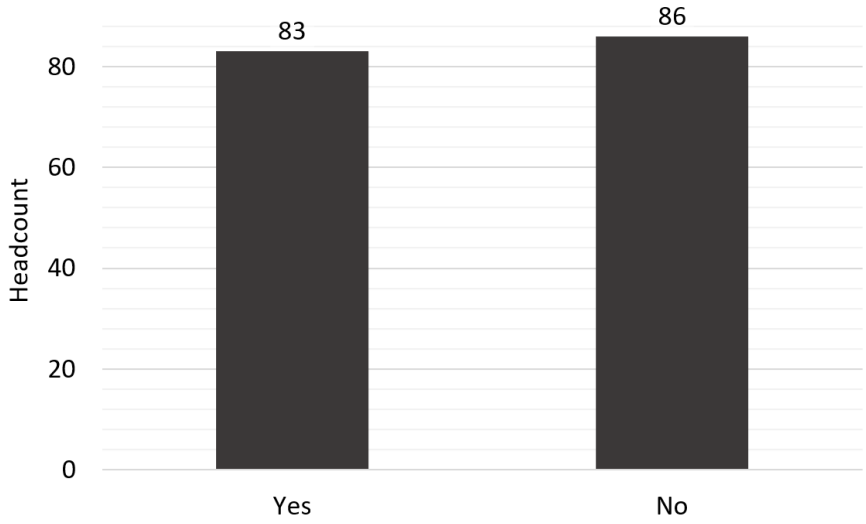


Figure 20: Survey analysis of the knowledge about the Hyperloop.

5.1.7 Hyperloop journey for the route between Zurich and Paris

The seventh question in the survey was: “Could you envision taking a journey from Zurich to Paris with the Hyperloop?”. The response options were yes, no, or maybe. The results of this question are shown in Figure 21. 129 out of 169 survey participants could imagine travelling from Zurich to Paris by the Hyperloop and would undertake the journey with this mode of transportation. 33 individuals are still uncertain and have indicated "Maybe". Seven survey participants would not travel from Zurich to Paris with the Hyperloop and do not consider this option. The result of this question indicates that approximately 76% of all survey participants would be willing to cover the mentioned route with the Hyperloop.

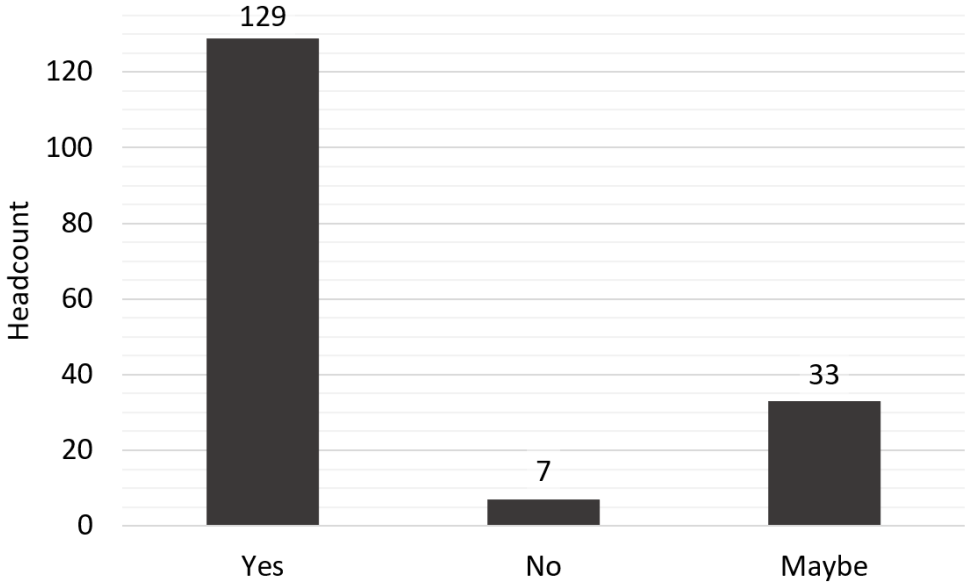
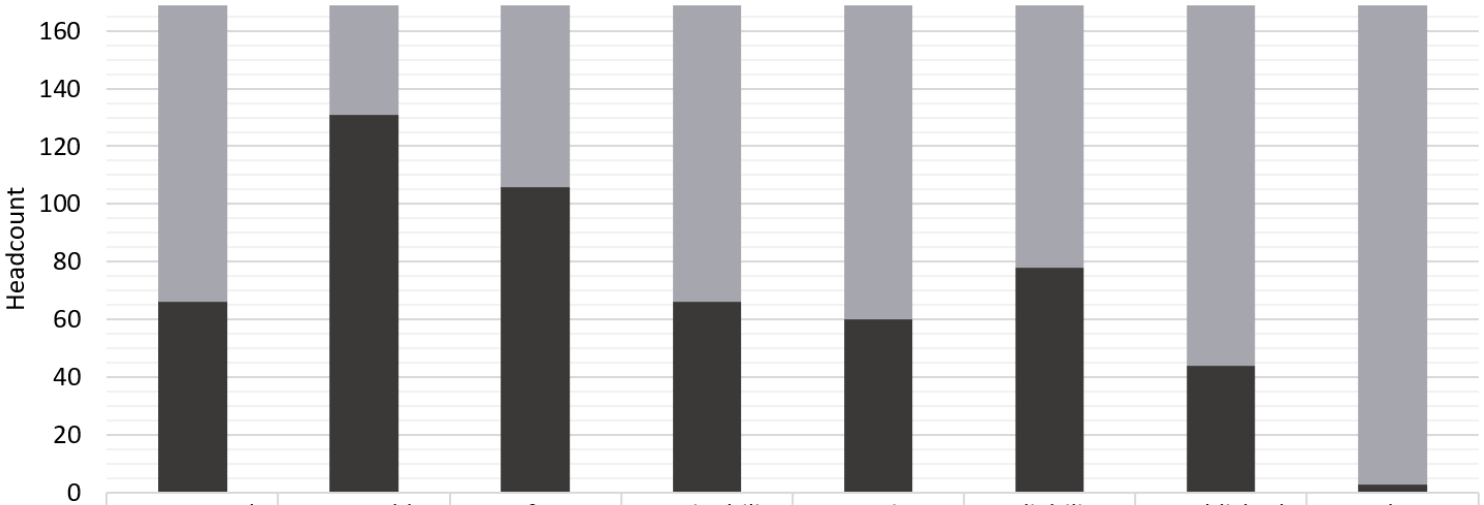


Figure 21: Survey analysis of the Hyperloop journey between Zurich and Paris.

5.1.8 Requirements for a trip with the Hyperloop

In this subsection, the following question was posed to the survey participants: “What requirements must be fulfilled for a trip on the Hyperloop from Zurich to Paris?”. For this question, the participants had the following response options to choose from, and they could select one or more answers: Fastest means of transportation, cheap or cost-efficient, safety, sustainability, convenience, reliability, must first be established or confirmed and other requirements with the survey participants having the option to provide their own response. The dark part of the bar indicates that the respondents prefer the factors and have selected this as a requirement. The light part of the bar indicates that the respondents do not need to have this requirement for a Hyperloop journey.

Figure 22 shows the results of this survey question. The cheap or cost-efficient factor received the most approvals from 131 survey participants. 38 individuals do not consider this aspect for a requirement. The second most important factor, with the second-highest number of approvals, was safety. 106 participants perceive this requirement as crucial, while 63 disagree and discern this aspect as less important. Reliability, sustainability, the fastest means of transportation and convenience were all rated relatively equally. However, for the majority are these factors not a requirement. The fact that the Hyperloop must first established and confirmed is important for 44 survey participants and not a requirement for 125 individuals. For the response option “other”, three different conditions were provided. For one survey participant is it crucial to have good connections from peripheral regions for the Hyperloop. For another respondent, the landscape should not be impaired too much. For another participant in the survey, the Hyperloop should be superior to the TGV in terms of cost efficiency and journey time.



	Fastest mode	Favourable	Safety	Sustainability	Convenience	Reliability	Established	Other
No	103	38	63	103	109	91	125	166
Yes	66	131	106	66	60	78	44	3

Figure 22: Survey analysis of the requirements for a trip with the Hyperloop.

5.1.9 Pricing for the Hyperloop

In the ninth part of the survey, the focus was on pricing with the question: “What is the maximum price you would be willing to pay for a Hyperloop journey from Zurich to Paris?”. Survey participants were required to specify the maximum price in Swiss Francs. Figure 23shows the results summarised in a

box plot and Figure 24 shows the results in a line chart. A box plot shows the minimum, the first quarter, the median and the mean value, the third quarter, the maximum, and the outliers, and therefore provides an effective representation of the answers to this question.
The lowest specified maximum price that a survey participant would be willing to pay is 15 Swiss Francs. Subsequently, the indicated maximum payment amounts were distributed and increased evenly. The median results in a maximum price of 160 Swiss Francs. The average of all stated prices is slightly above the median at 173.9 Swiss Francs. Furthermore, the figure indicates that the price range is 100 Swiss Francs at the first quartile and 200 Swiss Francs at the third quartile. The maximum payment amount of 200 Swiss Francs was the most frequently mentioned and was entered by survey participants 42 times, accounting for approximately 25% of all responses. According to the boxplot, the maximum price is 350 Swiss Francs. In addition, there were three outliers: Survey participants specified four times 400 Swiss Francs, and once each 500 and 600 Swiss Francs as the maximum payment amount for the journey from Zurich to Paris with the Hyperloop.

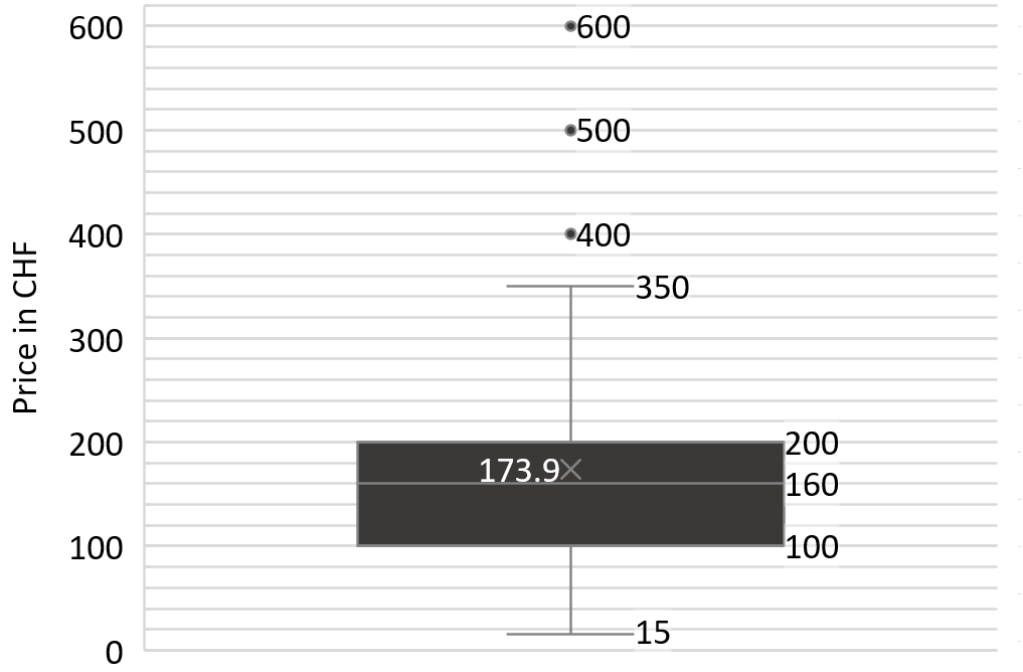


Figure 23: Survey analysis of the pricing for the Hyperloop in a box plot.

In the following Figure 24, the survey results for the pricing of the Hyperloop for the route from Zurich to Paris are visualised in a line diagram. The line chart provides a good overview of all the different answers with the distribution. The results are identical to the box plot but with a different view. At a price of CHF 300, 19 survey participants would use the Hyperloop for the route from Zurich to Paris, at CHF 200 there are 75 respondents, at CHF 100 there are 147 participants and at CHF 50 there are 165 passengers.

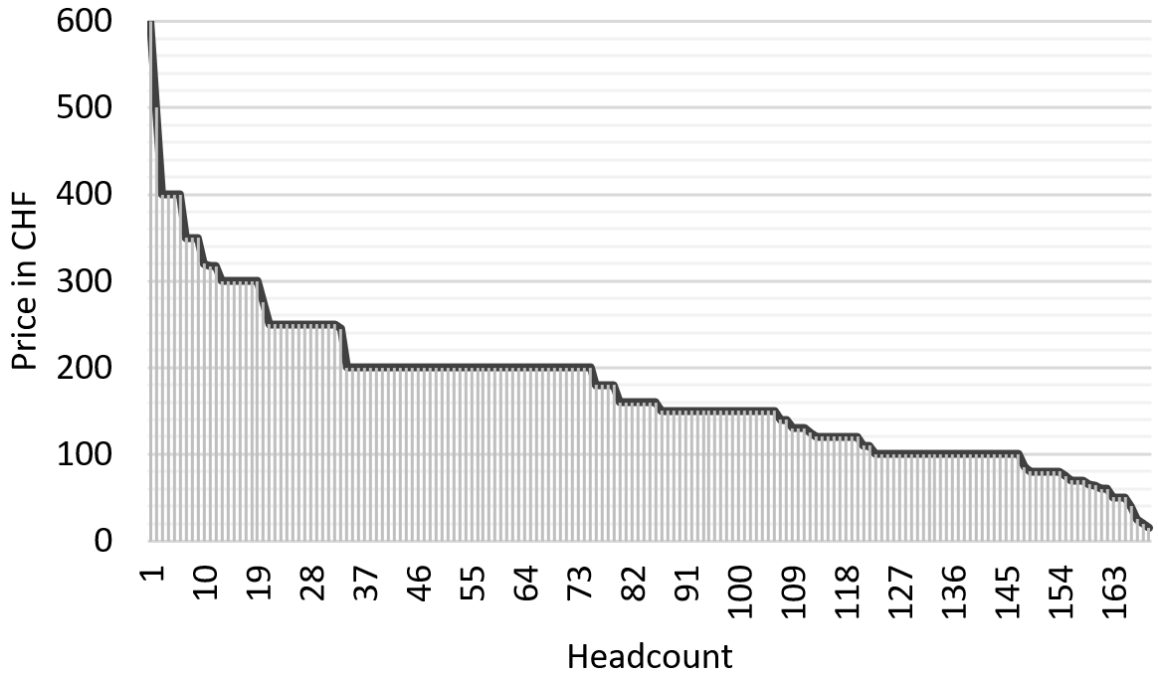


Figure 24: Survey analysis of the pricing for the Hyperloop in a line chart.

5.1.10 Optimum modes of transportation for future travel demand

In the final question of the survey, the focus was on the following factor: “Which mode of transportation could be the best way to fulfil your travel needs in the future?”. The survey participants had the following response options available: Bicycle, car, bus tours, motorbike, train, airplane, and Hyperloop. In this process, survey participants had to rank the various modes of transportation according to their preferences. The higher the preference, the higher the rating. The highest rating was represented by the number seven, and the lowest rating, indicating the least preference, was represented by the number one. Figure 25 presents the results, with the outcomes or preferences arranged sequentially.

The fulfilment of future travel needs is least guaranteed by the motorbike. The survey participants rated this mode of transportation with an average score of 2.25, and this is followed by the
the bus tours, receiving the second-lowest rating with an average score of 2.88. The airplane and the bicycle are very close to each other in ratings. The survey participants giving similar assessments, averaging 3.70 and 3.95 respectively. The Hyperloop received a very high rating for future travel requirements, despite not yet existing and being offered. The participants in the survey rated this mode of transportation with an average score of 4.86. The second most chosen mode of transportation for future travel needs is the car, with a rating of 4.89. This value is almost identical to the rating for the Hyperloop. The train was selected as the preferred mode of transport for the future and can best fulfil the future travel needs of the survey participants. The average value is 5.47. The train is the highest preference, and the value comes close to the number six. The train received the highest preference and, according to this survey, should provide the best fulfilment of the respondents' travel needs.

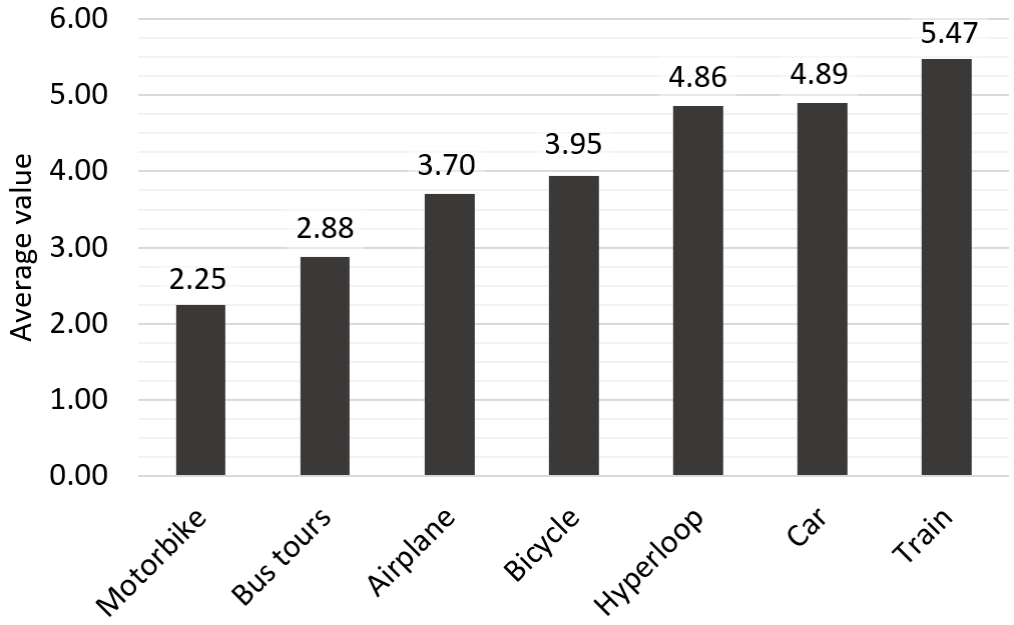


Figure 25: Survey analysis on optimal future transportation modes.

