Adoption of Hyperloop

Exploring Public Perspectives on the Development of Hyperloop

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HARDT HYPERLOOP

TU Delft

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Exploring Public Perspectives on the Development of Hyperloop in the Netherlands using Q-methodology

By

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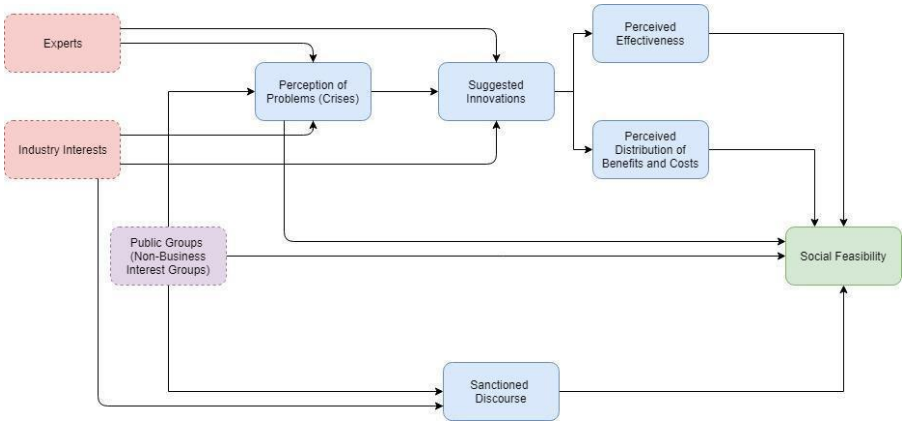
Kunal Shetty
Delft, February 2019

Executive Summary

Ever since it was conceptualized by Elon Musk, Hyperloop has promised to deliver a sustainable mode of transport travelling at speeds faster than any other mode of transport alternatives available. Other promises of Hyperloop include a cheaper mode of medium to long distance transport, which would enable faster and more efficient travel between two cities. This will have profound impact on the urban infrastructure planning as well as lifestyle trends of the wider society. The nature of its development makes it a large scale multi stakeholder project. For Hyperloop to be a successful innovation, it needs to be widely adopted by the society it intends to serve. Thus, studies are required to evaluate the factors that affect travel mode determinants. However, this innovation does not only impact the potential active users, but will also affect the non-users due to the extensive infrastructure development required for the project. Thus, in addition, studies have to measure the public perception to reduce the barriers or to generate awareness about the benefits of Hyperloop.

Therefore, to fill this knowledge gap on perspectives on the development of Hyperloop, the following research question was formulated:
"***What are the different public perspectives on the development of Hyperloop as a mode of transport?***"

To achieve the objective of identifying perceptions on the development of Hyperloop, the 'Political Economy Model for Transport Innovations' was used as a framework. The model was chosen since it is identified that adoption of an innovation with a large scale infrastructure development such as Hyperloop is not a function of individualistic decision making only. The model however was adapted to achieve the objectives of this study. Thus, the figure below was chosen as the framework.



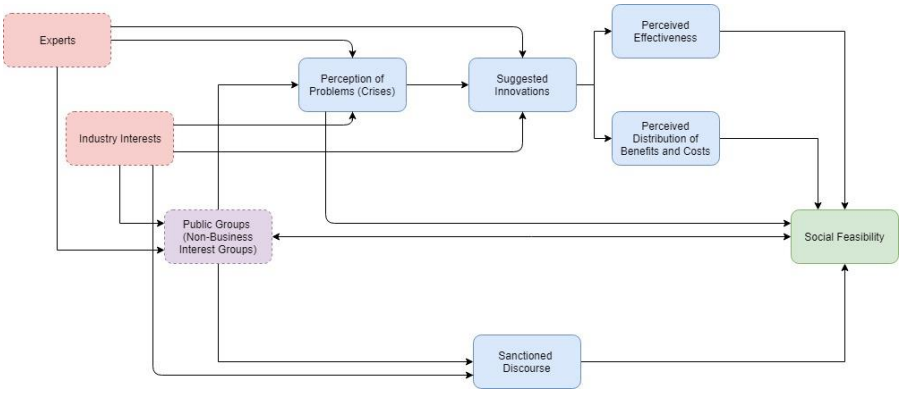
Political Economy Model to measure Social Feasibility (Feitelson and Salomon, 2004)

The research generated a set of opinions by interviewing experts from the field of transport innovations, Hyperloop and transport policy. The interviewers were a balanced mix of experts from academia and industry. Based on their input a set of 25 statements were presented to a sample set of respondents who would likely be affected by the development of Hyperloop in the Netherlands. Using Q-methodology steps, the existing perspectives on its development was evaluated. 4 distinct perspectives were identified based on the analysis and the results of Q-sorting. The first perspective is, 'Support for Research on Hyperloop'. This perspective

supported the R&D efforts on the development of Hyperloop, which would be beneficial for existing travel modes or future innovations. The second perspective was 'Improvement in Current Transport Modes'. This perspective supported the idea of improving the services of the current public transport modes such as rail and air services for the same purpose that is intended to be achieved with Hyperloop. The third perspective is 'Support for Implementation of Hyperloop', which supports the idea of a full-fledged development of Hyperloop in the Netherlands. The fourth perspective is 'Skeptical of Hyperloop Development' which expressed skepticism on the nature of the technology based on its promised benefits.

The analysis thus generated a set of 2 positive and 2 negative perceptions. However, it was found that even though the views were opposing, The relative ranking or priority given to statements were similar in some cases. The research infers that even though the opinions on certain aspects remain the same, the envisaged solutions or perspectives can differ. Thus, it is inferred that decision making on the development of Hyperloop needs to involve the affected public as a primary stakeholder. There should be a better flow of communication between the grass root level of government bodies to national government council, and the affected public. Also, involving and integrating development efforts of the existing transport modes in terms of research and development is the way forward for Hyperloop.

Through this study it was found that it is important to identify and achieve broad consensus among the stakeholders to increase acceptance of a particular innovation such as Hyperloop. This was in line with (Innes, 1996) research on building consensus for public infrastructure and development projects. Thus it was proposed that the model selected earlier be subject to iterations until a broad social consensus (Social Feasibility) is achieved among not only 'Public Groups', but also 'Experts' and 'Industry Interests'. Also, Q-methodology helps in iterative studies using the same model, providing statistical data to identify the distinct perspectives. The new model is shown below. Although not generalizable, the high replicability of Q-methodology helps in achieving the desired 'Social Feasibility'.



Recommended Model for Building Consensus for Social Feasibility

This research is an attempt to initiate literature on the adoption of Hyperloop as a viable mode of transport. The perceptions that are generated via this study are not generalizable. Also, the perceptions are subject to change, depending on the knowledge available about the topic to the public as well as changing needs in the landscape of transport modes. It was also found that a study of this nature improved the general awareness of individuals towards the technology of

Hyperloop. This could be used by the primary stakeholders to thus generate awareness among the wider society and address any concerns on the nature of its development. Similar studies can also be replicated across regions where the stakeholders foresee development in. The study can be replicated for cultural, political and social differences across borders. It could also be recommended to test the change in perception due to educational efforts on Hyperloop, or changing perceptions at different stages of its development. This can help the stakeholders incorporate better value sensitive design aspects as well as policy design around the technology.

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Chapter 1. Introduction

Hyperloop as a mode of travel was conceptualized and proposed by Elon Musk (2013), for passenger and freight transportation. Hyperloop consists of a sealed network of tubes through which pods carrying passengers and/or freight, travel at very high speeds at low air pressure (Nikitas et al., 2017), between two destinations. A typical Hyperloop system of transportation consists of pods carrying 12-24 people every 10 seconds in sealed low-pressure tubes, propelled by air or magnetic cushions. The pods are expected to travel at speeds faster than a commercial airline making it the fastest mode of passenger travel. Lack of air drag and induction motors would help these pods propel faster than the speed of sound (Anyszewski & Toczycka, 2017). The concept of Hyperloop was first imagined by an American researcher, Robert Goddard as 'vactrain', or train travelling through vacuum (Sirohiwala, 2007). Other sources mention the concept developed by a Russian professor, Boris Weinberg's train travelling in vacuum propelled by magnetic levitation (Nikitas et al., 2017). Hyperloop has also been referred to as Vaculev and Evacuated Tube Technology among others (Mathijsen, 2017).