5.2 Detailed analysis and comparison of the survey results

This subchapter provides a detailed analysis of the survey results, analysing and highlighting comparisons and dependencies. Conducting further research and analyses of the survey results is crucial to gain a deeper understanding of the underlying patterns, correlations, and implications. This detailed analysis should help to identify trends and influencing factors. By comprehensively comparing different survey questions with each other, correlations can be recognised, and insights gained into how different variables relate to each other. This enables the alignment of strategies, informed decision-making and the development of targeted solutions based on the findings. Overall, these analyses serve to provide a more comprehensive and differentiated overview of the survey data to facilitate informed decisions and measures.

5.2.1 Comparison of the age group and transport habits

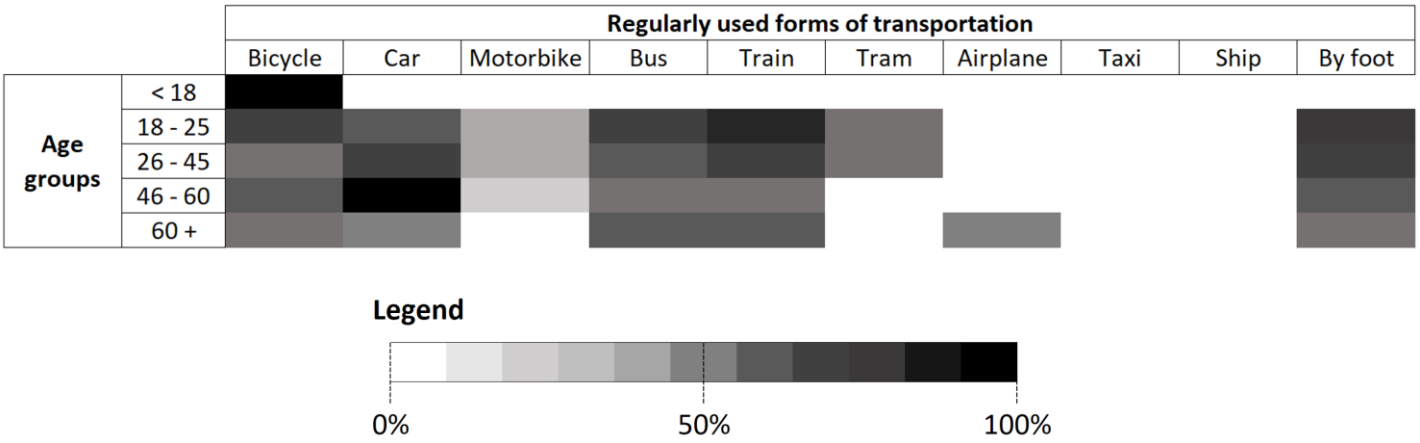
In this sub-chapter, the five age groups are compared and analysed with the transport habits and the means of transportation used by the survey participants. This enables the analysis of mobility aspects specific to each age group. This comparison makes it possible to identify patterns, preferences, and potential challenges in relation to transport use in different age groups.

The Table 2 shows the transport habits in relation to the age groups. It was analysed which means of transportation are most used today by which age groups. The different means of transport are shown on the x-axis: Bicycle, car, motorbike, bus, train, tram, airplane, taxi, ship and move by foot. And the age groups are listed on the y-axis: Younger than 18 years old, between 18 and 25 years old, between 26 and 45 years old, between 46 and 60 years old and the last age group is older than 60 years. The fields were coloured in such a way that the darker the field, the higher the percentage and therefore the higher the usage. Accordingly, a legend has been added at the bottom of the Table 2.

The most frequently used means of transportation are the bicycle, car, bus, train, and many survey participants also travel a lot by foot. The first age group, where the survey participants are younger than 18 years old, only use the bicycle as a regular mode of transportation. Age group two, which is between 18 and 25 years old, is the most frequent traveller on foot and by train. This is followed by

the bus, bicycle, and car. The tram and motorbike are also used sporadically. In the third age group, which is between 26 and 45 years old, the results are very similar. Survey participants commonly use the train, car, and frequently travel on foot more than three times a week. This is followed by the bus, bicycle, and motorbike. Age group four, which has an age range of 46 to 60 years, uses the car most frequently. Less than half of this age group travel on foot and by bicycle. The train, bus and motorbike are also used in isolated cases. A third of the final age group, aged over 60 years, use the bicycle, bus, and train. Survey participants in this age group also occasionally travel on foot, by car, and by plane. Neither taxi nor ship are regularly used by any survey participants.
Overall, the preferences vary between the age groups. The train, car and move by foot are chosen and used most frequently.

Table 2: Survey analysis of the comparison of the age group and transport habits.

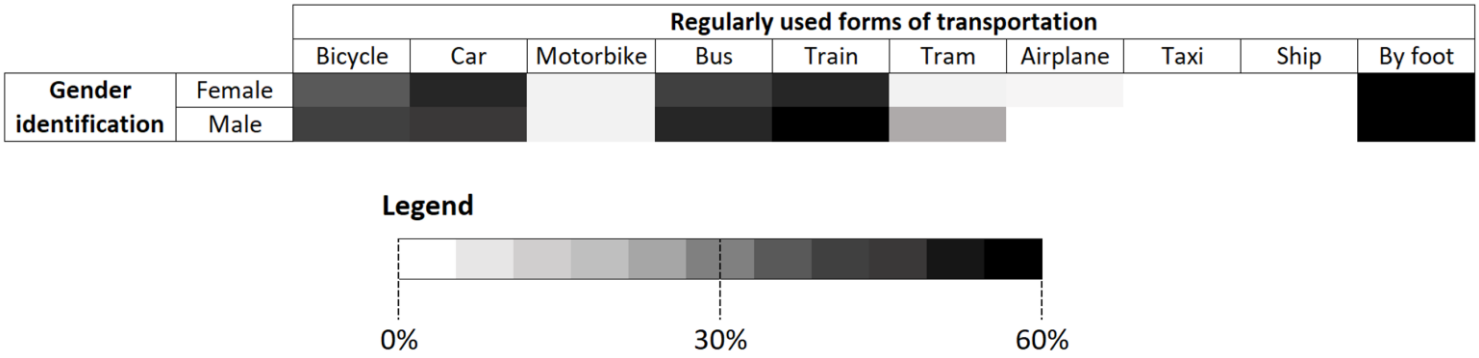


5.2.2 Comparison of the gender and transport habits

In the following chapter, transport habits are compared and analysed in relation to gender. The transport habits of the survey participants were compared with the genders to identify possible gender-specific differences or patterns in mobility behaviour. This analysis can provide insights into how the different genders use different modes of transport, what their preferences are and whether certain transport habits are gender dependent or not.
The Table 3 below shows the comparison of the different regularly used means of transportation with the genders. It was analysed and investigated which modes of transportation are used most regularly today and by which genders. The different modes of transport are shown on the x-axis: Bicycle, car, motorbike, bus, train, tram, airplane, taxi, ship and move by foot. The genders are listed on the y-axis. A total of two genders were identified by the survey participants: Female and male. The fields were coloured in such a way that the darker the field, the higher the percentage and therefore the higher the usage. The highest parameter is 60%. Therefore, a legend was inserted at the bottom of Table 3.
Both genders, as well as the male and female participants, travel regularly on foot in general transportation. In addition, both genders of survey participants frequently use the train more than three times a week. In comparison, the male participants use the train a little more than the female individuals.
The female survey participants travel most frequently on foot, then by car, followed by train, then by bus, closely followed by bicycle, next by tram and then by motorbike. One female participant also frequently uses the aeroplane as a means of transportation. The preference for the most frequently used forms of transportation among male survey participants is slightly different. The train is the most frequently used mode of transportation. After this, male respondents regularly travelled on foot, subsequently by bus, then by car, followed by bicycle. The tram is also used by several people and the

motorbike also by a few participants. None of the male survey participants used the aeroplane regularly. Neither the female nor the male participants regularly travelled by taxi or by ship. No one travelled regularly by these means of transportation. There is no statistically significant difference between the genders.

Table 3: Survey analysis of the comparison of the gender and transport habits.



5.2.3 Comparison of age and preferred transport factors

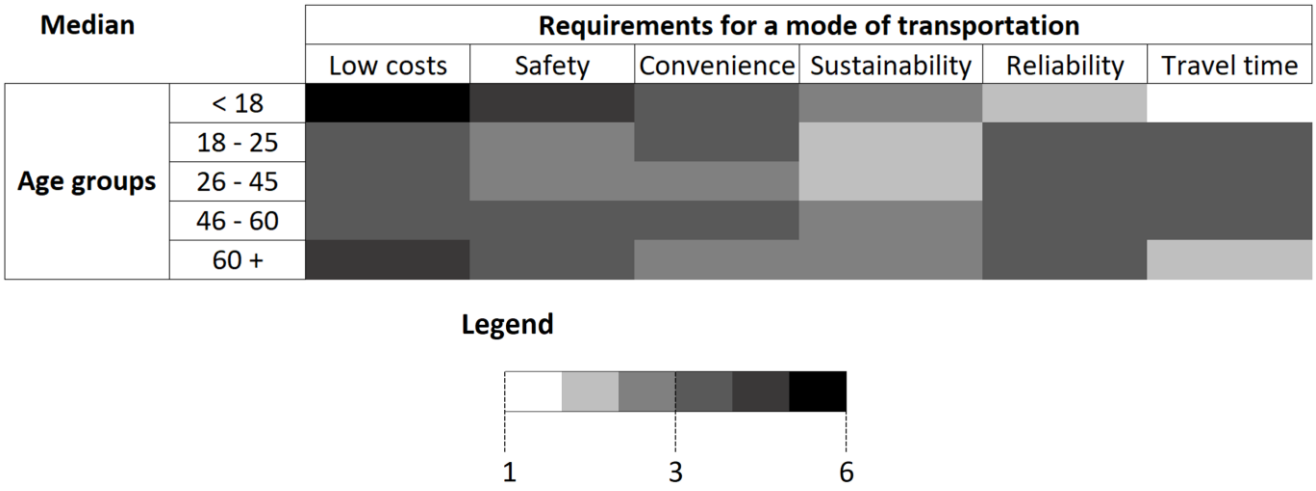
In this subsequence, the age groups are compared with the requirements and aspects of a method of transportation. This comparison makes it possible to identify age-specific differences in the preferences and behaviours of the survey participants. These findings are used to adapt transport services specifically to the respective age groups. By developing age-appropriate transport strategies, cities and municipalities can allocate resources more efficiently and improve transport infrastructure where it provides the best benefits for specific age groups. This promotes a targeted, needs-based organisation of the transport system. About the Hyperloop, the infrastructure and the entire system could be better aligned and developed according to the respective preferences.

Table 4 shows the comparison with the median. The Appendix on the page 95 also shows the first and third quartiles. The median was deliberately chosen because it is robust against outliers and provides a good representation of the data. However, the first and third quartiles were also analysed for a complete comparison. The x-axis lists the requirements for a current form of transportation: Low cost, safety, comfort, environmental aspect or sustainability, reliability, and travel time. The y-axis lists the five age groups: Younger than 18 years old, between 18 and 25 years old, between 26 and 45 years old, between 46 and 60 years old and the last age group is older than 60 years. The fields were coloured in such a way that greater darkness corresponds to a higher value, which indicates a stronger requirement. A legend has therefore been added at the bottom of Table 4.

At first impression, the distribution of preferences for all age groups shows a striking similarity. In the under 18 age group, favourable costs are considered the decisive factor for choosing a means of transportation, followed by safety and comfort. Travelling time is the least important factor, but these results are not meaningful as there are only two participants in this age category. In the second age block, the views of the survey participants vary considerably. The four most important requirements are short journey times, reliability, comfort, and low costs. The environmental aspect receives the lowest rating. Similar results can be identified in the third and fourth age groups, whereby the preferences are comparable and almost identical to those of 18–25-year-olds. The 26-45 age group attaches particular importance to low costs, reliability, and a short journey time, while safety and comfort carry less weight. In the fourth age group, reliability and short journey times are the top priorities, followed by low costs, safety, and comfort. For the over-60s, low cost is the most important aspect. However, it should be

noted that these results are not representative due to the small number of participants in this age group. In addition, reliability is named as the next most important factor, followed by safety, sustainability, and comfort. Travelling time is rated as the least important.
The preferences of the various age groups show that factors such as low costs, reliability and short journey times are consistently in the focus. Overall, reliability proves to be the most important criterion across all age groups.

Table 4: Survey analysis comparing the age group and preferred transport factors.

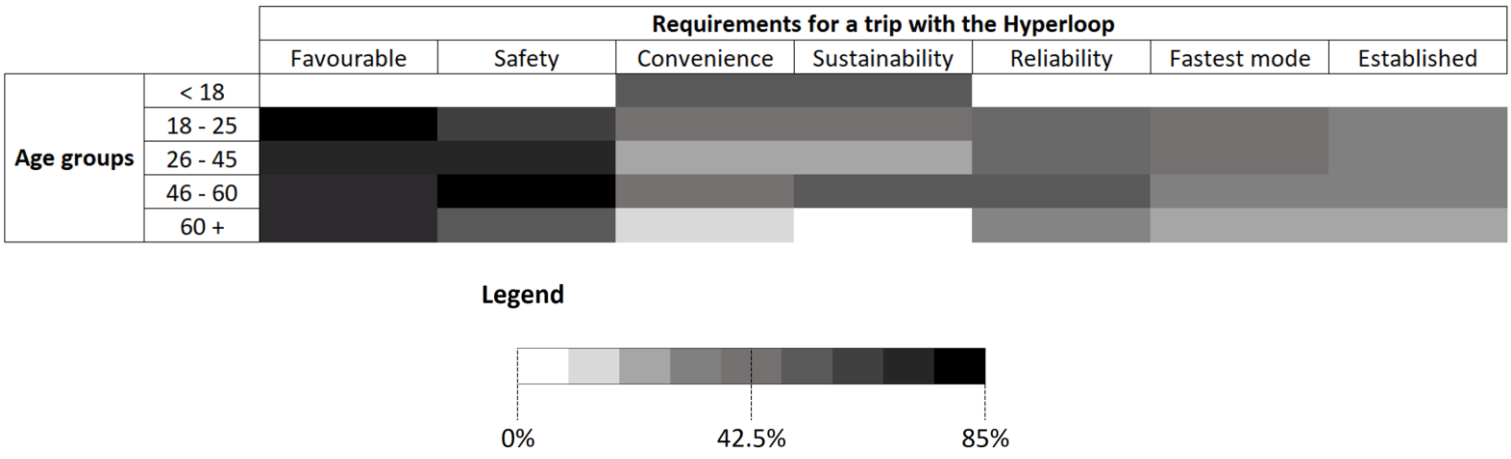


5.2.4 Age-Related Requirements in Hyperloop Travel mode

The section analyses the age categories with the requirements for a Hyperloop journey. The purpose of the analysis is to identify the needs and challenges of different age groups. This enables a targeted design and adaptation of the Hyperloop travel conditions to the different age categories, considering different needs. This should enhance the acceptance and utilisation of the Hyperloop system.
Table 5 shows the results of the analysis. The x-axis lists the requirements for a future journey with the Hyperloop: Fastest mode which means fastest mode of transportation, favourable, safety, sustainability which includes the environmental aspect, convenience, reliability and established. The five age blocks are listed on the y-axis: Younger than 18 years old, between 18 and 25 years old, between 26 and 45 years old, between 46 and 60 years old and the last age group is older than 60 years. The areas were coloured in such a way that darker colours correspond to a higher value, which indicates a higher priority. The highest value is 85%. A legend has therefore been added at the bottom of Table 5.
The low number of participants in the youngest age group impairs the validity of the results. However, sustainability and convenience were selected as requirements for the Hyperloop, although low costs and safety were favoured in the chapter 5.2.3 Comparison of age and preferred transport factors when comparing the age groups and the requirements for a current means of transportation. These statements are contradictory and therefore no clear conclusion can be derived from them.
In the second age group, which is between 18 and 25 years old, the value for favourable respectively low costs was rated highest. This is followed by safety. The aspects of reliability, sustainability, fastest method of transportation and comfort are close to each other and were each rated equally. This analysis is also contradictory to the evaluation in the previous chapter. For the current means of transport, four requirements such as reliability, short journey time, low cost and comfort were rated according to equal importance. However, if a future Hyperloop system is to be used, it must above all be cost-

effective. Safety was also rated highly compared to the previous comparison. These are contradictory findings from which no clear conclusion or solution can be derived.
The 26 to 45 age group also rated low costs and safety as the most important aspects. This was followed by reliability and the fastest means of transport as further requirements. The environmental aspect and comfort were considered less important. Compared to the requirements for conventional modes of transport, the results are similar. However, the survey participants emphasise that low costs are even more important for a Hyperloop system than for current technologies. It is notable that safety is rated higher for a Hyperloop than for other modes of transportation. The analysis shows that survey participants prioritise reliability and short journey times in traditional transport, while safety and cost efficiency are the main priorities in the Hyperloop. These differences indicate that in the acceptance and development of hyperloop systems, a particular focus is placed on safety aspects and economic efficiency.
The 46 to 60 age group rated safety as the most important factor. This is followed by affordability, sustainability, and reliability. Compared to the requirements for conventional means of travel, there are differences for a Hyperloop. With today's means of transport, reliability and fast speeds are prioritised primarily. The subsequent prioritisation of sustainability and reliability indicates that the participants attach particular importance to economic efficiency and safety aspects in future transport solutions.
The oldest age group, the over 60-year-olds, rated low costs as the most important aspect, followed by safety and reliability. Compared to current transport requirements, the weighting of the factors is different. Nowadays, low costs and reliability are important requirements. This is followed by safety, comfort, and sustainability. In contrast, sustainability and comfort are not a requirement for a Hyperloop system and are rated very low. It is remarkable that for these survey participants in the over-60 age group, low costs are particularly important when it comes to the acceptance and design of Hyperloop systems. This suggests that particular emphasis is placed on economic efficiency, with reliability and safety also being important aspects.
Overall, low costs and safety were rated as the highest. These are therefore the most important requirements for a future Hyperloop transport system.