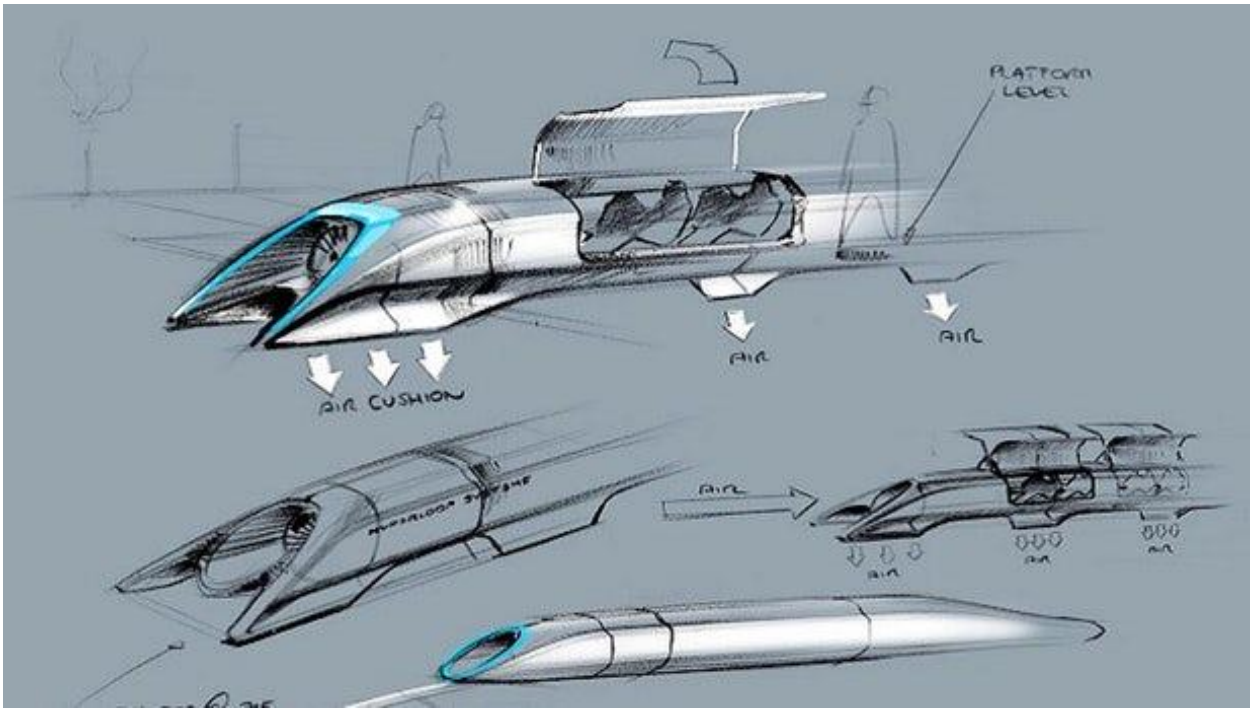

Figure 1: Hyperloop Conceptualization by Elon Musk (Hyperloop Alpha, Musk, 2013)

Several organizations are researching the development of Hyperloop in Europe. This includes start-ups trying to develop a fully functioning Hyperloop, such as Hardt Hyperloop (the Netherlands), Hyperloop Transportation Technologies, Zeleros Hyperloop (Spain) and national and international government bodies such as the Dutch Government, French Government and European Commission. Research & Development of Hyperloop is also being undertaken in universities such as TU Delft, ETH Zurich and TU Munich, who have represented and tested Hyperloop pods in competitions such as the one held by Elon Musk owned SpaceX, conducted annually in California.

Hyperloop aims to provide a faster, cleaner and cheaper mode of transport to solve the current problems in the transport sector. Europe has seen increasing levels of mobility over the past few years (MOTIF, 1998). Technological progress has also seen increase in travel speeds and travel infrastructure. Organizations have to look into the travel needs arising out of the constantly changing society and its

lifestyle patterns (Beirao & Cabral, 2007) caused due to the increased mobility and its speed. This has also significantly increased the spatial range of human activities. These needs were traditionally satisfied by expanding the already existing infrastructure of roads, rails, air and waterways such as canals. Also, concentration of development of such infrastructure localizes the pressure of accommodating economic activities in those areas. Another problem with the current transport modes are heavy dependence on fossil fuels. These transport modes are the major reason for the current rise in global temperatures.

Hyperloop has been envisioned to offer advantages to passengers such as reliability compared to a high speed railway service, reduction of reliance on air transport and fewer road transport issues (Nikitas et al., 2013). Hyperloop also would consume less energy compared to traditional modes of transport and will not be affected by weather conditions (Taylor, Hyde & Barr, 2016). However, it also has a lot of shortcomings in its realization. It is susceptible to seismic activity of the land as well as external terrorist activities and accidents (Musk, 2013). Experts argue that this would be true for any transport mode. However, given that pods would be carrying passengers in an enclosed tube, the focus on safety increases. Also, Hyperloop for passenger travel would be extremely uncomfortable as predicted by technology experts (Levy, 2013). Levy (2013) further elaborates that the high acceleration and high noise would cause major discomfort to the passengers travelling in a Hyperloop pod. Certain critics also point out the safety aspects of the Hyperloop. Scenarios such as power outage, equipment failure and emergency evacuation raise safety questions (Musk, 2013). Further critique on the development of Hyperloop can be found in other reports (Brandom, 2013; Levy, 2013; Plumer, 2013; Economist, 2013). Hyperloop also has to consider design challenges faced by other modes of travel such as the ones faced in the development of high speed railways (Lindahl, 2001).

1.1 Understanding need for Public Perception on Hyperloop

Hyperloop aims to provide a radical new mode of public transport[1] that can mitigate the negative effects of the existing modes of travel. Despite its advantages, the challenges to its implementation exist in its commercial realization and adoption. The concept of Hyperloop is still largely theoretical which affects the public[2] perception of the technology in terms of safety, comfort and susceptibility to environmental conditions, etc. A successful commercial implementation of Hyperloop requires a critical mass of adopters (Leibowicz, 2018). Early adoption of any technology by a critical mass of individuals helps it to establish network effects, economies of scale and continuous improvement through feedback and additional research (Howard and Dai, 2013). Such adoption also shapes market characteristics, policies and investments on the technology.

It is also important to understand how the perception[3] of general consumers would affect the development of Hyperloop. It is important for the stakeholders to incorporate the factors shaping the perception of the public during the development process of any technology to ensure successful adoption. Thus, study of the perception of travel mode choices is needed for long-term planning of transport infrastructure (Schafer and Victor, 2000). Studies on the development of travel mode choices often stress the complex interdependencies between factors causing and affecting travel behavior (Scheiner & Holz-Rau, 2007). The travel mode choice is determined by contextual factors such as environment of available travel mode

[1] Public Transport is defined as, "the transportation of large numbers of people by means of buses, subway trains, etc." also "the system, vehicles, or facilities engaged in such transportation"

[2] Public is defined as, "of, relating to, or affecting all the people or the whole area of a nation or state" (merriam-webster.com, n.d.)

[3] Perception is defined as "the capacity to view things in their true relations or relative importance" (merriam-webster.com, n.d.)

options, personal factors such as individual abilities and car ownership as well as psychological factors such as intrinsic motives (Domarchi, Tudela and Gonzalez, 2008). The study of such factors shaping public perception has been used by various organizations to implement policies such as promoting the usage of environmentally friendly modes of transport as well as to encourage use of public transport (Leibowicz, 2018).

Policies and strategies aimed at encouraging adoption of the public transport should improve the perception, market orientation and provide service quality utility (Beirao and Cabral, 2007). To achieve this organizations need to understand the factors that affect consumer perceptions and travel behavior (Moore and Benbasat, 1991). Further understanding of the perceptions will also help in integrating design aspects and public transport management principles (Beirao and Cabral, 2007) aimed at the adoption of Hyperloop.

1.2 Research Relevance

The possibility of developing a Hyperloop test track was investigated for the Ministry for Infrastructure and Environment, the Netherlands by (ARUP et al., 2017). The research included the exploration of the governance approach to develop a test track which could eventually be realized into a commercial track. These governance issues were researched through stakeholder analyses, exploratory interviews and (inter)national benchmarks. However, it failed to take the public into consideration as a stakeholder.

Any new technology involving large infrastructure developments represent innovations not only for the target audience of potential adopters but also, the non-users. Development and implementation of a large scale infrastructure based project such as Hyperloop may not always be readily accepted by the public. This is highlighted by (Andreatta and Porta, 2002) who studied the protest against the development of the High Speed railway in Italy. Planning of large scale infrastructure projects need to take into account public consensus as a key stakeholder. The perception of the effects of large scale investment projects on public space or the surrounding environment incite a greater reaction from the public than a thorough technical analysis only (Alexander, 1993).

Very few studies have assessed the impact of development of Hyperloop. Research regarding the public perception or adoption of Hyperloop as a mode of transport is non-existent at the time of initiation of this study. Studies on Hyperloop have been limited to descriptive papers such as that of Elon Musk's Hyperloop Alpha (2013), modelling and analysis of Hyperloop (van Goeverden et al., 2018; Abdelrehman, Sayeed & Youssef, 2018), infrastructure development dynamics (Janzen, 2017) and design and development of the different aspects of Hyperloop technology such as (Heaton, 2017; Decker et al., 2017).

1.3 Research Objective & Questions

The primary objective of the research is to explore the key perceptions that could influence the public's decision towards or against the adoption of Hyperloop. Perceived characteristics of any innovation is a critical construct in studying the technology acceptance in any domain (Agarwal and Prasad, 1997). Investigation into the perspectives of the public on Hyperloop will give the reader an overview into the factors affecting the public perception. This will lead to a better understanding of the eventual target consumers. The research attempts, through its results, to advise on the factors to be taken into account during the design and development process. This will contribute to the literature for future modes of travel, and transition to these modes. Identification of such factors also adds to the research in the field of behavioral economics affecting the adoption of modes of travel. The factors identified as the ones

affecting the public perception of Hyperloop can be tested for significance to study other modes of future travel.

The research also aims to initiate literature on Hyperloop for managerial relevance. It aims to complement the existing literature on factors affecting the adoption of new innovations and need to study perception as a determinant of adoption of an innovation, especially in the domain of transport.

To achieve the objective of this research, the central research question should be:

What are the different public perspectives on the development of Hyperloop as a mode of transport?

Since Hyperloop as a mode of travel has still not been developed on a commercial scale, the research can only be exploratory in nature. To answer the main research question, a set of sub-questions is formulated as follows:

1. ***Why is it important to identify the public perspectives on the development of a new mode of public transport?***

The research was initiated with the aim of understanding factors that would help adoption of Hyperloop as a mode of public transport. While researching these factors, it was found in literature that it is important for the stakeholders to also look into the perspectives that would affect the development of Hyperloop, due to the radical nature of the technology and the large infrastructural changes involved.

2. ***Which theory identified via literature review can adequately identify the different perspectives on the development of Hyperloop?***

The research will further look into various theories and select the one that can adequately explain the role of perception on the development and subsequent adoption of Hyperloop. This will answer the sub-question 2.

3. ***Which statements identified in interviews and a literature review adequately cover the concourse of Hyperloop?***

Sub-question 3 would help the research in determination of statements relevant to the case of Hyperloop. The research filters 25 statements adequately covering the concourse of the Hyperloop.

4. ***What are the recommendations that could be given to the stakeholders responsible for the development of Hyperloop?***

Sub-question 4 will provide recommendations based on the findings of this study to stakeholders in the development of Hyperloop. This sub-question will be answered after identifying the perspectives for the central research question.

1.4 Methodology

Research can be conducted using either qualitative or quantitative methods. Qualitative methods are used for research on emerging domains and complex constructs, contextual studies, and field settings where results could be subject to changes at the time of study (Johnson and Onwuegbuzie, 2013). Qualitative methods are used to develop grounded theories to be tested for further research (Eisenhardt, 1989).

Quantitative methods are used to gain more objective results in cases where results desired should be more generalizable. Results obtained from quantitative research methods are more reliable and comparable (Nagel, 1986). The research method chosen should best fit to achieve the research objectives (Yin, 1994).

Considering the nature of the research being explorative in nature as well as certain requiring empirical data on the factors affecting public adoption, a mixed methods research is used. A mixed methods model is used for research with more practice orientation (Johnson and Onwuegbuzie, 2013). The mixed methods model is chosen to generate information and add to existing knowledge on the development and implementation of new technology such as that of Hyperloop.

1.4.1 Literature Review

The 1st sub-question helps the reader understand the perceptions affecting adoption of a travel mode. Since the technology of Hyperloop doesn't exist yet, it is important for the research to assess the existing perceptions about it. The research will gather information on this through existing literature on similar topics done in transport literature. Literature review is a reliable way to assess the research already done on the subject, identify the gaps in knowledge, and identify the relevant experts in the field. This section will look into the theory of determinants of travel mode choice and consumer behavior towards using public transport modes. Literature on similar large scale infrastructure/transport and/or energy projects will be looked into to understand the importance of determining public perspectives.

Further, theories on adoption and diffusion of innovation were looked at. The theory selected should be such that it serves as a framework for data collection. Thus, it should take into account the nature and characteristics of Hyperloop development. This helped the research answer the 2nd sub-question.

Additionally, a literature review was done on the topic of Hyperloop. This was done with the intention to make the reader aware of the domain of Hyperloop.

Literature review for the research was done through scientific journals available in search engines Google Scholar, Scopus, Elsevier, etc. as well as scientific journals and textbooks.

1.4.2 Q-methodology

Q-methodology is a mixed method research methodology. Identifying various perspectives on development of Hyperloop is an explorative task. Perspectives on emerging innovations which have not been developed yet are difficult to make explicit. Face-to-face interviews used for recording the perspectives of consumers are unstructured and prone to subjective bias of the interviewer (Hollway and Jefferson, 2000). There are no guidelines on the selection of appropriate statements capturing the required perspectives. Similar shortcomings are faced in content and discourse analysis. Typically used for establishing patterns or shared perspectives among respondents through text analysis, the method is prone to subjective bias of the researcher's interpretation of text. Q-methodology helps in analyzing perspectives of respondents without the subjective bias of the above-mentioned techniques. Q-methodology was deemed appropriate for this study because studies exploring perspective on the development of Hyperloop have not been done yet. Also, Q-methodology helps establish a distinct set of limited views.

1.4.3.1 Literature Review and Expert Interviews for Q-methodology.

First, the research picked a limited set of statements from the literature review on Hyperloop. These statements were sourced from the research papers from sources mentioned in section 1.4.1. Further, these statements were also sourced from personal blogs, newspaper articles, and technology based websites.

The perceived causal connections and mechanisms was verified through semi-structured expert interviews. Semi-structured interviews includes a predetermined set of open questions with possibilities to explore a point of research in further detail. Unlike structured interviews, semi-structured method of interviewing can help the researcher in asking further details as the context of the interview develops. This will help the study gain different perspectives on the topic of Hyperloop. Also, since Hyperloop hasn't been researched for its social, cultural, economic and environmental impacts extensively, the study saw a need to interview experts on the topic of Hyperloop. This helped generate additional information on the topic which was used for the research.

These experts were selected from the domain of transport innovations, policy design, technology (Hyperloop) development, responsible ministerial offices etc. from industrial and academic fields. The experts were approached through personal and professional connections. They were also approached through professional networking website, LinkedIn. Experts were also contacted by sending requests via emails on their professional contact details.

A set of 25 statements was selected from a larger sample, which covered the entire concourse of Hyperloop. This answers the 3rd sub-question. The selected statements were then presented to certain participants in a survey, where they were asked to rank order them in a grid designed as per Q-methodology guidelines. The responses collected were then subject to factor analysis in a software called PQ Method, designed specifically for Q-methodology. A detailed description is provided in Chapter 3.

1.4.3.2 Target Group

It is essential for the direct stakeholders to interpret and understand the public perception of a technology under development for democratic accountability and transparency in policy design (Goodwin and Lyons, 2009). Q-methodology requires the respondents to differ in perspectives when queried on a particular factor (Brown, 1980). To achieve the objectives and answers to the research questions, this study interviewed general members of the public.

The study recorded the demographic distribution of the respondents (Gender, Age, Education Level, Income Level). It also took into account the geographical area of residence of the respondents. This is done since the constraints and availability of transport mode choices may differ according to the surroundings of the residence (Beirao and Cabral, 2007). This is distinguished as 'Urban' and 'Rural' places of residence. Additionally, the respondents were asked for their level of knowledge on Hyperloop.