Table 5: Survey analysis of the age-related requirements in the Hyperloop travel mode.



5.2.5 Price range in relation to the age group

In this section, the maximum payment amounts for the use of a Hyperloop route between Zurich and Paris are compared and analysed in relation to different age groups of the survey participants. This study not only provides insights into the cost awareness and willingness to pay of different age groups.

It could also be used in the future to develop strategic decisions regarding pricing to maximise the acceptance of the Hyperloop in different age groups. Furthermore, such a comparison could provide information on whether it makes sense to introduce differentiated pricing models for different age groups. Other benefits could also be realised by developing targeted marketing strategies to better address and attract specific age groups. However, this will not be analysed in this project. In an additional step, it would be possible to determine how many people in which age groups would travel from Zurich to Paris by Hyperloop at what price.

Figure 26 and Figure 27 shows the survey results along with the comparison between price and age. Figure 26 shows the outcome in a box plot. There are five boxplots for each age group: Younger than 18 years old, aged 18 to 25, aged 26 to 45, aged 46 to 60 and the last age group is older than 60 years. The y-axis shows the price range from zero to six hundred Swiss francs. The minimum, average, median, maximum and first and third quartiles are displayed in a box plot. Occasionally there are also some outliers.

The willingness to pay for a Hyperloop journey from Zurich to Paris varies according to age group. The youngest age group, which is under 18 years old, shows the least readiness to pay a higher amount for a Hyperloop journey from Zurich to Paris. The average and median values are both 32,5 Swiss francs. The second age group, aged between 18 to 25, shows the second-lowest willingness to pay, with a median of CHF 150 and an average of CHF 165,4. The price responses are mixed between the other age groups. The boxplot of the third age group is more compact and therefore shows a smaller variance and a more consistent willingness to pay. The majority of them hold the same view and many hold the same maximum amount to be paid for the aforementioned Hyperloop journey. The average value for the third age group is 184,5 Swiss francs. The median is a somewhat higher 190 francs. The fourth age block has more varied answers from the survey participants. The median is 200 francs, and the middle value is 207,9 francs. According to this survey, the fourth age group is most willing to pay for the journey from Zurich to Paris by Hyperloop. The oldest age group, with survey participants over the age of 60, has a wide price range. Each of the participants stated a different maximum price. The median is 200 Swiss francs, and the mean is 170 francs.

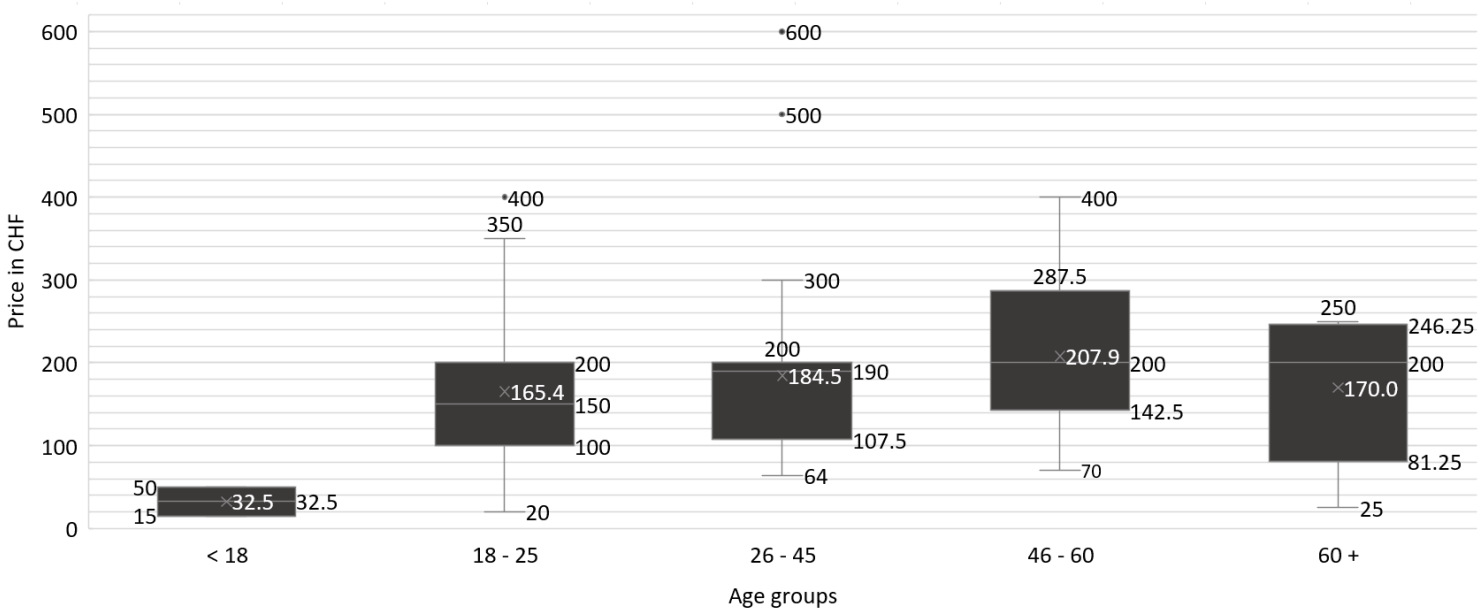


Figure 26: Survey analysis of the price range in relation to the age group with the box plot.

Figure 27 below also shows the result of the maximum amount paid for a Hyperloop journey from Zurich to Paris compared to age. However, the representation was analysed in a line diagram with the percentage proportions of the participants. The diagram helps and provides an overview of how many survey participants in which age category are travelling at what price. In the diagram, the youngest age group indicated the lowest maximum price to be paid for the Hyperloop connection. This was also evident in the boxplot. However, this is not meaningful as there are only two survey participants in this age block. At a maximum amount of CHF 50, one of the two survey participants is willing to take the trip and at CHF 20, both minors will take the trip.

More than half of the survey participants are aged between 18 and 25. At a maximum price of CHF 400, three percent of the people in this age group would choose the Hyperloop route from Zurich to Paris. At 300 Swiss francs, the proportion is ten percent, at 200 francs it is 38%, at 100 francs it is 86%, and at a price of 20 francs, the entire age category would take the journey. Although this is not a linear function, the result can be regarded as a discrete probability distribution.

The 26 to 45 age group represents the second largest block, with two outliers. One person would be willing to pay a maximum of 600 francs and another 500 francs. At a travel price of 200 Swiss francs, 17% of this age category would take part, at 100 Swiss francs it would be 30% of all survey participants and at 64 Swiss francs the entire age block would take part. This is also a discrete probability function.

The price line for the 46-60 age group appears steep. At a maximum price of 300 francs, 6% of the survey participants would take the Hyperloop journey, at 200 francs already 15%, at 100 francs 21% and at 70 francs the entire fourth age category. Comparatively little data is available in the oldest age group, which limits representativeness. The line in the line graph also appears steep. At a maximum price of CHF 250, one person would cover the distance with the innovative means of transportation. At 200 francs, it would be 4% of all survey participants in this age category. At the lowest stated maximum price of 25 Swiss francs, all six people in this age range would choose the Hyperloop to Paris.

Each age group indicated similar prices for the Hyperloop connection, but with a different distribution. This results in a differentiated probability allocation for each age category. However, no clear result can be derived from Figure 27. The income of the survey participants could be analysed for a further study.

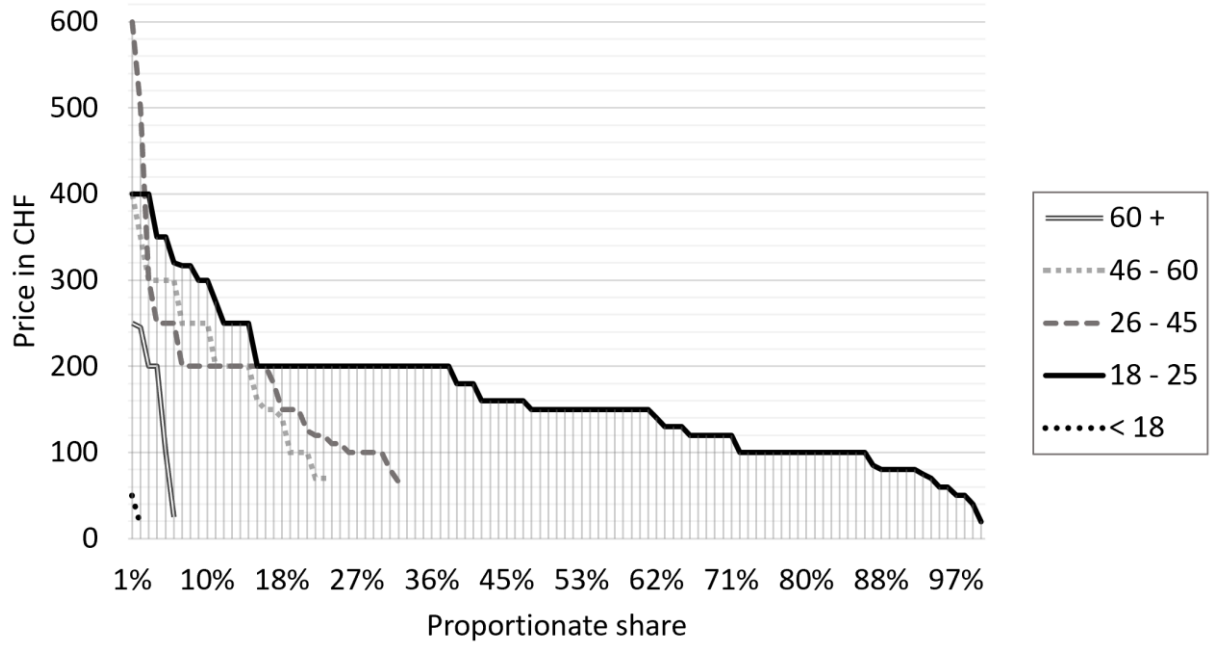


Figure 27: Survey analysis of the price range in relation to the age group in a line chart.

5.2.6 Age groups compared with future means of transportation

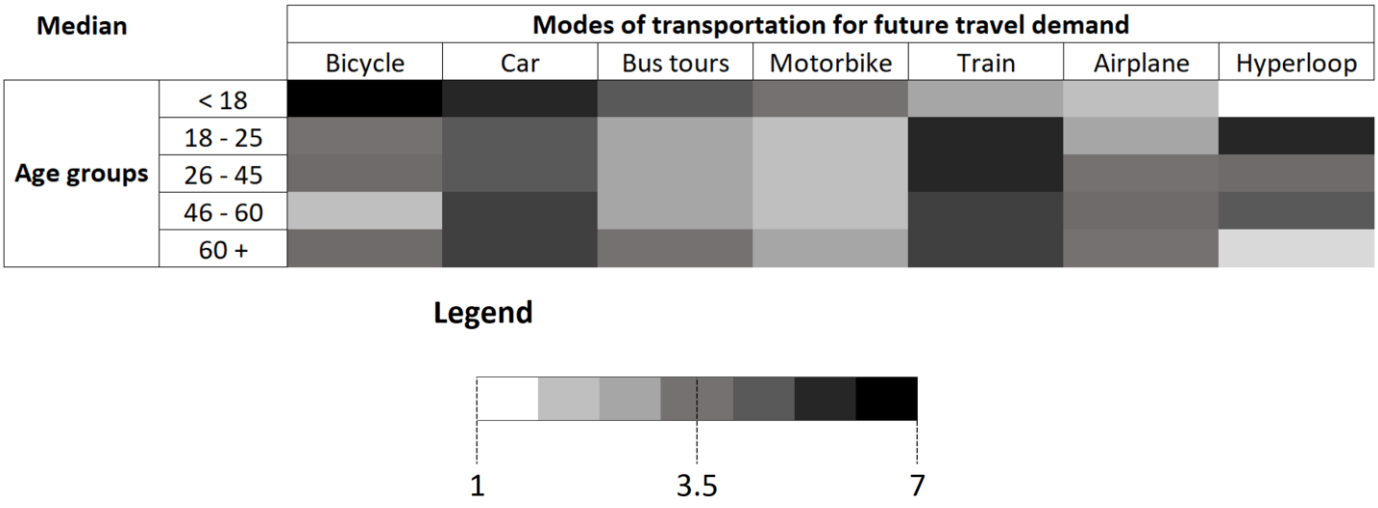
In this section, the different age groups are compared with the modes of transportation that can best fulfil the travel needs of the survey participants in the future. The benefit of this comparison is that it provides insights into the diversity of the population's needs and preferences. Particularly about the development and implementation of future means of transportation. By understanding the different priorities and requirements of different age groups, user-friendly solutions can be created that promote the acceptance and use of new transport technologies.

Table 6 shows the results of this comparison. The graph shows the median and the first and third quarters are shown in the appendix on the page 96. The higher the value, the higher the priority. In addition, the graph was coloured in such a way that the darker the field, the higher the priority. The x-axis lists the modes of transportation that could exist in the future and could fulfil the travel needs of the survey participants: Bicycle, car, bus tours, motorbike, train, airplane, or Hyperloop. The y-axis lists the five age groups: Younger than 18 years old, 18-25 years old, 26-45 years old, 46-60 years old and older than 60 years old.

For the youngest survey participants, the bicycle best fulfils future travel needs, although no representative statement is possible due to the small number of participants. Among 18–25-year-olds, the train and the Hyperloop fulfil the future travel needs the most. This is followed by the car and the bicycle. This is comparable to the analysis in chapter 5.2.1, whereby this age group uses the train the most nowadays. It highlights the importance of considering existing behavioural patterns to design effective transport solutions that respond to the changing needs and habits of the population.

In the 26-45 age category, the train also has the highest preference for the future. This is followed by the car, the bicycle, the Hyperloop, and the airplane. This is also in line with the previous analysis in section 5.2.1, with the train currently being used by this age group. In the 46-60 age group, the train and the car best fulfil future travel needs. This is followed by the Hyperloop and the aeroplane. Compared to the nowadays most frequently used means of transportation, the car was mentioned the most by the participants. For the future, the train received a higher preference than today. This means that participants in this age group could change their transport habits to an existing method of transportation. In the oldest age group, the car and the train are favoured for the future travel needs. This is followed by travelling by bicycle, bus tours or plane. Compared to the most used types of transport at the present time, the analysis is comparably similar, and the train and bus are used the most. Although the results are not representative due to the small number of participants, and it is not possible to make a statement.

Table 6: Survey analysis of the age groups compared with future means of transportation.



5.2.7 Comparison of preferences analysis of regularly used means of transportation

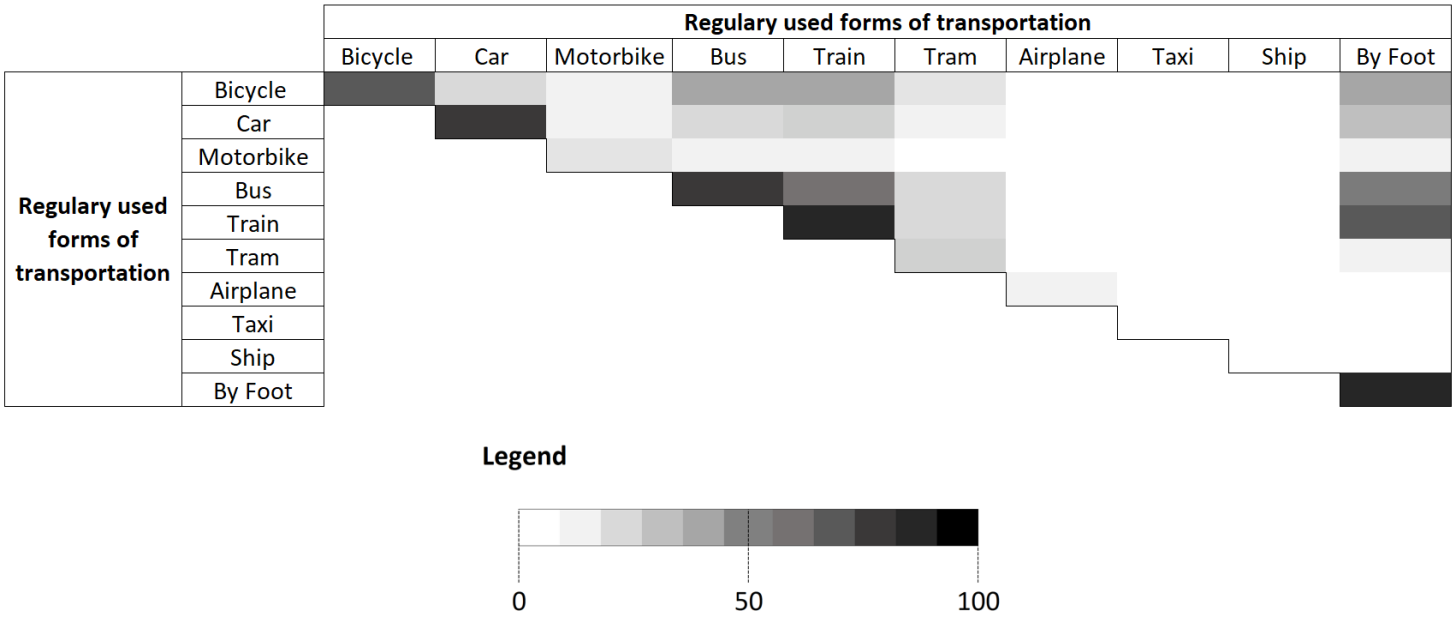
In this section, the means of transport currently used by the survey participants are analysed in pairwise comparisons. The different forms of transportation are compared with each other to determine which means of transport are frequently used in combination. In addition to revealing the combination of modes of transport, this comparative analysis provides potential passengers with information to help to choose the most suitable means of transportation for their needs and usage options. This information could be used to develop the future Hyperloop system in the best possible way. Table 7 shows the pairwise comparison of the regularly used modes of transport of the survey participants. The intensity of the colouring indicates how frequently the combined means of transport are used. The darker the field, the higher the use of the corresponding means of transport in combination. There is a legend in the Table 7, where the value 100 corresponds to the participants. The currently forms of transport used in the survey are as follow: Bicycle, car, motorbike, bus, train, airplane, taxi, ship and move by foot.

The comparison of modes of transport against the same means of transport certainly yields the highest results. The survey participants who regularly travel by bike are also often on foot, by train or by bus. and some also occasionally use a car. The same applies to those who regularly use the car. This people also travel on foot and use the train and bus.

The survey participants who frequently use motorbikes and aeroplanes are not representative and not meaningful due to the small number of participants. People who frequently use the bus also often use the train, and conversely. In addition, due to the public transport infrastructure, the individuals are often dependent on travelling on foot.

The comparisons of means of transportation in the survey show that users of certain types of travel often combine several modes of transport. This suggests that there is a need for integrated mobility solutions that combine different modes of transport to fulfil individual needs.

Table 7: Survey analysis comparing of the regularly used means of transportation.



5.2.8 Comparison of current transport preferences with travel needs

In this section, the regularly used means of transportation of the survey participants are analysed with the requirements for the modes of travel. This comparison enables to identify the requirements and

priorities of the users and to find out which features are most important. On this basis, innovative transport solutions such as the Hyperloop could be better adapted to people's individual needs and ensure that future means of transport optimally fulfil the requirements of users. In addition, the comparison supports the difference between the requirements of current mode of travelling and the expectations of the Hyperloop system.

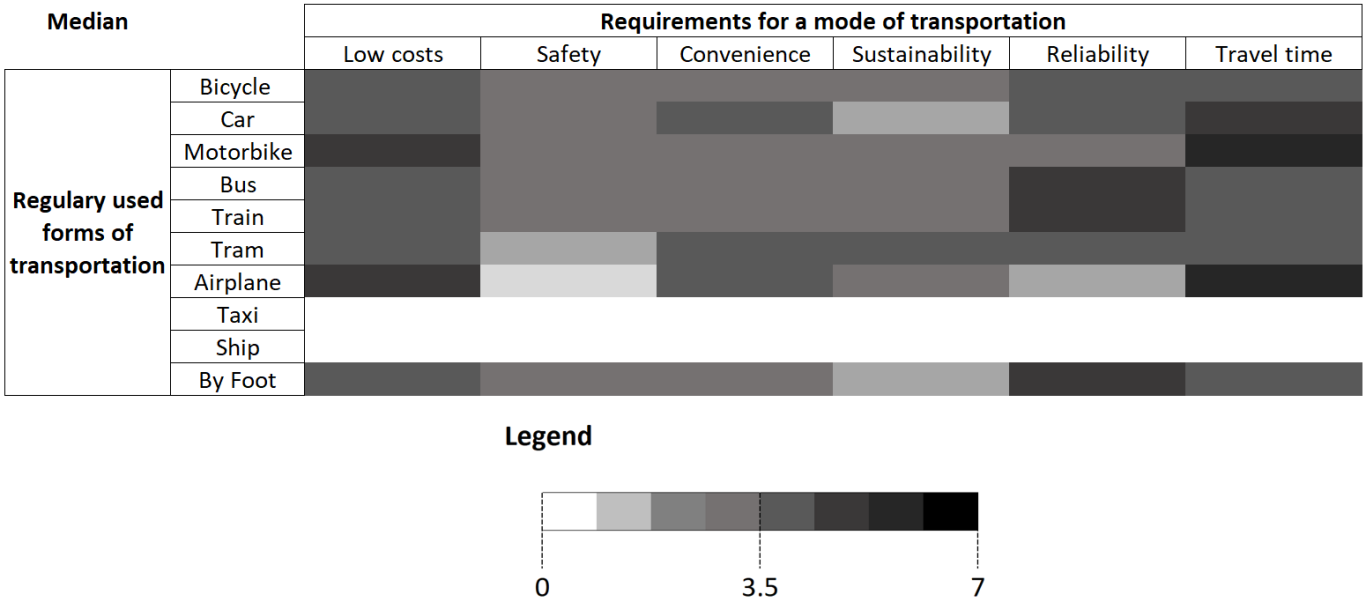
Table 8 shows the results of the analysis in a matrix with the calculated median. In addition, the first and third quartiles of the comparison were calculated, the details of which are described in the appendix on the page 102. The requirements for the means of transportation are listed on the x-axis: Low costs, safety, convenience, sustainability, reliability, and travel time. The y-axis represents the regular modes of transport used by the survey participants, including bicycle, car, motorbike, bus, train, tram, airplane, taxi, ship and move by foot. The individual factors were compared with each other, whereby the median was calculated. A higher median lead to a darker colouring of the respective field and indicates a higher prioritisation of the corresponding requirements. There is also a legend below the matrix. Each mode of transport was divided into separate groups to analyse the specific needs of each group in more detail.

The bicycle group prioritised low-cost options, travel time and reliability as the highest. This is followed by safety, comfort, and sustainability. Short journey times are also the most important requirement for car drivers. This is followed by low costs, comfort, reliability, and safety. The environmental aspect is the least prioritised. For the motorbike category, the two most important factors are short travelling periods and low costs. All other aspects were rated equally.

The bus and train groups have identical ratings, with reliability being favoured, followed by travel time and low costs. Safety, convenience, and sustainability ranked next. Due to the low number of participants, the aeroplane, taxi, and ship groups cannot be analysed. Respondents who frequently move by foot attach particular importance to reliability, followed by low costs and short journey times. The environmental aspect is least favoured.

Overall, the survey results show that participants rate low costs and short journey times as the highest priorities and therefore prefer these factors. Sustainability and safety receive the lowest prioritisation.

Table 8: Survey analysis comparing current transport preferences with travel needs.



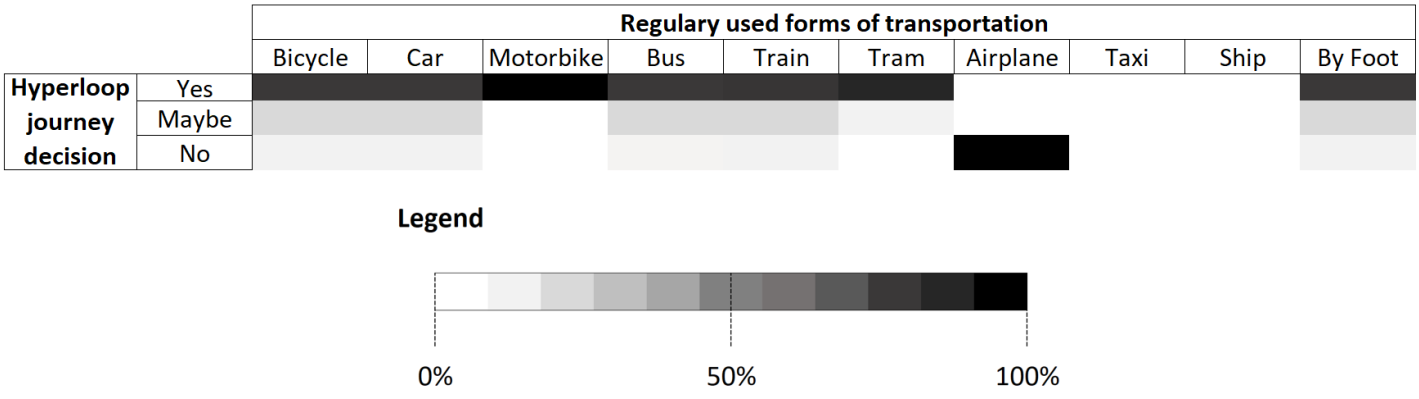
5.2.9 Current trends in transport that favour or oppose Hyperloop travel

The following section compares the regularly used modes of transport by the survey participants with the consideration of taking a Hyperloop journey from Zurich to Paris. It analyses which groups are considering the Hyperloop as a potential future means of transportation for the mentioned route. The aim is to find out which group that currently prefers a certain mode of transportation would be willing to switch to the Hyperloop for the journey from Zurich to Paris.

Table 9 shows the comparison in a matrix. The frequently used forms of mobility are listed on the x-axis: Bicycle, car, motorbike, bus, train, tram, airplane, taxi, ship and move by foot. On the y-axis, the decisions for future Hyperloop journey for the route from Zurich to Paris are listed: Yes, maybe or no. The percentages of all survey participants for each decision were shown in the matrix. A legend below the matrix explains that darker coloured boxes represent a higher proportion for that decision and that group of transport mode.

In all transport mode groups, approval for using the Hyperloop predominates, except for the aeroplane group. However, due to the small number of participants in the motorbike, aircraft, taxi, and ship groups, these are not representative and therefore not very meaningful. The bicycle, car, bus, and train and move by foot groups show identical results. In these groups, the decision to travel from Zurich to Paris by Hyperloop in the future significantly predominates with an approval rate of more than 75%. This is followed by the “maybe” option and the “no” option as the least chosen alternative, with a maximum share of 5%. In the tram category, 95% of participants voted in favour of yes and 5% for maybe. Overall, the majority of all groups are willing to use the Hyperloop from Zurich to Paris. Some are still hesitating with maybe and very few would never consider the Hyperloop.

Table 9: Survey analysis of current transport trends regarding Hyperloop preferences.

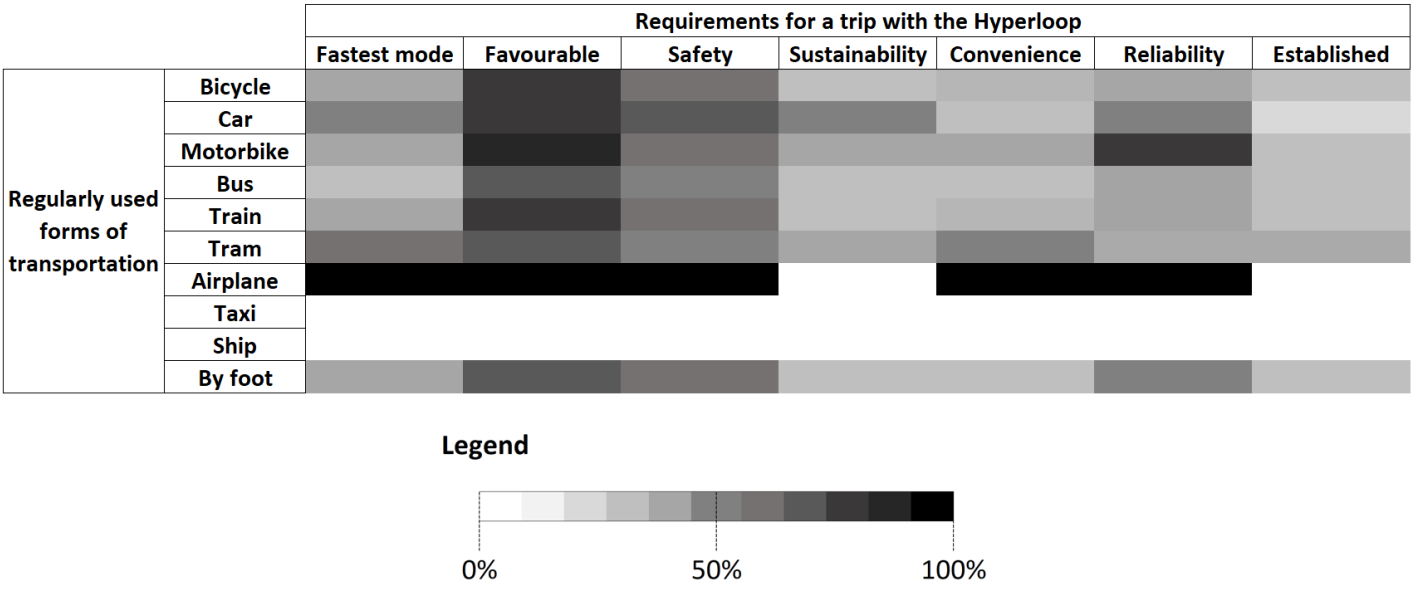


5.2.10 Current transport trends analysed with the requirements for Hyperloop travel

In this section, a comparison is carried out between the current means of transportation with the requirements for the Hyperloop system. The aim is to provide a feasible assessment of the Hyperloop system in comparison to already established alternatives. This analysis will determine whether the Hyperloop can fulfil the requirements of daily mobility and potentially represent an improved solution for frequently used transport routes. The focus on regularly used modes of transportation helps to identify specific advantages and efficiency gains of the Hyperloop in the operations of daily routine. In addition, it is analysed which groups have which requirements for the Hyperloop and whether these groups may have different requirements for conventional means of transportation and the Hyperloop system.

Table 10 shows the comparison and the results in the matrix. The requirements for a Hyperloop solution are shown on the x-axis: Fastest mode, favourable, safety, sustainability, convenience, reliability and established. The means of transport regularly used today by the survey participants are listed on the y-axis: Bicycle, car, motorbike, bus, train, tram, airplane, taxi, ship and move by foot. The fields of the matrix were coloured so that the darker the coloured field, the higher the value and the agreement of the survey participants and the higher the match. A legend is added below the matrix in the Table 10. In this context, the percentage of each category is calculated. This means that each mode of transport was assigned to a specific group and then the percentage proportion of this group in the requirements of the Hyperloop system was determined. As a result, a higher percentage share leads to a more intensive shading of the corresponding field.
The various means of transportation were categorised for the following analysis. The first thing that emerges is that the cost aspect is the most significant requirement of the Hyperloop system for all groups of regularly used modes of transportation. For the group of bicycles, the most important factor is low cost, followed by safety, reliability, and the fastest method of travel. This is followed by comfort, sustainability, and the fact that the technology has become established. For the survey participants, which regularly use the car as a transport mode nowadays, low costs are also one of the most important requirements for a future Hyperloop technology. This is followed by safety, reliability, the environmental aspect, fastest mobility solution, comfort, and established status.
Five groups are not representative due to the small number of participants and the fact that they are not used: Motorbike, tram, airplane, taxi, and ship. For the bus and train categories, the ranking is identical, with both groups favouring low costs for a Hyperloop journey. This is followed by safety, reliability, travelling fast, sustainability and convenience. Participants who frequently travel on foot also prioritise low costs as the main requirement for Hyperloop technology. Safety and comfort are in second priority.

Table 10: Survey analysis comparing current transport trends with Hyperloop travel needs.



Overall, it can be summarised that the low-cost factor is preferred by all groups. This is followed by safety and reliability. The aspects of establishment, sustainability and comfort are less prioritised. In comparison to the analysis in chapter 5.2.8 Comparison of current transport preferences with travel

needs, there are different demands between current means of transportation and the Hyperloop system. The requirements for current forms of mobility are diverse and evenly distributed, while the Hyperloop system prioritises low costs and safety. For currently used forms of transportation, short travel times, low costs and reliability are the most preferred factors. From this, it can be deduced that for a successful implementation of the Hyperloop system in the future, particular emphasis should be placed on ensuring that it is cost-effective and safe. These are requirements for the Hyperloop model for users to make the system attractive and user-friendly.

5.2.11 Comparison of current transport options with the affordability of the Hyperloop

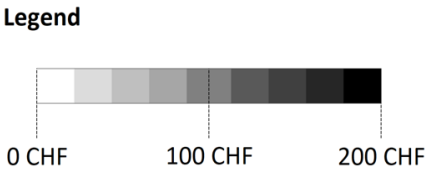
This section compares the current transport options in terms of the maximum price to be paid for a Hyperloop journey from Zurich to Paris. Each survey participant uses different forms of transportation for their daily journey. The participants were divided into groups according to their preferred means of mobility. The aim is to find out how much each user of a particular mode of transportation would be willing to pay for the mentioned Hyperloop journey. This analysis provides evidence of the financial aspects and preferences of the various user groups. And it offers a basis for the strategic pricing and market orientation for the future development of the Hyperloop. The comparison would enable the development of customised strategies for different customer segments and a more precise assessment of potential market demand.

Table 11 shows the comparison in the form of a matrix. The x-axis shows the regular modes of transportation: Bicycle, car, motorbike, bus, train, tram, airplane, taxi, ship and move by foot. The y-axis represents the price level. The median is calculated for this comparison. The first and third quartiles were not analysed further because the analysis with the median provides identical results. The colour of the fields in the matrix provides information about the price to be paid, with darker fields indicating higher costs. A legend below the matrix in the figure clarifies the colour coding.

According to this analysis, car users are the most willing to pay for a Hyperloop journey from Zurich to Paris compared to other modes of transport. The median for this category is 200 Swiss francs. The groups with the second highest willingness to pay are bicycle users and people who frequently move by foot, with a median of 160 Swiss francs for each group. The group of aeroplane users shows the least willingness to pay a lot for a Hyperloop route. But these results are not representative due to the small number of participants in this mode of transport category. Similarly, no statements can be made for the taxi and ship groups, as none of the survey participants regularly use these means of transportation. Overall, there is no recognisable difference between the various user groups.

Table 11: Survey analysis current transport options with the Hyperloop affordability.

Median	Regularly used forms of transportation									
	Bicycle	Car	Motorbike	Bus	Train	Tram	Airplane	Taxi	Ship	By foot
Price										



5.2.12 Current transport trends compared to future travel needs

This chapter compares the current regularly used means of transportation with those that will best cover and fulfil travel needs in the future. This allows insights to be gained into current preferences

and future requirements. It enables a well-founded assessment of possible changes and the adaptation of transport infrastructures to meet changing needs and develop innovative solutions for the future. The aim of this analysis is to record the current usage behaviours of the survey participants regarding various means of transportation and to determine the future preferences. It is investigated whether the respondents are open to change or whether they believe that a particular mode of transportation could better satisfy their needs in the future. Three views were analysed from the survey data for this representation of the results. Table 12 shows the comparison with the median. The analysis of the first and third quartiles is shown in the appendix on the page 101. It analysed how travel needs will change in the future. The y-axis shows the means of transport that respondents use regularly today: Bicycle, car, motorbike, bus, train, tram, plane, taxi, ship and move by foot. The x-axis shows the means of transport that could best fulfil future travel needs: Bicycle, car, bus tours, motorbike, train, plane, and Hyperloop. The boxes have been coloured in such a way that the darker the box, the higher the percentage and therefore the higher the use and choice. A legend was added at the bottom of the Table 12.