Since the research is conducted in TU Delft along with Hardt Hyperloop which are based in the Netherlands. This makes it difficult to interview respondents outside the country due to geographical constraints. Thus, the findings of the research are based on the input provided by the members of public in the Netherlands. For discussion, therefore these result are not generalizable to other countries.

1.5 Research Overview

As per (Verschuren & Doorewaard, 2010)'s guidelines the research will meet its objectives categorically. This is depicted using the research framework image below. Research framework helps the reader

understand the gap to be addressed, the domain of studies from where the knowledge required to achieve the objectives are obtained, and the insights from additional sources required to build a conceptual framework (Verschuren & Doorewaard, 2010). The gap for this research is the public perception of the Hyperloop technology. The research framework helps in presenting a clear picture of the arguments made to address the gap and allows the reader to further understand the literature that has been used for this study. This framework could be built upon by researchers to further study potential problems arising in the adoption of Hyperloop. The research overview is as follows:

Chapter 2 is a literature review of the research.

Chapter 3 will conduct the Q-Methodology on topic of Hyperloop.

Chapter 4 is the analysis performed on the individual Q-sorts.

Chapter 5 is the interpretation of perspectives obtained from Q-sorting. The findings of chapters 2, 3 and 4 contribute in this interpretation. Each perspective will be explained with narratives as well as similarities and differences between them.

Chapter 6 is the discussion and conclusion of the study. This section will also include limitations, criticism and areas of future research arising out of this study.

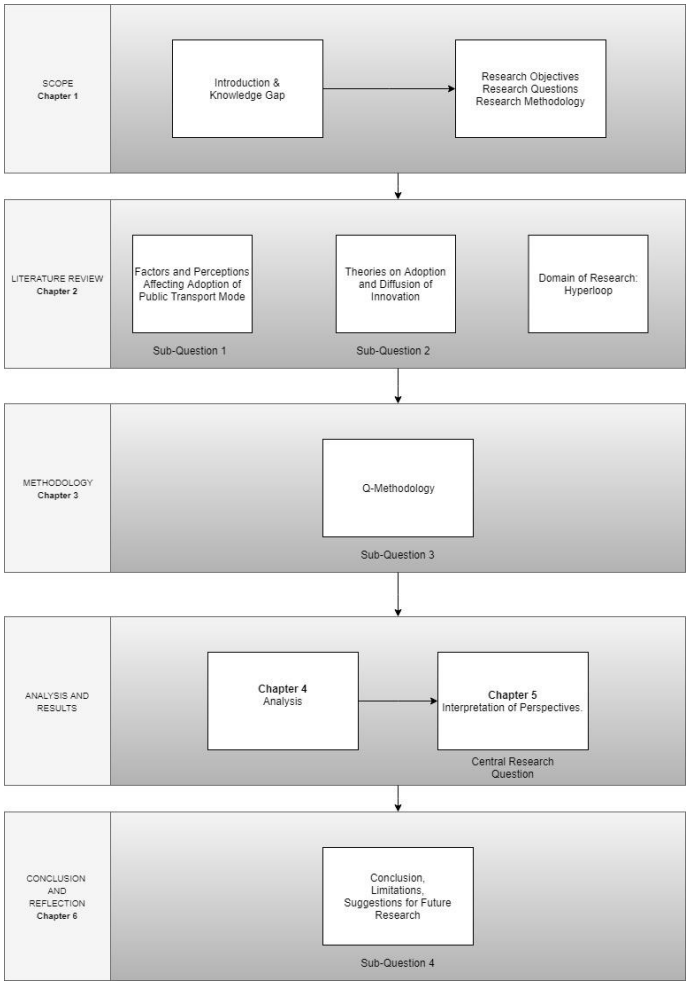

Fig 2: Research Framework

Chapter 2: Literature Review

This chapter will first answer research sub question 1, *"Why is it important to identify the factors & the public perspectives on the development of a new mode of public transport?".* The section will explore the various theories available on adoption of innovations, adoption of travel mode choices, factors affecting the perception of travel mode choices, determinants of travel available in scientific literature. While exploring factors it was found that identifying perspectives on the development of a radical transport mode with heavy infrastructure development also should be taken into consideration for its successful adoption. Thus literature regarding public acceptance, public participation and opinion as well as including public groups as an active stakeholder in infrastructure development projects were looked at to determine the importance of studying perspectives.

Section 2.2 will explore the theories that can help the research determine the various public perspectives affecting adoption of any technology. Hyperloop development includes provision of a radical innovation as an alternative to existing transport modes. It would also involve active participation of multiple stakeholders due to the nature of the technology as well as its heavy infrastructural development.

Section 2.3 will give the reader a brief overview of the technology of Hyperloop. This will also include its key performance indicators, criticism and current developments.

2.1 Factors and Perceptions Affecting Adoption of a Public Transport Mode

Several factors or determinants affect the choices of individuals in selecting one mode of travel over another. The study of such factors has been essential in determining measures or designing policies to affect change in travel behavior. Examples of such studies are (Forward, 1998; STIMULUS, 1999; Steg, 2001; Nilsson and Kuller, 2000; Hagman, 2003; Bamberg et al., 2007) etc. Examples of factors affecting travel mode choices could be categorized under various categories such as socio-demographic, psycho-sociological, situational, the journey type, as well as perceived service performance of each transport mode for that type of journey (Kuppam et al., 1999 as quoted in Beirao and Cabral, 2007). The choice of travel mode depends also on its advantages and disadvantages, and costs. The individual's priority towards flexibility, comfort and sustainable travel practices determine his or her travel mode choice (Johansson et al., 2006).

Socio-demographic characteristics are one of the primary characteristics taken into consideration in any travel mode behavior based study (Anable, 2005). Factors such as age, gender, education, income levels, and job type are included under socio-demographic categories (Kuppam et al., 1999). (Golob and Henesher, 1998) state that attitudes and preferences are also dependent on socio-demographic characteristics. The attitudes and preferences as well as moral or social norms of an individual are categorized under psycho-sociological variables (Cools et al., 2012). Environmental concern is seen to play a more important role as the years progressed. This is highlighted by growing importance given to this factor in the research work on travel mode determinants. Environmental concern is highlighted in (Steg and Vlek, 1997; Jensen, 1999; Nilsson and Kueller, 2000; Beirao and Cabral, 2007; Cools et al., 2012). This is also seen as a psycho-social variable (Steg and Vlek, 2007). Also, factors such as protection, autonomy and prestige are other psycho-sociological factors and explain an individual's preference to use car instead of public transport modes (Hiscock et al., 2012).

(Kaufman, 2000) finds that certain sections of public prefer individual modes of transport such as cars irrespective of the level of service quality of public transport available to them. He attributes this to factors such as speed and autonomy. Other research works such as (Anable, 2005; Jenson, 1999) attribute this also to factors such as convenience and comfort. For the public transport to provide a viable alternative to car users, it has to increase its service quality. Service quality includes, but not bounded by

factors such as comfort, speed and cost efficiency of transport modes available to the public (Prioni and Hensher, 2000).

Travel time using public transport is another factor that is considered when an individual uses public transport modes (Beirao and Cabral, 2007). Travel time is taken into consideration in different regions according to the infrastructure available or built for public transport (Hensher and Rose, 2007). For example, if the commuter wishes to travel for work in cities with exclusive bus lanes, he or she could reach the destination faster. Similarly, if the roads are not equipped with separate lanes for public transport or without good connectivity between two railway stations, the person might choose to travel by car. Both these examples were cited in participant surveys done in (Beirao and Cabral, 2007). Travel time could also include reliability of public transport modes. The reliability is measured in terms of timeliness of the arrival of the transport vehicle (Hensher et al., 2006). For non-discretionary trips, such as travelling for work, reliability of public transport should be high in terms of timeliness (Cools et al., 2012). For discretionary trips such as the ones done for leisure, factors such as flexibility and comfort play a greater role (Anable and Gatersleben, 2005 as quoted in Cools et al., 2012). The flexibility provided by a transport mode is also highlighted as a factor by (Hagman, 2003). The service level quality of public transport modes also depends on its frequency towards the destination (Hensher et al., 2003). Also information on delay or halt of services due to specific reasons, or added or reduced services due to special occasions provided by the public transport modes adds to its positive service quality (Edvardsson, 1998).