The current modes of travel, taxi, and ship are not considered in more detail as they are not used by any of the participants. The focus is on considering the train as the preferred mode of transport in the future, especially for people who currently use other forms of transportation frequently. For people who regularly use a bicycle today tend to prioritise the train in the future. This is followed by the Hyperloop, the bicycle, and the car with comparable preferences. Bus journeys, aeroplanes and motorbikes are less frequently favoured as future means of transportation.

Car drivers will also favour the train in the future, followed by the car and the Hyperloop. Bicycles, aeroplanes, bus tours and motorbikes are less favoured to manage future mobility. Those survey participants who frequently travel by motorbike today also choose the train for their future travel needs, followed by Hyperloop, car, and bicycle. Surprisingly, the motorbike was named as the least preferred future means of transportation. However, due to the small number of survey participants who regularly use motorbikes today, no definitive statement can be made in this group.

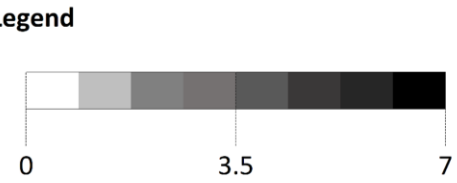
For regular bus users, the train is the top choice, followed by the Hyperloop and car. Airplane and bicycle are also considered as options. People who regularly use the train or the tram show similar preferences, with the train and the Hyperloop being the highest rated and therefore the preferred choice. This is followed by the car and the Hyperloop with a very similar rating.

For the survey respondents who frequently use the airplane today, the car is preferred for the future, followed by the airplane and the motorbike. However, these results are not representative, as only one person uses the airplane today. Participants who frequently travel on foot prefer the train the most for the future, followed by the Hyperloop and the car with equal weighting. Airplanes, bicycles, bus tours, and motorbikes are considered less suitable for addressing future needs.

Overall, the train is the best option for satisfying and fulfilling the future travel needs. Following closely behind the train are the Hyperloop and the car, which are also highly prioritised. Bus tours, aeroplanes and motorbikes are less favoured and are not considered preferred options for satisfying individual preferences.

Table 12: Survey analysis of current transport trends and future travel needs.

Median		Modes of transportation for future travel demand						
		Bicycle	Car	Bus tours	Motorbike	Train	Airplane	Hyperloop
Current regular transport habits	Bicycle							
	Car							
	Motorbike							
	Bus							
	Train							
	Tram							
	Airplane							
	Taxi							
	Ship							
	By foot							



5.2.13 Comparison current transport requirements with Hyperloop conditions

In this section, a comparison is conducted between the current requirements for conventional modes of transportation and the future requirements for the Hyperloop system. The analysis aims to identify potential differences and innovations in the demands. By identifying specific requirements of the Hyperloop system, targeted measures could be adopted to utilise its full potential. This information provides a solid basis for the development and adaptation of transport strategies to promote innovative and sustainable solutions.

The results of this analysis are summarised in a matrix in Table 13. The requirements for the Hyperloop system are listed on the x-axis: Fastest mode, favourable, safety, sustainability, convenience, reliability and established. On the y-axis, the requirements for today's forms of transportation are listed: Low costs, safety, convenience, sustainability, reliability, and travel time. The matrix in Table 13 shows the median value of each requirement in comparison. The comparison of the requirements with the values of the first and third quartile were not analysed, as the median represents the central value of the data series and provides a reliable summary. The darker the coloured field, the higher the median value and the higher the agreement. And the higher the median value, the more preferred and desired the requirement of the survey participants. A legend is also placed below the matrix.

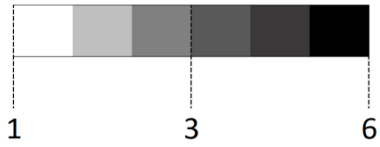
Low costs, reliability and short travel times are important expectations and requirements of the survey participants for both existing modes of transportation and the future Hyperloop system. Respondents who prioritise Hyperloop travel aspects such as short travel times, cost-effective, safe, sustainable, comfort and reliability rate low costs, comfort, reliability, and short travel times as particularly important for conventional forms of transport. Safety and environmental aspects are less favoured compared to conventional means of transportation and are therefore prioritised less. For participants who want the Hyperloop to be established, they prioritise comfort, reliability, and short travel times for today's mobility solutions.

Overall, the comparison shows that low costs, comfort, reliability, and short journey times are prioritised for both current travel options and the Hyperloop. These requirements should be offered for a successful introduction of the Hyperloop.

Table 13: Survey analysis comparing current transport requirements to Hyperloop criteria.

Median		**Requirements for a mode of transportation**					
		Low costs	Safety	Convenience	Sustainability	Reliability	Travel time
Requirements for a trip with the Hyperloop	Fastest mode						
	Favourable						
	Safety						
	Sustainability						
	Convenience						
	Reliability						
	Established						

Legend



5.3 Persona

The two personas are created based on literature research, survey results and the interpreted values of the author of this thesis. The aim is to develop a comprehensive understanding of the target group, identify their needs and promote the customer-centred development of the innovative Hyperloop system.
The first persona, Lukas Schneider, is presented on the next page. Lukas is 28 years old and lives with his wife in Winterthur, Switzerland. He grew up in an urban environment, studied business informatics and graduated with a bachelor's degree. Now he works as a system architect for the retail company Migros. Julia, his wife, works as a biologist at the company MiSANTO AG. They also have a little dog called Rocky. Lukas social network consists of people with similar interests from the technology and creative industries. He enjoys travelling with his wife as well as with his colleagues. These can be beach holidays, city trips and sports holidays. It's the variety that makes the difference. His favourite means of transportation for his daily commute are train and bicycle, due to the heavy traffic and congestion in the city. When he goes on holiday, Lukas mainly travels by plane and train.

Lukas represents a pragmatic, nature-loving character who combines his passion for technology and finance with his love of outdoor activities and do-it-yourself projects. He is known for saving money and looking for cheap and quick solutions, even if they are not always the most sustainable. He is not yet very interested in environmental issues or sensitised to them. However, Julia is enlightened by her job and is keen to involve Lukas and inform him. She is trying to incorporate sustainability into their shared lifestyle and gradually integrate it into their everyday lives.
In terms of transport requirements, Lukas sees it primarily as a means of getting around efficiently. It fulfils the functional task of transporting him safely, quickly, and comfortably from one place to another, with aspects such as punctuality and reliability also being important. Lukas uses transport for commuting to work, leisure activities and holidays. When commuting on the train, he enjoys watching videos and reading reports, which is part of his daily routine. In his free time, he likes to use Mobility carsharing, buses, trains, and bicycles, depending on the activity and weather conditions.

For Lukas, high costs, unreliability, delays, limited flexibility, and overcrowded trains are pains. He avoids overloaded means of transportation and tries to get around this by working flexible hours. He also avoids journeys with frequent changes to save time. In contrast, Lukas appreciates the fact that his company pays an annual contribution towards his general abonnement, which leads to cost savings. Due to the many traffic jams on the roads, he appreciates the time efficiency and convenience, as he doesn't have to drive himself to commute to work but can just ride along. He also finds the trains very comfortable.

As an adult male, he generally makes independent decisions about his own purchases. He bases his decisions on his needs, preferences, and financial considerations. When making joint purchases, he makes decisions together with Julia.
As a systems engineer and in view of the emerging global environmental problems, Lukas could in future be influenced by developments in the technology sector. In addition, his insights at Migros and through his social contacts could also change his view of transport, perhaps focussing on other modes of transportation. New technologies in the field of transport or smart living could spark his interest and potentially influence his lifestyle.

Name of the persona: Lukas Scheider

Gender and age: Male, 28 years old

Social milieu: Lukas grew up in an urban environment, he lives in Winterthur and has a bachelor's degree in business informatics. He works as a system architect at the retail company Migros. His social network consists of people with similar interests from the technology and creative industries.

Family: Lukas is married with Julia, who works as a biologist at MiSANTO AG. Although he has an awareness of sustainable practices and understands the importance, he tends to live thriftily and has not yet fully transitioned into a sustainable lifestyle. He is known for being a money saver and looks for cost-effective solutions, even if they are not always the most sustainable.

Hobbies: Lukas enjoys outdoor activities such as hiking, climbing and mountain biking. In addition to his adventures in nature, he enjoys reading financial literature and finds variety in home improvement.

Description:

Lukas represents a pragmatic, nature-loving character who combines his passion for technology and finance with his love of outdoor activities and do-it-yourself projects. His pursuit of cost efficiency is reflected in his lifestyle. He also has the feeling that he lacks the time for many things.

Influencers:

Lukas makes independent decisions regarding his choice of transport, which he uses every day for work and leisure. However, his employer supports public transport and pays 1/3 of the cost of a 2nd class GA travelcard each year.
Julia and his social network have an influence on his decisions regarding mode of mobility when it comes to travelling together or environmentally conscious mobility.

Trends:

As a system engineer and the emerging global environmental issues, Lukas could be influenced by developments in the technology industry. New technologies in transport or smart living could attract his interest and change his lifestyle.

Use cases:

Lukas uses the product in various use cases in the context of his mobility. He uses the means of transport on his daily commute to get to work efficiently and on time. It is important to him that the product is cost-efficient and reliable. In his free time, he uses transport to get to social meeting places without stress. He appreciates flexibility and a pleasant journey. For holiday trips, he uses the product to get to various destinations comfortably and efficiently. In these use cases, the system integrates various mobility options, whereby Lukas travelling needs are satisfied.

Jobs to be done:

A form of transportation fulfils the functional task of efficient movement by transporting Lukas safely, quickly, and comfortably from one place to another. Aspects such as punctuality and reliability can have an important influence in this context. The mode of transport also helps to strengthen social connections and could facilitate social interactions through shared use options. Overall, it satisfies basic needs such as safety, efficiency and supports Lukas in his everyday life through the mobility option.

Pains:

- High costs
- Unreliability
- Complexity and stress
- Limited flexibility
- Many transfers and loss of time

Gains:

Lukas could be happy with cost-effective and stress-free transport options. Fast, reliable, and flexible transport options could satisfy his needs and provide him with time for other activities. Technological innovations and a comfortable, relaxing travelling experience could satisfy his interests in technology and increase his satisfaction. Products that provide a positive user experience by making his journeys enjoyable could delight him and potentially exceed his expectations.

The second persona, Elena Müller, is presented on the next page Elena embodies a dynamic, design-orientated personality who balances her professional commitment to graphic design with a vibrant family life. At 44, she is not particularly concerned with sustainability, but she is open to environmentally conscious options. Elena is married and enjoys family outings, so she needs a versatile mode of transport to seamlessly integrate her family's activities into her schedule.

For Elena, transport is a practical necessity where she strives for efficiency and flexibility. Her commute to the graphic design studio and organising family outings require a reliable and adaptable mode of transportation. She values the ability to be flexible in attending her children's activities without feeling rushed and emphasises the need for a transport solution that adapts to her family's dynamic schedule.

In terms of holidays Elena is looking for a transport solution that enables seamless travel planning and improves the overall holiday experience for her family. She envisions a mode of transport that will not only get her to her destination efficiently, but also provide comfort and convenience while travelling. The ability to accommodate luggage, provide a family-friendly environment and ensure a smooth journey are key factors for Elena when choosing a mode of transport for her holiday.

Elena would prefer a mode of transport that allows her family to relax and enjoy the journey, whether it's by choosing family-friendly airlines, comfortable train connections or the convenience of travelling in their own car. The focus would be on making the journey enjoyable and stress-free and tailoring it to the different needs of their family to contribute to the overall success of the holiday adventure.

Elena suffers from the challenge of balancing her work and family commitments. She is looking for a transport solution that can accommodate her varied lifestyle and is characterised by reliability, ease of planning and seamless integration into her daily routine. Her benefits include the potential for stress reduction, more time for family and a simplified approach to managing her multiple tasks.

As a decision maker, Elena tends to prioritise functionality and aesthetics. Joint decisions with her husband are essential to ensure that the chosen mode of transport suits both her needs and preferences. Due to her background in graphic design, Elena may be influenced by new trends in smart, design-led transport solutions, fuelling her interest in innovative and visually appealing options. In addition, Elena's social interactions and experiences within her community could play a crucial role in developing her views on transport and lifestyle.

Name of the persona: Elena Müller

Gender and age: Female, 44 years old

Social milieu: Elena comes from a rural background and now lives in a family-friendly suburban community. She is a graphic designer with a bachelor's degree in design. Her social circle combines successful professionals and dedicated parents. Elena is active in a network of creative professionals and parent organisations and values the social interaction in her community.

Family: Elena's family is the central focus of her life. As a loving wife and mother of two children, she plays an active role in the family community. Her supportive husband and two children give her life structure and meaning.

Hobbies: Elena finds balance in nature and enjoys family outings at the weekend. She has a penchant for photography and creative do it yourself projects. As well as riding, she is also in a book club.

Description:

Elena embodies a creative and versatile personality that seamlessly blends her extensive background in graphic design with her role as a devoted wife and mother. Her passion for design will always lead her to new creative horizons. Despite the demands on her time, Elena remains a beacon of creativity and balance in her hectic world.

Influencers:

Elena's decisions are significantly influenced by her husband, children and in the areas of graphic design and technology. Design experts inspire her when it comes to innovation and vehicle aesthetics. At the same time, her family's recommendations and preferences play a crucial role, especially when it comes to family-friendly and practical transport options.

Trends:

Elena closely follows the trends in sustainable mobility and smart transport solutions. The increasing focus on environmentally friendly transport influences her decisions as she looks for innovative solutions that fulfil her needs and are ecologically responsible.

Use cases:

Elena looks at various use cases to assess the functionality of her mode of transport. These include scenarios such as the morning commute to the graphic design studio, planning family outings at the weekend and flexible participation in her children's activities. These use cases help her to assess the suitability and efficiency of her chosen mode of transport for her individual requirements.

Jobs to be done:

Elena needs a mode of transport that supports her efficient commute between home and the graphic design studio. At the same time, she wants stress-free organisation of family outings and the flexibility to take her children to their activities. Her ideal mode of transport must seamlessly accommodate both her work commitments and the demands of her family life.

Pains:

- Traffic jams and delays
- Limited flexibility
- Complexity and stress
- Limited flexibility
- Uncertainty about environmental impact

Gains:

Elena benefits from an efficient commute that allows her to move smoothly between home and the graphic design studio. Having a well-organised mode of transport makes it easier to plan and implement family outings, allowing precious family time to be enjoyed. The flexibility with children's activities creates a stress-free environment for Elena when it comes to accompanying her children to their activities without feeling time pressure.

5.4 Critical analysis of the results

The results are critically analysed and examined in the following chapter. The critical analysis has various objectives, including the examination of the validity of the results, the identification of methodological strengths and weaknesses, the contextual interpretation of the research results and the assessment of representativeness.

The survey was conducted successfully, and the chosen methodology was effective. With 139 participants in the German version and 30 in the English version showing an acceptable level of participation. Nevertheless, this number is not sufficient to consider the survey representative. This may be sufficient for the scope of this work, but the low number of participants does not allow any reliable conclusion. A critical point was the unclear question design for question 4 “Preferred transport factor” and question 10 “Optimum modes of transportation for future travel demand”, which led to possible distortions due to an unclear question design.

To summarise, the requirements for a currently means of transportation are low costs and reliability. Low costs and safety are the most important factors in favour of the innovative Hyperloop system. Around half of the participants are prepared to pay a price similar to a train ticket about 160 Swiss francs for a Hyperloop journey from Zurich to Paris. It is noticeable that most survey participants stated that the train could best fulfil their travel needs in the future, followed by the Hyperloop and the car.

A possible change could result if the Hyperloop were cheaper than the train, but this cannot be deduced from this survey. This aspect is missing to draw definitive conclusions. Nevertheless, a solid comparison could be drawn between the different survey questions.

5.5 Interim conclusion

The survey provides informative details of the participants preferences for the Hyperloop project. Reliability and low costs are decisive, with the train being favoured for the Zurich-Paris route. And around half are familiar with the Hyperloop and 76% can imagine using it.
Low cost and safety are key requirements for the Hyperloop, with an accepted price range of CHF 173.9. Future preferences show the train, the Hyperloop, and the car as top options. The results provide a solid basis for the Hyperloop project by identifying user needs.
The survey shows that the Hyperloop is seen as a promising innovation, whereby low costs could increase acceptance. Larger samples are required for more detailed findings.

The creation of two personas provides insights into potential users of the Hyperloop system. The persona represents a pragmatic character with an interest in technology and the transport requirements emphasise efficiency, safety, and comfort.

In terms of targets values, it is concluded that the Hyperloop has potential, particularly emphasised by its cost efficiency and environmental friendliness. Uncertainties remain regarding possible behavioural changes with the introduction of the Hyperloop. The results provide a basis for strategic decisions and optimisations in the development of the project.

6 Discussion

The discussion chapter begins with the interpretation of the results and targets values. This interpretation and the definition of target values serve to understand the collected data, make well-founded decisions in the project, and carry out optimisations. In addition, the effects on industrial work will be analysed to determine the contribution of the current results and their implications. It also describes the direction in which the results and research can be continued. Finally, the applied research methodology is critically analysed, identifying weaknesses, and making suggestions for improvement. Figure 28 shows the structure and sub-chapters of the discussion.

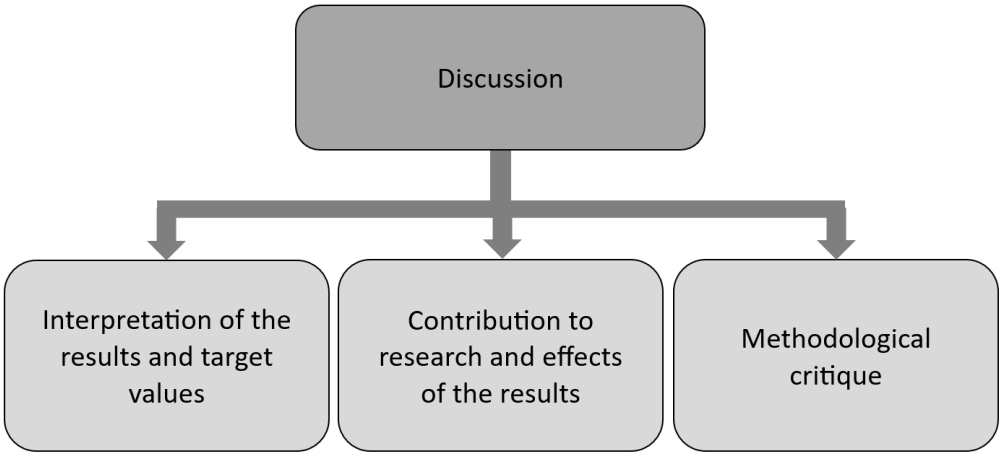


Figure 28: Overview of the discussion chapter.