Another factor that is considered important in travel mode choice is the costs associated with the transport modes (Kaufmann, 2000). Costs play a key role in the determination of opting to travel with public transport modes among the lower income groups of people (Beirao and Cabral, 2007). In addition, the accessibility of certain destinations as well as travel distances between two distances play a major role in selection of travel mode choices (Kaufmann, 2000; Bracher, 2000)

Finally, safety and comfort provided by a transport mode are factors that are considered when selecting a public transport mode (Parasuraman et al., 1985). Comfort can be manifested as clean seats, pleasant smell and optimum temperature control inside the vehicles (Beirao and Cabral, 2007). Individuals often select public transport modes over cars for effort free travel such as to be able to spend time reading newspapers or work while travelling (Jensen, 1999). However abstract factors like leisure time, safety and comfort are difficult to quantify and measure (Beirao and Cabral, 2007).

The above literature review identifies several factors that affect the travel mode choice. However, the travel mode choice cannot be directly attributed to these factors. (Fujii and Kitamura, 2003; Steg et al, 2001) attribute this instead to the psychological factors. These factors are affected by perceptions of problems, attitudes towards solutions and current travelling habits of the public (Ajzen, 1991). Thus, it is important to study psychological factors to understand how to affect the travel behavior of the public. Examples of similar studies explore the effect of psychological factors on attitude-behavior-adoption/ diffusion of innovations, to predict travel mode choice (Ambak et al., 2015; Bamberg, Ajzen and Schmidt, 2003; Forward, 1998). These studies suggest that travel mode choice is a clearly dependent on perception of the travel mode and its effectiveness. This is also important for this study, since Hyperloop at the time of this research is not existent yet. The only developments in the current year (2018) are test pods that are subject to tests of safety and speed. Hyperloop as a mode of commercial transport is assumed to be launched only in the future. Thus, the study hypothesizes that to increase acceptance, perceptions instead of factors should be given more importance.

Also, (Anable, 2005) states that when travel behavior is studied taking into consideration only socio-demographic characteristics, only a limited number of differences can be outlined. The research further points out that travel research methodology and policy intervention based studies often overlook

instrumental, situational and psychological factors affecting distinct groups of people in different ways (Anable, 2005). Although, travel mode research and analysis are only getting better in studying travel mode choices, the segmentation of public is rarely done based on their distinct perceptions. (Anable, 2005) further points out that in consumer behavior and marketing studies, consumers are distinguished according to their perceptions since they can be targeted in a similar manner. It is important to take every individual's viewpoint on a particular topic or consider the distinct perceptions of the public. Every individual is motivated by different factors and is affected by policies in distinct ways (Anable, 2005)

Problems related to travel mode choice or problems faced while travelling with a particular mode are interpreted as 'commons dilemmas' (van Vugt et al., 1995). The term 'commons dilemmas' describes the dilemmas faced by the individual in choosing a transport mode by resolving the conflict between short-term and long-term interests. Common dilemmas is similar to the concept of "delay of reinforcement" proposed by (Huey and Everett, 1996). 'Delay of reinforcement' further adds that an individual is more affected by the immediate costs and benefits of a certain travel mode than the long-term interests of the collective society/environment. These concepts and studies such as (Forward, 1994; Bamberg and Schmidt, 2001) show that along with factors mentioned in the above section, perception on effectiveness, trust on the transport mode and social value orientation as well as cognitive beliefs of the public matters in predicting widespread use of a particular transport mode (Anable, 2005). This holds even more truth, when it comes to assessing the importance attached to environmental sustainability in the transport sector by the public (Nilsson and Kueller, 2000).

Also, the need to study perceptions on a particular public mode of transport is important for this research, given the nature of its development. The technology is still in its conceptual stage and commercial implementation aspects of its comfort and safety have not yet been proved. Also, although Hyperloop promises to be a sustainable mode of transport, the claims are only based on predictions and concepts around the possibilities. It is important for the researchers to study the social, technical and environmental effects of the development of a fully-fledged commercial Hyperloop. This could be compared to the development of High Speed Rail in countries such as China, Japan, Germany, etc., where even though experts believed that its development would be useful in provision of a sustainable mode of transport with less emissions, eventual research on the social and environmental impact showed otherwise (Janic, 2003; van Wee et al., 2003).

Such developments have thus led to eventual distrust in the development authorities such as the developers of technology itself as well as government bodies as perceived by the general public (De Carlo, 2006). Opposition of any sort on the development of Hyperloop in this case would lead to roadblocks or bottlenecks in decision making, leading to eventual delay in its implementation (He et al., 2015). Opposition to the technology could be regarding the development of infrastructure through public spaces and open views, similar to the concepts describing the 'Not In My Backyard' movement (Hermansson, 2007) to the taxes spent on development of a radical technology instead of incrementally improving the existing alternatives. Opposition could also be faced due to the noise and light pollution linked to Hyperloop (building of infrastructure or otherwise as perceived). The extensive change due to the building of Hyperloop infrastructure on urban planning and landscape design, would certainly draw opposition to its development (Fedi et al., 2012). Thus it is important to understand the perception of the public in also building of the technology.

Similar initiatives around the development of new mode of public transport, for example, the High Speed Rail line from Lyon to Turing has seen stakeholders take into consideration, the importance of open communication and information provision to the affected public (Marincioni and Appioti, 2009). It is increasingly also observed, that involvement of the public in different stages of infrastructure development and taking into account varied perspectives based on the popular opinion has helped resolve environmental and social conflicts (De Carlo, 2006). This process of decision making is also referred to as

consensus-building among stakeholders including the affected public (Margerum, 2008), and its importance cannot be ignored. Thus it is imperative to study the perceptions on the development of Hyperloop to understand the nature of decision making and policy design to be implemented around it.

2.2 Theoretical Models

In this section, the research will look into several theoretical models that explain the diffusion and adoption of innovations. Although, several such theoretical models have been explained in literature over the years, care should be taken to select the appropriate one, especially for large scale transport and infrastructure based innovations. The model should be able to predict to some extent the success of the innovation before it has been developed, which for this research is Hyperloop. The section has borrowed its framework from the book, "Transport Development and Innovations in an Evolving World" (Beuthe et al., 2004).

2.2.1 Review of Theoretical Models

Radical or incremental innovations in transport modes have been continuously introduced in the market. However, not all the proposed innovations are successful. New innovations and ideas are adopted if the proposed innovations are deemed useful (Feitelson and Salomon, 2004). Successful adoption of innovation not only includes analyzing the objective measures such as technical feasibility but should also take into account the existing subjective bias of the target population. This is true for innovations with long term commitments and high sunk costs such as infrastructure development projects. Implementation of large scale projects requires framing of new rules and regulations, which affects the daily life of people (Feitelson and Salomon, 2004). A project with such high investment and requiring building of new infrastructure will require framing of rules and regulations.

Adoption of new innovations has been explained by theories exploring the attributes of the technology or the target group (Bjerkan, Nørbech, & Nordtømme, 2016). Theories such as Rogers Model of Diffusion of Innovation (Rogers, 1960) explore the attributes of the technology. Theories such as Technology Acceptance Model (Davis, Bagozzi, & W., 1989) and Theory of Planned Behavior (Ajzen, 1991) explore the underlying motivations of the general public in adopting innovations. These theories emphasize on the public perception of these technologies with respect to ease of use, increased utility derived, influence of society and facilitating conditions (Venkatesh and Davis, 2000).

The research will further briefly look at various theoretical models existing in literature.

Technology Acceptance Model - Venkatesh and Davis (2000).

Technology Adoption (TAM) model states that the "behavioral intention" or the intention to use an innovation is determined by two variables: 1. perceived usefulness and 2. perceived ease of use. Perceived usefulness of an innovation is the belief that its use will enhance the user's performance. Perceived ease of use is the belief of the user that use of the innovation will be of minimal effort. Additionally, perceived usefulness is also affected by perceived ease of use of an innovation, since the easier the innovation is to use, the more useful it will be. External variables such as the innovation's characteristics, the development process and training to use the innovation, on intention to use is mediated by perceived usefulness and perceived ease of use. TAM has been used mainly to study the innovations in information technology and services sector.

Theory of Reasoned Action - Fishbein and Ajzen (1975)

The theory of reasoned action (TRA) states that a consumer's behavior is determined by his behavioral intention. Behavioral intention is in turn determined by a positive or negative attitude towards the behavior and 'subjective norms' which is how the people around the individual perceive the innovation to

be. The theory does not predict the individual's attitude towards the innovation. It instead predicts the individual's intention to perform a particular behavior by judging his attitude towards the behavior (Hansen et al, 2004). The theory takes into account rational, volitional and systematic behavior of the individual using the innovation (Fishbein and Ajzen, 1975 as quoted in Hansen et al, 2004). Theory of Reasoned action has been used to study the public perception towards use of renewable energy (Bang, Ellinger, Hadjimarcou, 2000).