6.1 Interpretation of the results and target values

The following section analyses the results and findings in comparison with the target values. As part of the evaluation of the target values, the results were summarised and assessed to gain information for a comprehensive perspective.

The main objective was to determine the utilisation of the Hyperloop connection from Zurich to Paris. This could not be fully resolved by the survey, but some assumptions can be made. At a ticket price of 200 Swiss francs for the Hyperloop journey from Zurich to Paris, the survey showed that the predicted utilisation would be 44%, while at a price of 100 francs it would increase to 87%. Moreover, in the future, the Hyperloop would be the third most used mode of transport after the train and the car. It should be noted that a detailed list of advantages and disadvantages could potentially influence preferences. In addition, many people are currently dependent on the existing and available means of transportation, and the introduction of the Hyperloop could bring a new form of dependency in the future. It is not clear that one mode of transport will be replaced by another in the future. The survey was not sufficiently precise in this respect. Respondents nevertheless believe that they will use buses and aeroplanes less in the future and that their travel needs may be better fulfilled by alternative means of transportation. It was also recognised that survey participants who regularly use a certain mode of transport today believe that the train will be best able to meet their future travel needs.

This analysis shows the feasibility and potential of the Hyperloop and that it would be accepted, even if the Hyperloop is only the third most popular choice for the future according to these results.

Another target definition was the resilience of the Hyperloop system. The results of the survey indicate that the majority of participants, 76.3% to be precise, would accept the Hyperloop as a promising innovation in the transport sector. Many of the survey participants would be prepared to travel and use

the Hyperloop. However, the survey does not provide sufficient detail to allow a more precise statement to be made. There is no in-depth comparison between the train and the Hyperloop in the available results.
Regarding the last target definition, whether people would be prepared to replace their current mode of transport with the Hyperloop for the journey from Zurich to Paris, no clear statement could be made. There are no clear results on this. The survey also did not go into sufficient detail. The number of participants in the survey was too small due to the specific route. Due to the speed and attractive price, many people would certainly switch to the Hyperloop, but this cannot be clearly emphasised from the results.

The objective was achieved in the sense that the survey can predict the capacity utilisation for a Hyperloop from Zurich to Paris and can also indicate a price range. However, as the results are not representative, no definitive conclusions can be formulated.
Overall, the results of the survey provided an insight into the attitudes and preferences of potential Hyperloop users. The personas developed serve as representative models that illustrate the behavioural patterns and needs of the target group. These results form the basis for strategic decisions.
However, it should be noted that these findings are influenced by various factors. For example, a mode of transport that is used for holidays has a different meaning than one that is used daily for commuting to work. Furthermore, this study did not consider how behaviour would change if the Hyperloop was introduced. For example, someone could live in Paris and commute to Zurich every day to go to work. Or there could be spontaneous travelling between cities, as the distance can be covered in just 30 minutes, which in today's world is a comparable distance from Zurich to Zug. A successful Hyperloop system could revolutionise transport and globalisation worldwide. It is important to emphasise that these considerations are assumptions and have not yet been confirmed or verified.

6.2 Contribution to research and effects of the results

This subchapter analyses and describes the contributions and effects of the results obtained in the industry work. This survey provides valuable information and provides the basis for important decisions in the Hyperloop project. By analysing the results, it was possible to gain an impression of the potential use and preferences of the target group.
The contribution of this survey is that it provides guidelines for pricing. The identified price sensitivity shows that an appropriate tariff is crucial for a high utilisation of the Hyperloop system. This enables a targeted strategy development to maximise acceptance and profitability.

The survey results also enable the feasibility and acceptance of the Hyperloop system to be assessed. The high willingness of 76.3% of participants to use the Hyperloop indicates its innovative potential. These findings are valuable for decision-makers to drive the project forward and direct investments in a targeted manner.

With the available data, future developments can be better predicted. The changes in preferences, particularly the shift towards rail transport, indicate an evolving market. This information can be used to adjust the Hyperloop design or marketing strategy to meet changing needs.

Overall, the survey results as well the persona provide a valuable basis for strategic decisions in the Hyperloop project. The identification of price sensitivities and acceptance factors enables targeted development and implementation of the Hyperloop system. However, the results should be seen as a

starting point that requires further research and validation to ensure the sustainability and effectiveness of the Hyperloop project.

6.3 Methodological critique

This section provides a critical reflection on applied research methodology. The methodology used proved to be robust but was found to be limited in some aspects. In addition, the limited sample size of the survey and the lack of interviews posed certain limitations. The survey could not attract enough participants to be considered representative. In relation to the specific industrial project, the methodology proved to be appropriate and useful.

The positive evaluation relates to the survey and the creation of two personas. The decision in favour of the survey as an instrument offered the opportunity to reach a larger number of participants compared to individual interviews. This is considered appropriate for this study. However, it is noted that the limited number of participants and the lack of interviews have affected representativeness.

6.4 Interim conclusion

The discussion includes a critical evaluation of the research methodology and the obtained results. The interpretation of the results and target values was used for decision-making and optimisation in the project. The survey results indicate that the Hyperloop would be accepted. Nevertheless, it remains unclear whether it will replace existing means of transportation.

The research showed a high level of willingness to use the train and the Hyperloop in the future. Nevertheless, the results are not representative, which limits the conclusions. The positive impact on strategic decisions in the Hyperloop project was emphasised, but the limited number of participants was identified as weaknesses. A possible integration of qualitative methods was suggested to strengthen the study.

7 Conclusion and prospects

This section summarises the conclusion and the outlook. On the one hand, the findings and benefit of the research are summarised. Finally, an outlook for future research is described. The aim is to describe what has emerged from the research and how to proceed further. Figure 29 shows the structure and sub-chapters of the conclusion and prospects.

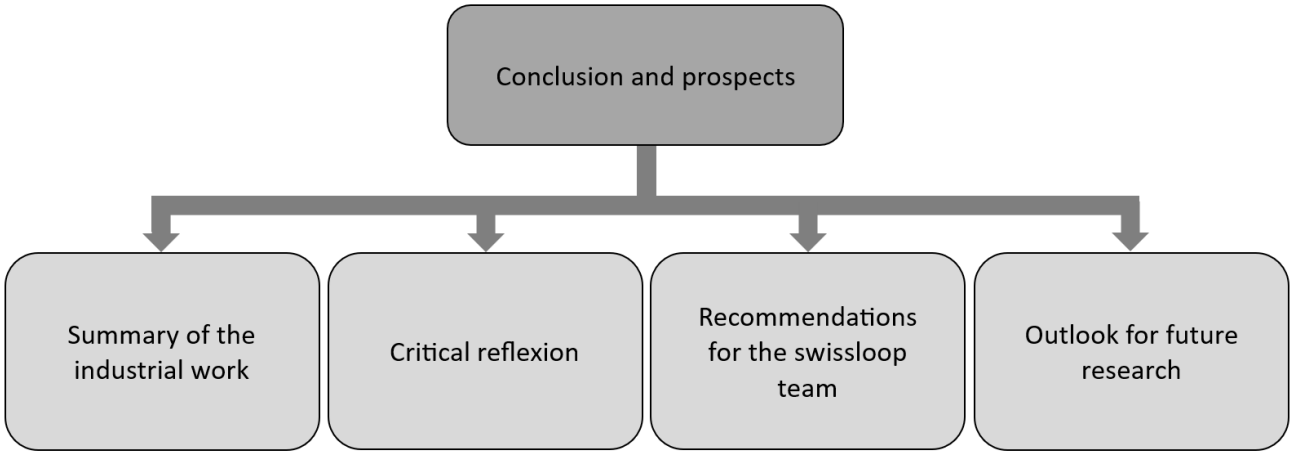


Figure 29: Overview of the conclusion and prospects chapter.

7.1 Summary of the research

In this project, findings were obtained on the feasibility and acceptance of the Hyperloop transport system. The interpretation of the survey results and the definition of target values enabled a well-founded analysis of potential utilisation and price sensitivity. Although the results are not representative, they provided valuable orientation points for strategic decisions in the Hyperloop project.

The findings indicate that the Hyperloop is considered a realistic and accepted transport option with an attractive ticket price. The willingness of 76.3% of participants to use the Hyperloop underlines the innovative potential of this mode of transport. The creation of personas also provides a clear insight into the needs and behaviour of potential Hyperloop users.

The results of this study provided an analysis of the feasibility and acceptance of the Hyperloop transport system. The interpretation of the survey results and the definition of target values provided valuable insights into the potential use and price sensitivity of the Hyperloop. The creation of personas deepened the understanding of the needs and preferences of potential users. Despite limited representativeness, the results provide important clues for strategic decisions within the Hyperloop project.

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Appendix

The appendix contains supplementary tables and notes that support the comprehensibility and substantiation of the work. The following appendix contains the surveys as well as extended analyses and evaluations of the survey.

7.2 Advantages and disadvantages of the current means of transport

In the following chapter, the advantages, and disadvantages of different means of transport are analysed. This research helps with the choice and optimisation of transport options. By analysing the advantages and challenges of different modes of transport, efficiency, safety, environmental compatibility, and cost-effectiveness can be evaluated. This makes it possible to identify suitable transport solutions for different requirements and to develop measures to improve existing systems. In addition, research in this area supports the planning of more sustainable and effective transport infrastructures.

Each mode of transportation possesses its unique set of advantages and disadvantages. The subsequent subsection will enumerate these factors, enabling a later comparison during the analytical phase. Figure 30 visually presents the advantages and disadvantages.

Figure 30: Benefits and drawbacks of the different means of transportation (Blevins, 2021).

7.2.1 Advantages and disadvantages by car

The utilisation of automobiles as a mode of transportation offers the advantages of convenience, accessibility, comfort, independence, and mobility (Anwar, 2009). However, this convenience may lead to negative aspects such as traffic congestion, and the environmental impacts, including greenhouse gas emissions and air pollution (Giroux, 2023). Moreover, safety concerns persist due to the risk of car accidents. And the costs associated with car ownership, maintenance, and infrastructure development can be substantial. Additionally, the space requirements for parking and road infrastructure, as well as the contribution to noise pollution in urban areas, are notable disadvantages that should be considered when the use of cars as a transportation mode. The advantages and disadvantages are summarised and presented in Table 14 and Table 15.

Table 14: Overview of the advantages of the car.

Advantages
Convenience Cars provide personal mobility and flexibility to travel at any time and reach various destinations. Traveling by automobile offers significant convenience as well.
Accessibility Cars allow access to areas with limited public transportation options. The establishment of a seamless door-to-door connection is nearly assured.
Comfort Traveling in a personal vehicle can be more comfortable and provide a sense of privacy.
Independence Car owners have the freedom to travel wherever and whenever they want without being reliant on schedules or routes.
Mobility The transportation network in Switzerland is notably robust, featuring cost-effective toll mechanisms, such as the Swiss car vignette. Furthermore, the road infrastructure exhibits a higher level of interconnectivity in comparison to alternative modes of transportation**.**

Table 15: Overview of the disadvantages of the car.

Disadvantages
Traffic Congestion Over-reliance on cars can lead to traffic jams and time wasted in congestion.
Environmental Impact: The burning of fossil fuels in cars contributes to greenhouse gas emissions, worsening climate change. The car contributes negatively to air pollution.
Safety Car accidents can result in injuries and fatalities, posing a risk to road users.
Cost Owning and maintaining a car can be expensive, including fuel, insurance, and maintenance.
Infrastructure Costs Building and maintaining road infrastructure can be expensive and require ongoing investments.
Space Parking and road infrastructure can take up significant urban space.
Noise Pollution Cars can contribute to noise pollution in urban areas, affecting the quality of life for residents.

7.2.2 Advantages and disadvantages by motorbike

Motorcycles offer advantages such as manoeuvrability, quick acceleration, fuel efficiency, cost savings, and reduced parking needs (Advantages and Disadvantages of a Motorcycle., 2023). However, they have limitations in passenger and cargo capacity, safety concerns, weather sensitivity, noise and emissions, lack of safety features, and require special licensing (Asuncion, 2021), (KROW, 2023). The advantages and disadvantages for the motorbike are summarised in Table 16 and Table 17.

Table 16: Overview of the advantages of the motorbike.

Advantages
Agility and Manoeuvrability Motorcycles are highly manoeuvrable and can navigate through congested traffic and narrow spaces more effectively than larger vehicles, contributing to reduced traffic congestion.
Quick Acceleration Motorcycles generally offer rapid acceleration, which can be advantageous for merging into traffic and making quick manoeuvres.
Fuel Efficiency Motorcycles typically exhibit higher fuel efficiency than most four-wheeled vehicles, reducing fuel consumption and environmental impact.
Cost Savings Motorbikes typically have lower acquisition costs, reduced maintenance expenses, and lower insurance premiums compared to cars, making them an economically efficient mode of transportation.
Reduced Parking Space Requirements Motorcycles require less parking space, helping alleviate urban parking issues and reducing the demand for parking infrastructure.

Table 17: Overview of the disadvantages of the motorbike.

Disadvantages
Limited Passenger and Cargo Capacity Most motorcycles are designed for one or two passengers and have limited cargo-carrying capacity, which may be insufficient for certain transportation needs.
Safety Concerns Motorcyclists are at higher risk of accidents and injuries due to their vulnerability in collisions, necessitating the use of safety gear and responsible riding.
Weather Sensitivity Motorcycles are weather-dependent and may be less suitable for use in adverse weather conditions, such as rain, snow, or extreme heat.
Noise and Emissions Motorcycles can be noisy and may produce emissions that contribute to air pollution and noise pollution.
Lack of Safety Features Motorcycles often lack advanced safety features found in automobiles, such as airbags and crumple zones.
Special Licensing Requirements Riding a motorcycle typically requires specialized licensing, and not all individuals may qualify or be willing to obtain the necessary endorsements.

7.2.3 Advantages and disadvantages by bus

Bus transportation offers advantages such as lower carbon emissions, enhanced social connectivity, cost efficiency, broad accessibility, and relief from urban traffic congestion (Barrett, 2019). On the other hand, has the bus limitations, including inflexible schedules, overcrowding, extended travel

times due to frequent stops, limited comfort on long journeys, irregular timetables in some regions, and dependence on supporting infrastructure quality (Schneider & Brechbuel, 1991), (Chernenko, 2023). The advantages and disadvantages for the bus are summarised in Table 18 and Table 19.

Table 18: Overview of the advantages of the bus.

Advantages
Environmental Sustainability Buses generally exhibit a lower carbon footprint per passenger-kilometre in comparison to private automobiles, owing to their capacity to accommodate numerous passengers.
Social Interaction Bus travel often fosters passenger interaction and enhances social connectivity.
Cost Efficiency Buses are typically a cost-effective mode of transportation compared to other modal choices such as air travel or rail.
Accessibility Buses enjoy extensive coverage in urban and rural areas, rendering them readily accessible to a broad demographic.
Reduction of traffic congestion Buses serve as a practical solution for circumventing traffic congestion and parking issues in many urban settings.

Table 19: Overview of the disadvantages of the bus.

Disadvantages
Limited Flexibility Bus travellers are constrained by predefined routes and timetables, lacking the flexibility to alter their itinerary on the spur of the moment.
Overcrowding During peak hours, buses may become overcrowded, compromising comfort and the overall travel experience.
Time Constraints Buses may entail extended travel durations due to frequent stops and adherence to fixed schedules, in contrast to the relative swiftness of private automobiles or trains.
Comfort Limitations Comfort levels on buses are often constrained, especially during extended journeys.
Irregular Schedules Bus timetables in certain regions may lack consistency, complicating travel planning.
Infrastructure Dependency The quality of bus transportation is substantially contingent on the availability and condition of supporting infrastructure, a potential challenge in some areas.

7.2.4 Advantages and disadvantages by train

Trains offer numerous advantages, including environmental sustainability, safety, efficiency, high capacity, speed, scalability, convenience, and punctuality (Mouratidis, De Vos, Yiannakou, & Politis,

2023). They are effective in reducing congestion, utilising space efficiently, and maintaining an organised structure. However, they come with limitations such as fixed routes and schedules, potential waiting times, economic challenges in rural areas, substantial capital investment, limited door-to-door accessibility, and perceived slowness on short urban routes (Mehta, 2022), (Trepáčová, Kurečková, Zámečník, & Řezáč, 2020). Finances and safety are seen both as advantages and disadvantages of rail travel (Palnik, 2018), (Buyukgunay, 2023). The advantages and disadvantages of the train are listed in Table 20 and Table 21.

Table 20: Overview of the advantages of the train.

Advantages
Environmental Sustainability Trains are generally energy-efficient and emit fewer harmful emissions compared to other modes of transportation, resulting in reduced environmental impact.
Safety The railway system is one of the safest modes of transportation.
Efficiency and high capacity The railway system enables efficient long-distance travel and the transportation of voluminous goods, which may not be easily conveyed by road vehicles. And trains often possess substantial capacity, capable of concurrently accommodating a significant number of passengers or freight.
Speed and Consistency It serves as a rapid and consistent mode of transportation.
Punctuality Trains are frequently recognised for their timeliness and reliability according to schedules.
General The train, serving as a platform for social engagement, panoramic vistas, anxiety-free travel, and designated seating arrangements. Moreover, the railway system offers congestion relief, occupies less space than road networks, and maintains a highly efficient organisational structure.

Table 21: Overview of the disadvantages of the train.

Disadvantages
Inflexibility and Route Limitations Rail transport is characterised by its inflexibility, with fixed routes and timetables that cannot be tailored to individual requirements.
Waiting Times Trains often entail waiting periods both before departure and during transfers.
Capital-Intensive Infrastructure Railway transport necessitates substantial capital investment, marked by elevated construction, maintenance, and overhead costs, contrasting with other transportation modes.
Limited Accessibility Trains may not provide direct door-to-door connectivity, necessitating supplementary travel time and effort for passengers to reach their ultimate destinations.
Reduced Speeds on Short Routes On short distances and in densely populated urban areas, trains can be perceived as relatively slow, particularly when contrasted with rapid modes of transit.

7.2.5 Advantages and disadvantages by airplane

Air travel offers notable advantages, including safety, swiftness, accessibility to global destinations, efficiency for long-distance journeys, and a high level of in-flight comfort and amenities, making it a preferred choice for international travel (Nedeva & Genchev, 2018), (Zubova, 2018). Nevertheless, it raises environmental concerns due to significant CO2-emissions, may be cost-prohibitive on international routes, relies on airport access, restricts passenger flexibility with fixed schedules and routes, involves time-consuming security procedures and potential delays, and can provide limited space and comfort in economy class seating (Ferrer, 2022), (Advantages and disadvantages of air transport everything you need to know, 2023). The advantages and disadvantages of the bus are outlined in Table 22 and Table 23.

Table 22: Overview of the advantages of the airplane.

Advantages
Safety Air travel is widely considered one of the safest transportation methods, characterised by stringent safety standards and protocols.
Speed Aircraft represent the swiftest means of covering substantial distances in a relatively short time.
Long-range Accessibility Aircraft provide access to global destinations that are challenging to reach with other modes of transportation.
Efficiency for Long-distance Travel For international or transcontinental travel, aircraft often prove to be the most practical option.
Comfort Aircraft typically offer a high level of comfort, with amenities such as seating arrangements, entertainment options, and catering.

Table 23: Overview of the disadvantages of the airplane.

Disadvantages
Environmental Impact Aircraft emit a relatively high level of CO2 per passenger-kilometre, contributing to environmental pollution.
Cost Air travel can be costly, particularly on international routes, placing a premium on ticket prices.
Airport Dependency Air travel necessitates access to airports, which can be problematic in remote areas.
Limited Flexibility Passengers are bound by flight schedules and routes, with limited ability to adjust travel plans on short notice.
Security Checks and Delays Air travel often involves time-consuming security checks and can be subject to delays due to weather conditions or technical issues.

7.2.6 Advantages and disadvantages by bicycle

Bicycles serve as an environmentally sustainable, cost-effective, and health-promoting mode of transportation. They significantly reduce emissions and the financial burden associated with fuel and vehicle maintenance while promoting physical fitness as a non-motorised means of exercise (Šťastná, Zapletalová, Ševelová, & Vaishar, 2018). Bicycles excel in navigating traffic and mitigating congestion, requiring minimal infrastructure, and reducing road space and maintenance demands. Nevertheless, bicycles have limited cargo capacity and range, are weather-sensitive, and present safety concerns when sharing roads with motorised vehicles (Porter, Suhrbier, & Schwartz, 1999). Table 24 and Table 25 summarise the advantages and disadvantages for the bicycle.

Table 24: Overview of the advantages of the bicycle.

Advantages
Sustainability Bicycles are an environmentally sustainable mode of transportation, producing zero emissions and contributing to reduced air pollution and greenhouse gas emissions.
Economic Efficiency Bicycles are a cost-effective mode of transportation, with low acquisition and maintenance costs.
Physical Fitness Cycling promotes physical activity, enhancing cardiovascular health, and overall fitness.
Traffic Congestion Mitigation Bicycles are agile in navigating through traffic, making them a practical solution for urban transportation and reducing traffic congestion.
Compact Infrastructure Bicycles require minimal infrastructure, reducing the demand for road space, parking, and maintenance costs compared to motorised vehicles.

Table 25: Overview of the disadvantages of the bicycle.

Disadvantages
Limited Cargo Capacity Bicycles have limited cargo-carrying capacity, which may be insufficient for certain transportation needs.
Limited Range Bicycles are best suited for short to moderate distances and may not be practical for longer commutes or travel between distant locations.
Weather Sensitivity Cycling is weather-dependent and can be less favourable in adverse weather conditions, such as rain, snow, or extreme heat.
Safety Concerns Cyclists are vulnerable to accidents and injuries, particularly when sharing the road with motorised vehicles, necessitating the provision of dedicated cycling infrastructure.
Infrastructure Gap Cycling infrastructure may be lacking or inadequately developed in some areas, limiting the feasibility and safety of bicycle transportation.

7.2.7 Advantages and disadvantages by ship or ferry

Maritime transport offers cost-effective long-distance cargo transportation and reduces urban road congestion (Paixão & Marlow, 2002). Although, the ship or the ferry suffers from slower speeds, limited accessibility, vulnerability to adverse weather, safety concerns, environmental impact, and substantial infrastructure and maintenance costs (Ardisana, 2022), (Prasanna, 2022). In Table 26 and Table 27 are the advantages and disadvantages of the ship or ferry listed.

Table 26: Overview of the advantages of the ship or ferry.

Advantages
Economical for Long Distances For long-distance travel or international trade, ships are often the most cost-effective option, particularly for goods.
Reduced Traffic Congestion Ships help reduce road congestion, particularly in urban areas with busy ports, by diverting goods away from land-based transportation networks.
Reliability Ships are less prone to traffic-related disruptions that affect land-based transportation.
Efficiency in Bulk Cargo Ships are highly efficient for transporting large quantities of cargo, particularly bulk goods like raw materials and containers.

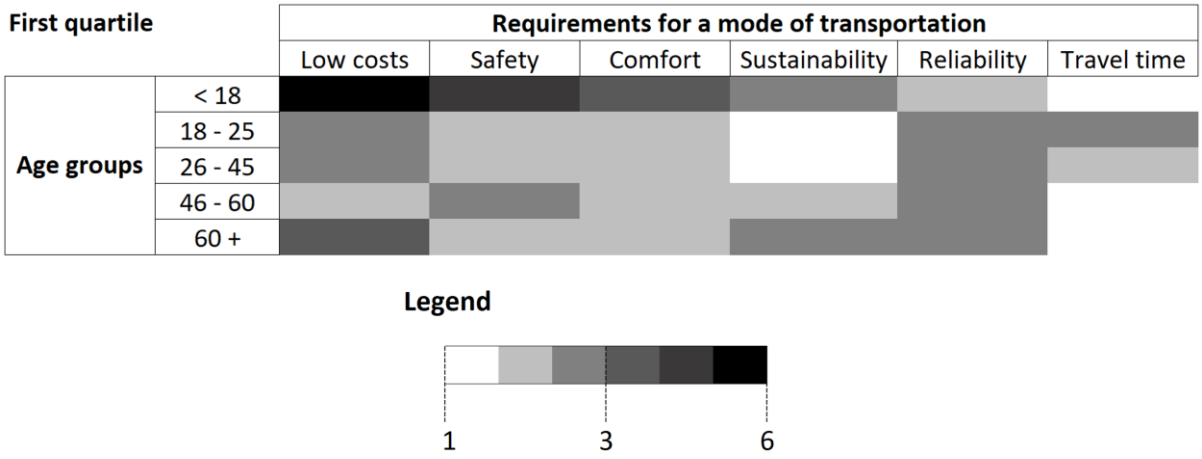
Table 27: Overview of the disadvantages of the ship or ferry.

Disadvantages
Slow Travel Speed Ships are generally slower compared to other forms of transportation, making them less suitable for time-sensitive passenger travel and just-in-time logistics.
Limited Accessibility Access to ships typically requires access to ports, which may not be convenient for all destinations, especially landlocked areas.
Weather-Dependent Ships are sensitive to adverse weather conditions, which can result in delays, safety concerns, and disruptions to schedules.
Safety and Accidents Maritime transport can be subject to accidents, particularly in congested waterways, and poses specific safety challenges, especially for passengers.
Environmental Impact While ships are generally more fuel-efficient, they can still produce emissions and contribute to pollution, particularly in the case of older, less environmentally friendly vessels.
Infrastructure and Maintenance Ports and harbours require substantial infrastructure and maintenance, which can be costly and time-consuming.

Comparison of age and preferred transport factors

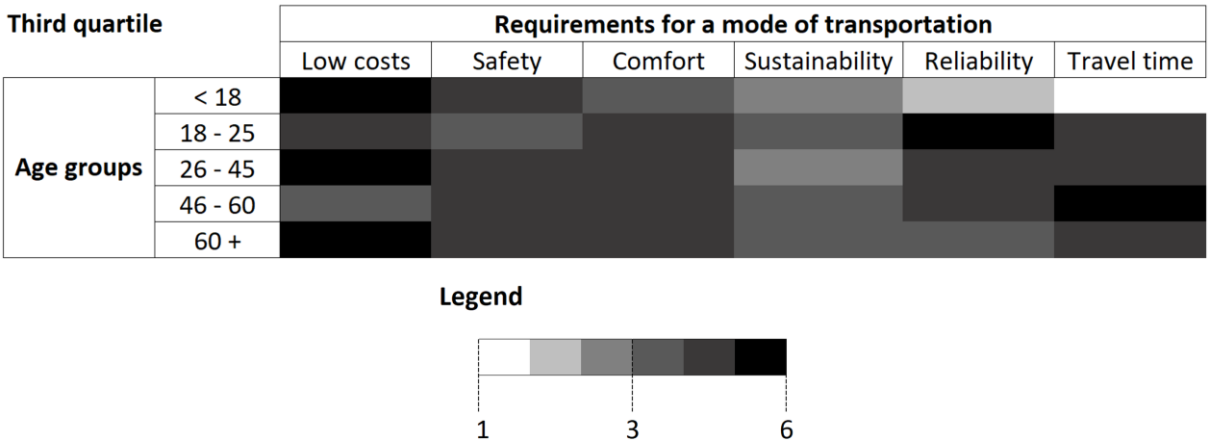
This appendix section depicts the other data from chapter 5.2.3 Comparison of age and preferred transport factors. The results of the first and third quartiles are presented in the following Table 28 and Table 29.
The results of the first quartile are very similar to the results of the median analysis. For the majority, i.e. three age groups, travelling time is rated the lowest and is therefore considered the lowest requirement. In general, the age groups from 18 to over 60 years rated the requirements very similarly. Low costs and reliability were rated highest overall. It is striking that the youngest age category, the under 18-year-olds, rated low costs as the most important factor. However, this is not representative based on the small number of survey participants in this category.

Table 28: Survey analysis of the Q1 comparing the age group and preferred transport factors.



The prioritisation and evaluation show a slight shift in the third quartile of the results. In general, low costs and comfort were rated highly in all age groups. In the age groups from 18 to over 60-year-olds, travelling time, reliability and safety were also seen as important factors. In contrast, the environmental aspect received the lowest rating and was not prioritised.

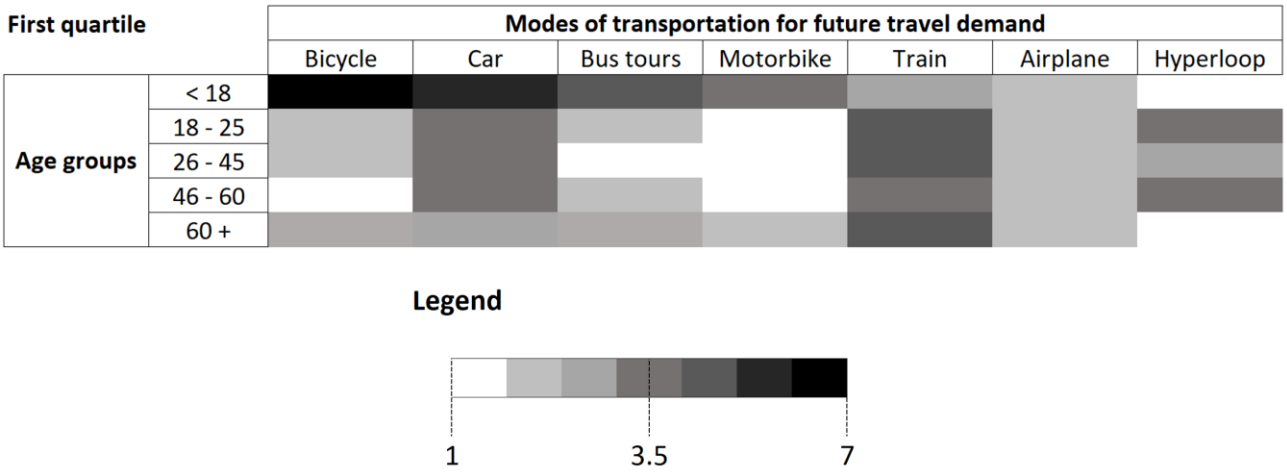
Table 29: Survey analysis of the Q1 comparing the age group and preferred transport factors.



Current transport trends analysed with the requirements for Hyperloop travel

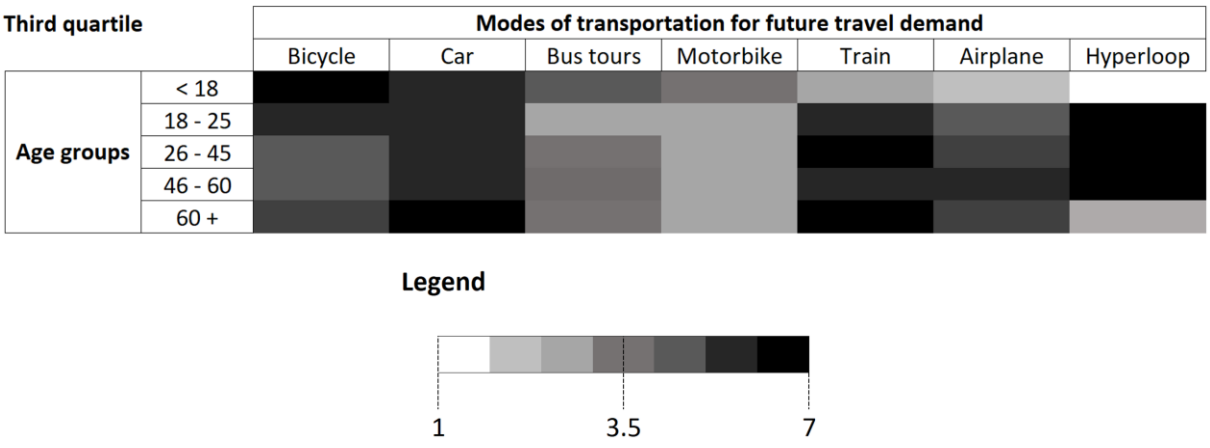
This appendix section represents additional data from chapter 5.2.6 Age groups compared with future means of transportation. The results of the first and third quartiles are presented in the following Table 30 and Table 31.
The results of the first quartile are very similar for three age groups, which are between 18 and 60 years old. For these age categories, the train best fulfils future travel needs, followed by the car and the Hyperloop. The train is prioritised highest for the oldest age group. The other modes of transport received a comparably low rating. The youngest age group is not representative due to the low number of participants and has the same rating as the median.

Table 30: Survey analysis of the Q1 comparing age groups with future means of transportation.



Compared to the first quartile, the results of the third quartile show slight differences. Across all age groups, the car and train are rated highest for future travel needs. Among 18 to 60-year-olds, the Hyperloop is also prioritised as a potential means of transportation. For additional requirements, the bicycle and the aeroplane will also be preferred as additional forms of travel in the future.

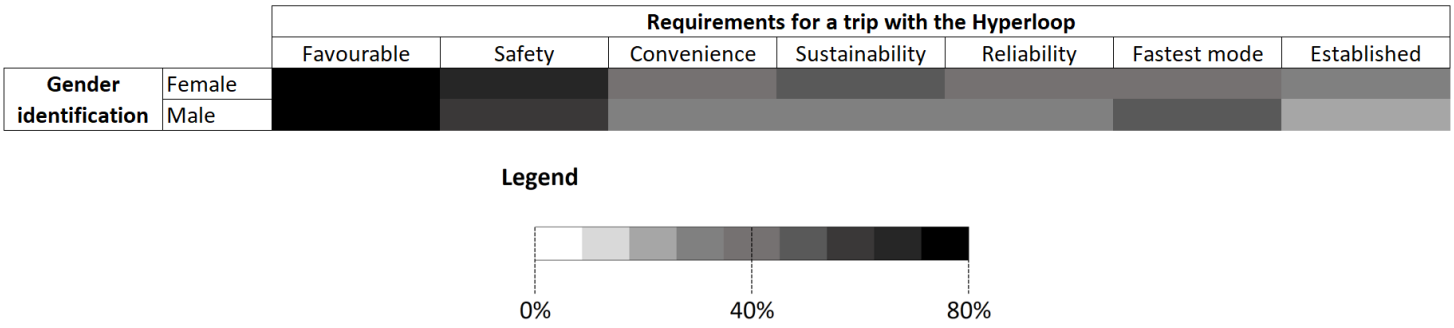
Table 31: Survey analysis of the Q3 comparing age groups with future means of transportation.



Gender belongings to the requirements in the Hyperloop travel mode

This section contains an additional analysis that is not included in the main part of the paper. It examines which requirements for a Hyperloop journey are important for each gender and which were prioritised highest. The results of this analysis are shown in Table 32. The x-axis lists the various requirements for a Hyperloop connection: Favourable, safety, convenience, sustainability, reliability, fastest mode and established. The genders are on the y axis: Female and male.
For both genders, the most important requirement for the Hyperloop system are low costs. Safety and the environmental aspect follow by the female survey participants. For the male respondents, the cost aspect is also followed by the safety factor, but then the fastest means of transport is favoured. The other requirement aspects all received roughly the same rating and are therefore additional factors for the Hyperloop system. A difference can only be recognised in the third most important requirement. Whereby the female individuals favour sustainability and the male individuals the speed aspect.

Table 32: Survey analysis of the gender belongings to the requirements in the Hyperloop travel.