Theory of Planned Behavior - Ajzen (1991)

The theory of planned behavior (TPB) is an extension of theory of reasoned action. TPB adds the variable of perceived behavioral control as a variable to the model proposed in TRA that affects the behavioral intention of the individual using the innovation. Perceived behavioral control is the individual's belief that there might be certain factors that will either make it easier or more difficult to use an innovation. Theory of planned behavior has been used by several researchers to investigate the use of, and attitude towards use of public transport (Bamberg, Ajzen and Schmidt, 2010).

Rogers Model of Innovation Diffusion - Rogers (2003)

Rogers model of innovation diffusion theorizes that widespread use of any innovation goes through several stages. Diffusion of innovation is its spread across the society for general use in public (Rogers, 2003). The innovation is communicated across the members of the public through various channels. This increases the awareness of the presence of the innovation. This creates a perception about the innovation. The perception of innovation is based on variables such as "relative advantage, compatibility, complexity, trialability and observability" (Rogers, 1995 as quoted in Lee, 2004). Based on this perception, the individual then either decides to adopt or reject the innovation. Adoption is the selection of the innovation for general use by the public (Carr, 1999). If adopted, the innovation is then implemented which is followed by confirmation of its use.

The research also reviewed other theories available in literature such as the Social Cognitive Theory (Bandura, 1986), Motivation Model (Davis et al., 1992), Model of Acceptance and Peer Support (Sykes et al., 2009).

2.2.2 Political Economy Model of Transport Innovations

Feitelson and Salomon (2004)

Innovations according to (Feitelson and Salomon, 2004) are a result of entrepreneurial activities and not necessarily a result of need. Any innovation in the domain of transport come to fruition as a result of a push from two specific set of actors - industry and the experts.

The 'Industry' is represented by a set of actors who are motivated by profits. They develop products or design measures that increase the productivity or profitability of their business. Industry interests thus include producers of transport products. They also include firms that advance measures to help them transport their goods, structure their business more effectively or limit the ability of their competitors (Feitelson and Salomon, 2004). 'Experts' are represented by a set of actors who advance innovations as well as the policies surrounding them. These actors are also referred to as 'policy entrepreneurs' (Kingdon, 1984). Experts can use economic policies as well as regulations surrounding the technology as entrepreneurs to design measures (Feitelson and Salomon, 2004).

Innovations like the Hyperloop are advanced constantly. However, they are taken into consideration only when 'policy windows' open (Kingdon, 1984). Policy windows are specific moments in the process of decision making when the solutions addressing certain problems aligns with the interests of the politics at

the time as well as the need for policies (Kingdon, 1984). The actors from the group of industry interests and experts as well as other communities propose their own set of solutions to be adopted in this policy window. An innovation in such a policy window is only adopted if it is perceived to be technically, economically, politically and socially feasible.

For an innovation to be technically feasible, the innovation in question should demonstrate its technical workings. The innovation should also be feasible economically when its cost and benefits are weighed. Economic feasibility is generally considered as a minimum requirement since it is subject to a wide range of variables. If an innovation cannot clearly highlight its benefits compared to its costs, from a societal perspective it would be considered not feasible.

Innovation can also be considered socially feasible if the majority of voters support its development. Social feasibility is thus highlighted as a function of public perception of problems as well as public perception of the effectiveness of the innovation in overcoming the problems (Rienstra et al., 1999). These perceptions are affected by experience with policies surrounding similar innovations. The set of actors from the experts' group can either support or oppose an innovation through communication via different channels. Actors such as environmental activists, economists and lobby groups can also affect the public perception of an innovation. The collective efforts of these set of actors result in a set of possible 'sanctioned discourse'. However, decision-makers choose the discourse that is found politically acceptable and suitable. Social feasibility and sanctioned discourse affect the political feasibility of the innovation, and the decision makers have to take the voter preferences into consideration.

However, the general public or the 'Non Business Interest Groups' does not vote on transport investments and policies surrounding them directly. These decisions are taken by the decision makers, consisting of politicians. As decisions taken on long-term projects are not realized in a short period of time, the politicians use these decisions for incentives such as financing of their campaigns by actors representing industry interests and avoid negative publicity generated by these actors. The politicians and decision makers also consider the interests of the actors representing the experts, such as environmental activists and social workers. Moreover, the development of such innovations is proposed in areas where it would receive high visibility. These areas are generally where such support groups are located at or work in. Thus, by identifying target groups, politicians hope to gain an advantage among such groups at minimal costs. The politicians' and the decision makers' goal is to address the problems as perceived by the public via solutions proposed by the industry and supported by the experts.

Innovations that are politically feasible are supported by a wide range of actors including the public, industry and the experts. The costs for such innovations are borne by the public. This is rationalized as meeting the public good and addressing an urgent problem. However, not all politically acceptable innovations are ultimately adopted. The real costs of technologies such as Hyperloop only become apparent after its implementation. If the costs are high, it is possible that innovations might not be implemented at all or implemented at a very small scale or with major modifications. This is relevant for innovation with high innovations and predicted sunk costs.

The visual representation of the theory is provided in figure 3 below. The variables 'Experts', 'Industry Interests' and 'Public Groups (Non Business Interest Groups)' are the active 'players', who influence the eventual adoption decision of any technology.

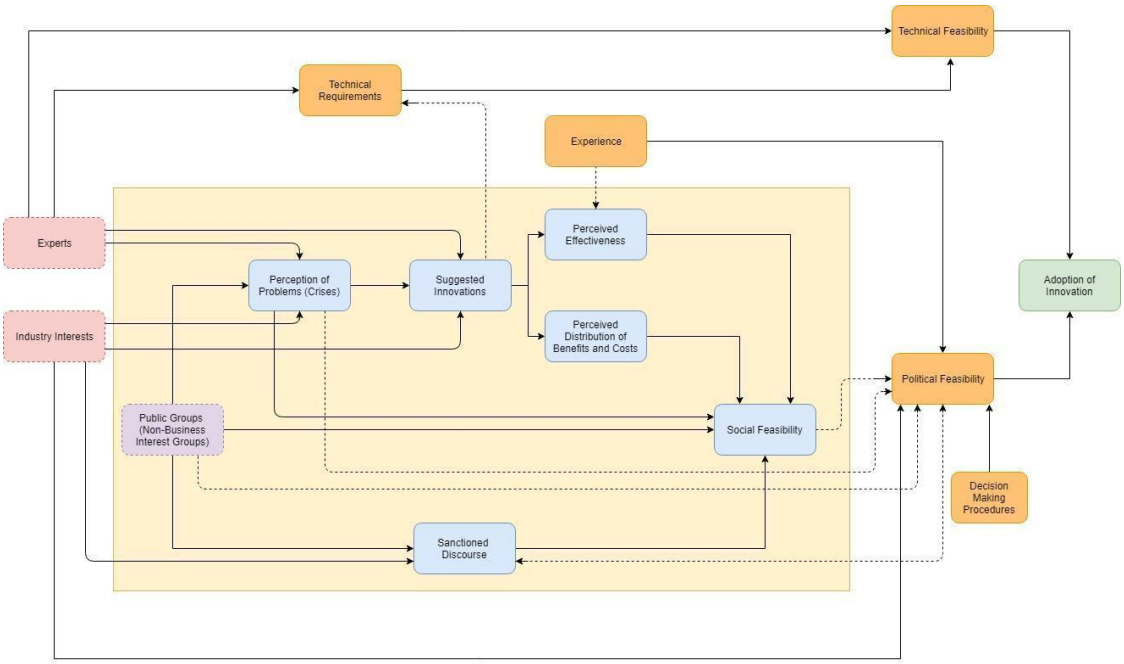

Fig 3: Political Economy Model of Transport Innovations (Feitelson and Salomon, 2004).

2.2.2.1 Adapted Framework for Thesis

The objective of this research is to explore the various public perspectives on the development of Hyperloop. In the framework, the research observes that 'Experts', 'Industry Interests' and 'public groups' (Non-Business Interest Groups) are active agents that affect the other variables in the framework. Since, 'Public Groups' or (Non-Business Interest Groups) only affect 'Perception of Problems (Crises)', 'Suggested Innovations', 'Perceived Effectiveness', 'Perceived Distribution of Benefits and Costs', 'Social Feasibility' and 'Sanctioned Discourse', we only take these variables into consideration.