Price range in relation to the gender belongings

The following section analyses the maximum prices to be paid for a Hyperloop trip from Zurich to Paris, taking gender into consideration. This is used to identify possible differences in costs between the genders. The results of the analysis help to identify possible gender-specific differences in costs. The benefit of this study is that it provides insights into potential gender-related disparities in travel costs. The analysis can reveal any inequalities that could indicate gender-specific factors or influences. The results are illustrated in Figure 31, which contains two boxplots. One boxplot represents the female survey participants, the second the males. The y-axis shows the prices in Swiss francs.
The results for both genders show a remarkable similarity. For the female survey participants, the minimum price for a Hyperloop trip from Zurich to Paris is 15 Swiss francs, while for the male participants it is 20 francs. The median for both genders is also close together. Female participants have a median of 150 Swiss francs and an average of 169.7 francs. For male participants, the median is CHF 160, and the average is CHF 177.8. The maximum amount based on the boxplot is 317 francs for the male individuals and 350 francs for the women. An interesting detail is that the female survey participants have two outliers with high prices, i.e., 500 and 600 francs, which are not present among the male participants. Overall, there is no significant difference between the genders. Both genders are in a similar price range and no significant differences can be identified.

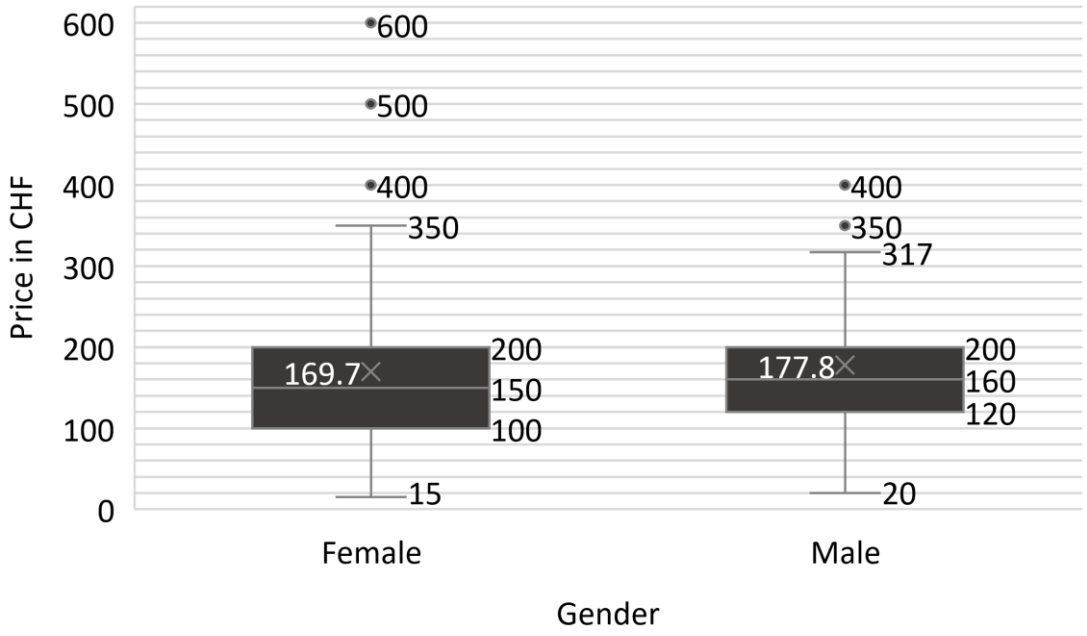


Figure 31: Survey analysis of the price range in relation to the gender belonging with the box plot.

To obtain a further overview of the different prices, an alternative representation was created in the form of a line diagram. This also compares the maximum amounts to be paid from Zurich to Paris, taking gender into account. The price range is shown on the y-axis in Swiss francs, while the x-axis represents the headcount of survey participants.
Figure 32 shows the gender analysis with the maximum price paid for a Hyperloop trip from Zurich to Paris in a line chart. The lines of the female and male participants are very similar and overlap in certain sections. At a price of 300 Swiss francs, 10 of female participants are willing to travel the specified route by Hyperloop, at 200 francs it is 34 participants, at 100 francs 67 and at 50 francs 79 of the 82 female survey participants. Among the male participants, nine individuals would be prepared to travel

from Zurich to Paris by Hyperloop at CHF 300. At a price of 200 francs, 41 of male survey participants would take part in the trip, and at a price of 100 francs, 80 persons would. These results are very similar and there is no significant difference between the genders. The number of survey participants is too small to be considered representative and therefore the results are not meaningful.

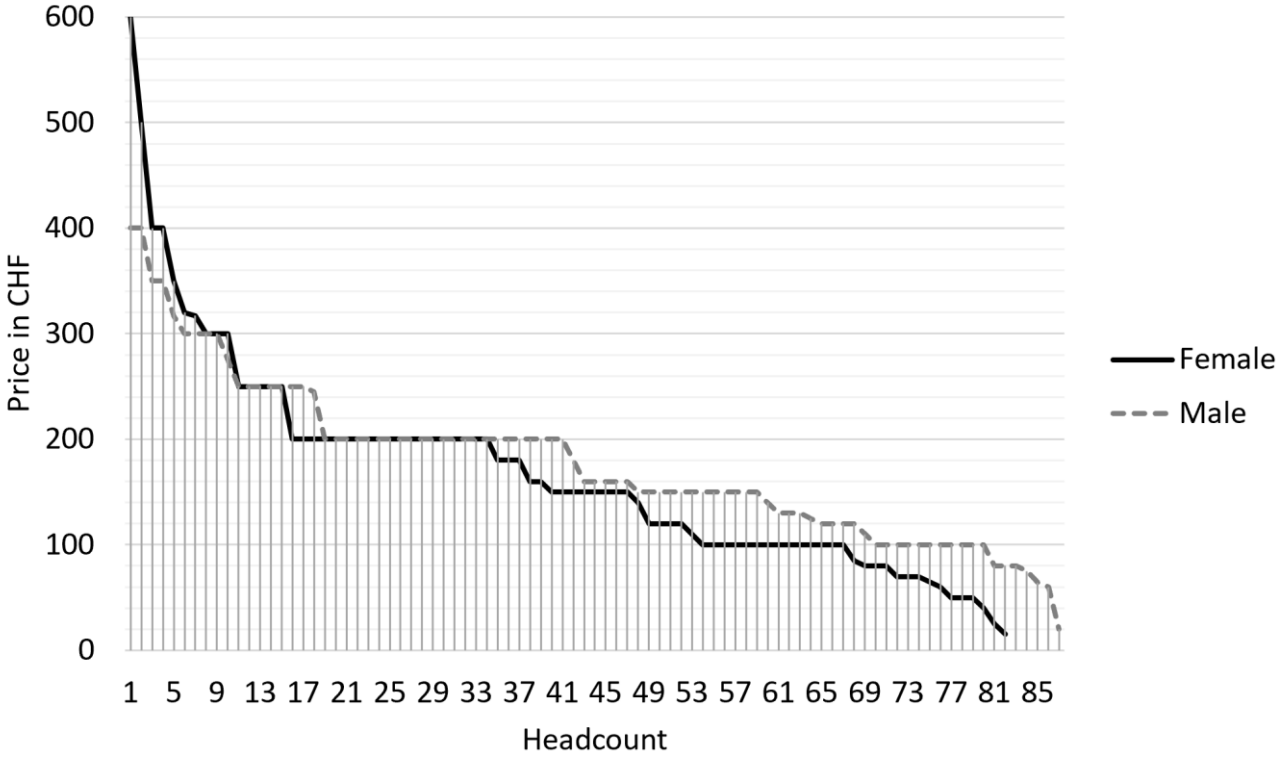
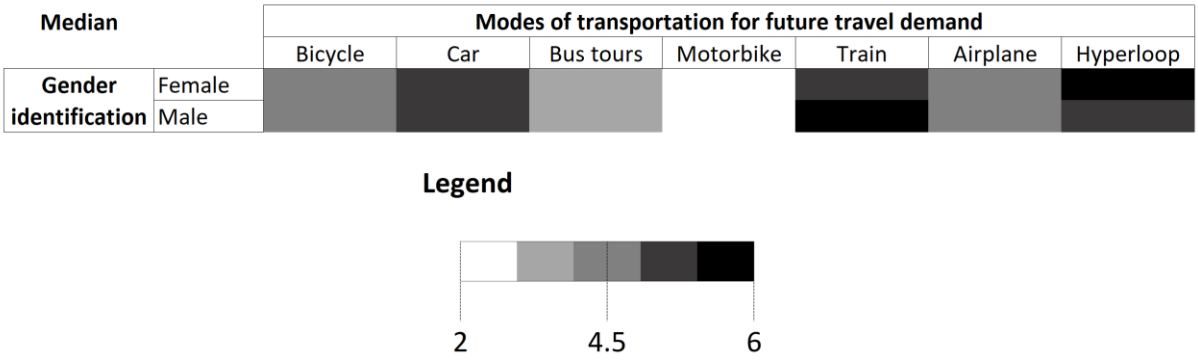


Figure 32: Survey analysis of the price range in relation to the gender belonging in a line chart.

Gender belongings compared with future means of transportation

For a further comparison, an analysis was carried out that relates the means of transport to the genders of the survey participants in terms of their suitability to fulfil future travel needs. The results of this analysis are shown in Table 33. The x-axis represents the different potential means of transport that could fulfil the needs of the survey participants in the future. The y-axis shows the two genders, female, and male. Only the median was calculated and the results of the first and third quartiles were omitted. This was done because the median did not show a significant difference between the genders and therefore this analysis was not pursued further. The fields in the graphic were coloured in such a way that the thinner the field, the higher the prioritisation and the more preferred the choice of means of transportation. In addition, a legend has been added for better interpretation.
Among the female survey participants, the Hyperloop is the preferred mode of transportation and is considered the most suitable for future travel needs. This is followed by the car and the train. Among male participants, the majority favoured the train first, followed by the Hyperloop and the car. The bicycle, plane and bus tours received similar ratings from both genders and were prioritised less. Overall, the genders rated the prioritisation equally, only the train and the Hyperloop were preferred differently. Due to the small number of survey participants, the results are not representative. However, there is no significant difference between the survey participants.

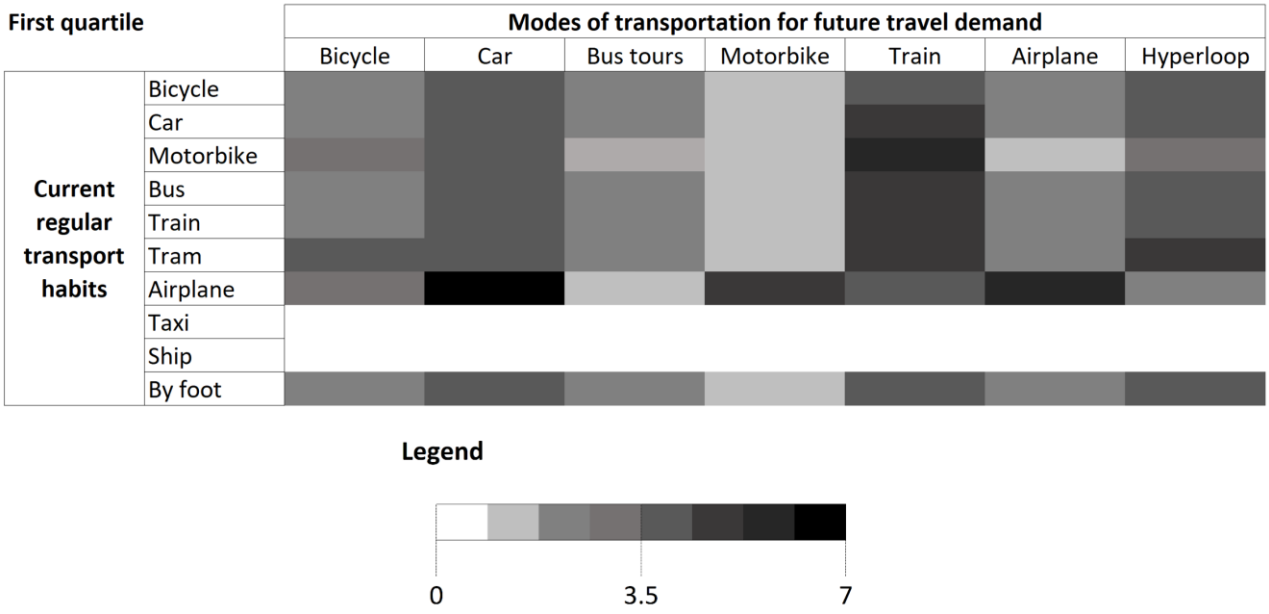
Table 33: Survey analysis of the gender compared with future means of transportation



Current transport trends compared to future travel needs

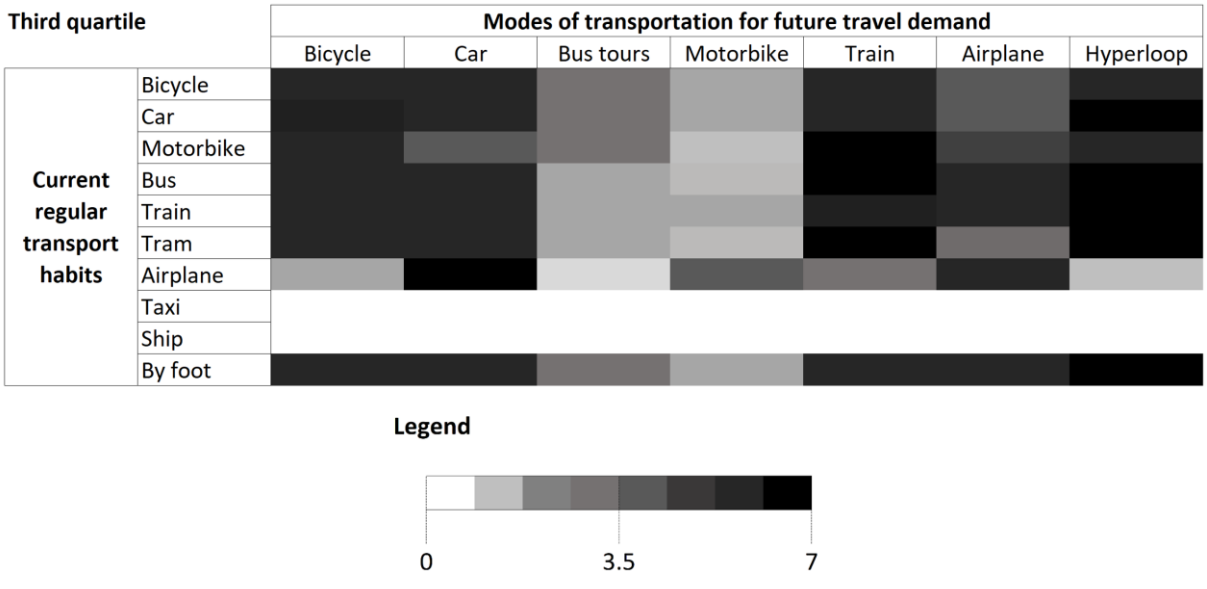
This appendix section represents additional data from chapter 5.2.12 Current transport trends compared to future travel needs. The results of the first and third quartiles are presented in the following Table 34 and Table 35.
The results are similar to the calculated median. Almost all survey participants who currently use a different mode of transport consider that the train can best fulfil future travel needs. This is followed by the Hyperloop and the car. According to this analysis, this means that many survey participants would change their mode of transport in the future.

Table 34: Survey analysis of Q1 of current transport trends and future travel needs.



Compared to the first quartile, the results of the third quartile show slight differences. The Hyperloop is favoured by almost all survey participants. This is followed by the train, the car, and the bicycle to fulfil future travel needs.

Table 35: Survey analysis of Q3 of current transport trends and future travel needs.

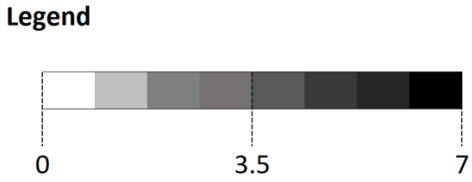


Comparison of current transport preferences with travel needs

This appendix section represents additional data from chapter 5.2.8 Comparison of current transport preferences with travel needs. The results of the first and third quartiles are presented in the following Table 36 and Table 37.
The results show a similarity to the analysed median. For current means of transportation, the reliability factor is favoured above all. This is followed by low costs and short journey times.

Table 36: Survey analysis of Q1 comparing current transport preferences with travel needs.

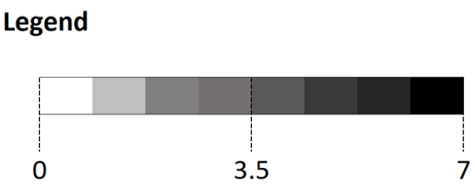
First quartile		Requirements for a mode of transportation					
		Low costs	Safety	Convenience	Sustainability	Reliability	Travel time
Regulary used forms of transportation	Bicycle						
	Car						
	Motorbike						
	Bus						
	Train						
	Tram						
	Airplane						
	Taxi						
	Ship						
	By Foot						



Compared to the first quartile, the results of the third quartile show slight differences. The third quartile favours short travel times and low costs. Reliability comes next. There are no anomalies between the different means of transport users.

Table 37: Survey analysis of Q3 comparing current transport preferences with travel needs.

Third quartile		Requirements for a mode of transportation					
		Low costs	Safety	Convenience	Sustainability	Reliability	Travel time
Regulary used forms of transportation	Bicycle						
	Car						
	Motorbike						
	Bus						
	Train						
	Tram						
	Airplane						
	Taxi						
	Ship						
	By Foot						



Comparison of travel needs with the transport choices of the future

This section contains an additional analysis that is not included in the main part of the paper. It is analysed which modes of transportation will be preferred in the future compared to the factors required of a mode of transportation today. This allows to identify which requirements are important today and which means of transport can best fulfil them in the future. The x-axis lists the means of transport that could best fulfil the travel requirements in the future: Bicycle, car, bus tours, motorbike, train, airplane, and Hyperloop. The y-axis lists the aspects of the current means of transport: Low costs, safety, convenience, sustainability, reliability, and travel time. Table 38 shows the results of the analysis.

The most preferred means of transport that best fulfils the travel needs of the future is the train, followed by the Hyperloop and the car. According to this analysis, these fulfil the factors of low costs, comfort, reliability, and travel time.

Table 38: Survey analysis comparing travel needs with the transport choices of the future.