The research does not take into consideration 'Technical Requirements' and 'Technical Feasibility' which is influenced by 'Experts' group, since these variables are not affected by 'Public Groups'. Similarly, 'Experience' is an independent variable outside the influence of 'Public Groups'. Variable 'Political Feasibility' is affected by 'Public Groups' through the mediating variable of 'Social Feasibility'. Thus, it was deemed appropriate to only measure 'Social Feasibility' for the purpose of this research. Furthermore, since 'Decision Making Procedures' is an independent variable in itself, it is excluded from the model for this research.

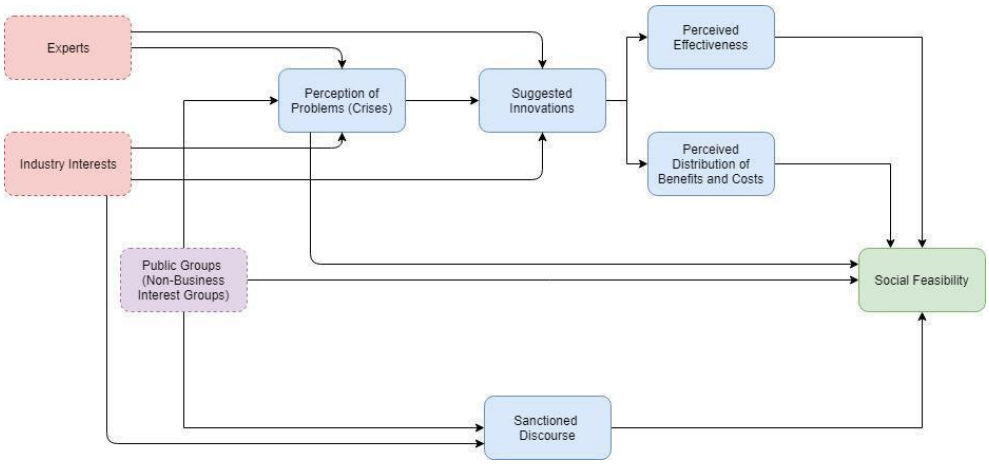

Fig 4: Political Economy Model to measure Social Feasibility (Feitelson and Salomon, 2004).

The framework of Political Economy Model for Transport Innovations is thus modified for the purpose of this specific research. The 'Experts' and 'Industry Interests' put forth their suggested innovations according to the problems they perceive are the ones relevant in this day and age. The 'Experts' and 'Industry Interests' are considered as the primary stakeholder groups for the sake of this research. Both sets of stakeholders have their own perceptions on how effective these innovations are. Similarly, they estimate the distribution of net costs and benefits of these innovations.

This research will put forth the perceived problems and the innovation, Hyperloop to the 'Public Group' set of (secondary) stakeholders, which for this research would be the respondents for the Q-sorting. Also, 'Public Group' will be asked for their perception of the effectiveness of Hyperloop and net costs and benefits. This will be done by asking the respondents selected to represent 'Public Group' to rank order a set of statements covering the variables 'Perception of Problems (Crises)', 'Suggested Innovation', 'Perceived Effectiveness' and 'Perceived Distribution of Benefits and Costs'. The responses will be collectively analyzed and through the results obtained, the research will be able to determine the Social Feasibility of the Hyperloop. Furthermore, based on these insights, the research will discuss possible sanctioned discourses in the concluding chapter. Thus, the recommendations will cover the variable of 'Sanctioned Discourse'.

2.2.3 Justification for Selection of Political Economy Model for Transport Innovations

The theories of technology acceptance model, reasoned action and planned behavior rely on the fact that positive attitude towards intention to use an innovation translates to its adoption or widespread use. (Bagozzi, 2007) theorizes that these models fail to explain how a positive attitude towards an innovation or the intention to use an innovation converts to its actual use. Also, these theories fail to factor in the objectives or goals that the innovation intends to achieve (Bagozzi, 2007). Also, adoption of a particular innovation should be evaluated further as a process from behavioural intention (as shown in TAM, TRA and TPB) to achieving the goals of the innovation (Bagozzi and Dholakia, 1999). Roger's model of Innovation diffusion does not take into account external stakeholders involved in implementation of a large scale infrastructure project such as Hyperloop, in adoption. It mainly works for smaller product innovations, where its widespread adoption is mainly dependent on the individual's discretion. This is true for TAM, TRA and TPB as well.

As (Feitelson and Salomon, 2004) state, a large scale transport innovation will have a high degree of acceptance if it is clearly more useful than the existing options. However, these theories fail to take into account the decision making process of implementing an innovation of such a large scale. Hyperloop requires high investments, design of new policies and regulations, standardization, environmental and economic impact assessments, etc. The successful adoption of Hyperloop cannot be judged based on the atomistic decision making process of an individual from a large public group (Feitelson and Salomon, 2004).

2.3 Hyperloop

This section will provide the reader with a thorough understanding on the topic Hyperloop. It will first describe the conceptualization of the technology, and how it is intended to work as a public mode of transport. This section will not delve deeper into the technical specifications calculated for Hyperloop across various research papers. To gain a deeper understanding with technical specifications, please refer (Werner et al., 2016; Taylor, Hyde and Barr, 2016; Decker et al., 2017; Janzen, 2017; ARUP et al., 2017; van Goeverden et al., 2017; Yang et al., 2017). The section will also highlight the performance indicators of the Hyperloop system. The section will then briefly describe the criticism directed towards Hyperloop and highlight the various developments around the technology in the Netherlands and world over.

2.3.1 Conceptualization

Hyperloop is a conceptual mode of transportation that will carry people and cargo in pod-like vehicles accelerated in tubes between two stations (Werner et al., 2016). The tubes will be maintained at low pressure and the pods will be accelerated at high velocities (van Goeverden et al., 2012). The pods will be accelerated by linear moving motor systems mounted on pods and linear stationary motors mounted on tubes according to (Werner et al., 2016). Also, companies like Hardt Hyperloop are exploring the possibilities of levitating the pods through magnets, essentially like a Maglev (Wink, 2018). This rids the pods of rolling friction due to its magnetic levitation and the air friction due to low pressure in the tubes (Wink, 2018). This creates a nearly lossless (zero loss in energy due to friction and other spent forces) transport mechanism.

Hyperloop is proposed as an alternative to flying between two cities at relatively short and medium distances. The proposed routes for the Hyperloop tracks in consideration are those between Los Angeles to San Francisco, Amsterdam to Paris, Dubai to Abu Dhabi (Hardt.com, n.d.) and Mumbai to Pune (Hyperloop-one.com, n.d.). The research thus considers medium distance to be $\leq$500 kms. However, there is also consideration for building a Hyperloop track between Shanghai and Shenzhen (Hardt.com, n.d.) which would cover a distance of about 1450 kms. Flying is considered as the fastest and cheapest mode of transport for long distances, however not as efficient for short and medium distances (van Goeverden et al., 2012). Additionally, commercial aircrafts are built to travel long distances and are not optimized for short and medium distances (Decker et al., 2017). The Hyperloop system also aims to reduce inefficiencies associated with air travel such as checking in, waiting time, boarding and departing (Decker et al., 2017).

The Hyperloop system is expected to achieve speeds of up to 970 km/hr according to (Musk, 2013), Mach 1 (1234 km/hr) according to (Yang et al., 2017) and 1220 km/hr as projected by (Werner et al., 2016). To put this into perspective, the distance between Amsterdam to Paris would take 21 minutes by Hyperloop, 145 minutes by High Speed Rail, and 213 minutes via airplanes (Hardt,. n.d.). It takes longer with airplanes taking into consideration the check-in times, boarding and departure times. Alternatively, Musk (2013) projected that it would take 35 minutes to travel from Los Angeles to San Francisco, 75 minutes

via airplanes and 148 minutes via High Speed Rail. This would make it a faster and more efficient mode of transport.

The Hyperloop uses the technologies used in aerospace and ground transportation to deliver an efficient and environmentally friendly mode of transport (Decker et al., 2017). It is intended to be powered through renewable energy generated through solar panels mounted on the tubes (ARUP et al., 2017). Hyperloop is intended to provide an environmentally sustainable mode of transport which is at least 3 to 6 times more energy efficient than a traditional airplane (Van Goeverden et al., 2017). It is designed to provide an aerodynamic system such that the pods resemble the movement of aircraft instead of a train, the trajectory of which would be on ground level (Decker et al., 2017). This makes it even more efficient to airplanes in terms of its environment friendliness due to the energy saved due to lack of climbing and descending between altitudes. The pods are thus moving at cruise conditions (Decker et al., 2017) and with lower drag forces against the pod (Taylor, Hyde and Barr, 2016). This also reduces the maintenance costs of the (ARUP et al., 2017). The maintenance costs are also reduced by the fact the pods travel in enclosed tubes, unaffected by the external weather conditions (ARUP et al., 2017). Additionally, the movement of pods will generate lower noise due to the low pressure environment inside the tubes (van Goeverden et al., 2017), thus causing less noise pollution (50 dB A) compared to a High Speed Rail which can generate anywhere between 80-100 dBA (Wolf, 2010).

The tubes for the Hyperloop will be elevated on pillars above the ground level (van Goeverden et al., 2012). These tubes can also be built underground or under water as per (Decker et al., 2017). They will be built parallel to each other between any two destinations that will allow the system to transport people and cargo between the two destinations (van Goeverden et al., 2012). The infrastructure when scaled can connect cities between different regions and countries. A fully developed Hyperloop network would work as a network of highways with connectivity between cities, without transfers and point-to-point connections (Hardt.com, n.d.).

The tubes are maintained at a certain pressure through vacuum pumps (Decker et al., 2017). The pumps would also help in de-vacuuming and vacuuming in case of any air leakage accidents. They are also mounted linearly along the tubes (van Goeverden et al., 2017). The tubes are further divided into three sections according to (van Goeverden et al., 2017)'s modelling of a Hyperloop system. The first chamber is the one maintained at low atmospheric pressure for the traversing of pods between stations. The second chamber is maintained at normal atmospheric pressure for passengers to board and alight the pod. The third chamber is also maintained at normal atmospheric pressure for the pods to rest.

The movement of pods was based on levitation through air cushions as proposed by Musk (2013). However (Janzen, 2017) highlights the shortcoming of such a system due to its high positional dependence. Hence, to maintain a sufficient level of passenger comfort, the pods could be levitated using electromagnetic poles. This also reduces maintenance costs due to fewer components affected by vibration, increased reliability due to less breakdowns of vibration sensitive components and reduced requirement of smoothness of the pod surface. Max Wink of Hardt Hyperloop additionally highlighted the reduced costs of building a pod propulsion system based on magnetic levitation. This makes it similar to a Maglev system, and thus helps in faster development of the Hyperloop due to the already existing knowledge.

Hyperloop could be built to be more efficient than a magnetically levitated high speed railway (Maglev). This is achieved through low atmospheric pressure maintained in the tube chamber (Decker et al., 2017). The low pressure also reduces the drag friction on the pods. The drag can be further reduced, by mounting an air compressor in the front end of the pod, to transfer air to its rear (Yang et al., 2017). This enables "pulse and glide mission profiles" (Decker et al., 2017). The result of such a design is that a lighter, more affordable system could be built compared to Maglevs, with fewer levitation components required for

Hyperloop. The low drag also translates to need for acceleration and deceleration only in certain sections of the tube (Nikitas et al., 2017). The Hyperloop pod resembles an airplane, its propulsion based on dynamically generated lift rather than a Maglev train dependent on buoyancy or static (Decker et al., 2017). However, a balance needs to be found between maintenance of low pressure in the tube and energy needs for it to be technically viable and sustainable compared to a Maglev (Decker et al., 2017).

Initially (Musk,2013) in his Hyperloop Alpha paper proposed that pods could be built either purely for passenger transport carrying 28 individuals or passenger and freight transport with 14 individuals and freight equivalent to 3 full sized automobiles. However, for the sake of this research we consider that the pods will carry 12-24 people at an interval of 10s between each pod (van Goeverden et al., 2012). The interval between the launch of every pod was estimated to be less than 2 minutes by (Musk, 2013). Furthermore, (Decker et al., 2017) calculated the frequency of the pods to 2 pods/minute taking into account safety measures in case of an accident[4]. The developers need to model and find an optimum level of capacity including variables such as speed, frequency and capacity of pods such that it rivals the capacity of passengers transported by High Speed Rail and airplanes, to make it economically feasible.

To ensure a smooth operation of the Hyperloop system with continuous traversing of pods across destinations, a robust traffic control and management system needs to be designed (Decker et al., 2017). This could also be developed using artificial intelligence and machine learning applications (Janzen, 2017) as being tested by a Canada based Hyperloop company, Transpod. To make it safe, the pods are equipped with redundant battery packs to power the life support systems, in case of a power outage (Magnusson and Widegreen, 2018). Also, the pods would have the capacity of independent mechanical brakes and emergency systems (Werner et al., 2016).

2.3.2 Criticism on Hyperloop

Musk (2013), in his Hyperloop Alpha paper, estimates the cost of building the Hyperloop track at $6 billion from Los Angeles to San Francisco. However, many critics highly doubt this estimate (Cunningham, 2017; Matt, 2013; Marshall, 2017; Hern, 2016). (Alon Levy, 2013) points out that a tube system on elevated pylons is rather more expensive than building the system on the ground level. He further elaborates that real estate outside city limits[5] would be cheaper to build the tracks on than build on expensive pylons supporting the tubes. The cost of building High Speed Rail is estimated to be $50 to $80 million per mile (Parsons Brinckerhoff, 2012). Also, one of the assumptions in the Hyperloop Alpha paper is that the tunnels built for a tube will be narrower than that built for High Speed Rail. However, (Alon Levy, 2013) points out that the same unit cost can be achieved if the trains or High Speed Rail are narrower than they currently are. Thus, even with conservative estimates, the unit cost of Hyperloop cannot be built for one-tenth of the cost as advertised in Hyperloop Alpha (Musk, 2013). The Hyperloop was estimated to cost at least $100 billion by Michael L. Anderson, economist at University of California, Berkeley (Brownstein, 2013). Additionally, High Speed Rails avoid the costs of low pressure tubes and maintenance of motors. The cost of building a narrower pipeline for transporting oil alone costs $5-$6 million (Anderson as quoted in Brownstein, 2013).

Also, at the suggested $6 billion construction costs, Hyperloop Alpha (Musk, 2013) suggests that the average individual can travel at $20 dollars per ticket. This would recover the capital costs amortized over 20 years. However, if the costs as suggested by Anderson run up to $100 billion, each individual would have to buy the ticket at $1000 on (Musk, 2013)'s 840 riders per hour capacity and estimated construction

[4] Refer (Decker et al., 2017) for detailed analysis.

[5] taking Central Valley Land in California as a reference point.

costs. This was also pointed out by van Goeverden (2018), when he was interviewed for this research, where he pointed out that Hyperloop might have to focus on premium segment of travelers. Also, little attention is given to cost sharing of building a network of Hyperloop tubes across countries.

The comfort of passengers travelling via Hyperloop is also questionable (Levy, 2013). Taking into account the lateral acceleration, curve of the radius and the proposed speed of the Hyperloop pod, the ride is going to be extremely uncomfortable for the passenger[6] (Levy, 2013). Carlo van de Weijer, Head of 'Strategic Area Smart Mobility', TU Eindhoven, highlights that for the pod to achieve 1000 km/hr speed, the pod should only be accelerated for 30 seconds to one minute. Anything more than this cannot be tolerated by humans (van der Kolk, 2016). He also further points out that for the pod to travel at the suggested speed, the curve radius of the tube should be 16 kms (van der Kolk, 2016). Thus, the tubes should be as straight as possible (as quoted by Rutten, 2018). This makes integration of Hyperloop with the existing infrastructure difficult. If built outside the city limits, a dedicated system would be required to access the Hyperloop stations (as quoted by Konings, 2018). This not only makes the system more expensive, but makes the idea of faster door to door travel time doubtful (Levy, 2013). Further, there is criticism on whether Hyperloop would really be able to achieve sustainability in several research papers (van Goeverden, Janic and Milakis, 2018; Levy, 2013). There is further criticism on whether a tube with low air pressure can really be maintained.[7]

2.3.3 Current Developments

After Elon Musk's paper on Hyperloop titled Hyperloop Alpha (2013) was published, a host of companies have started working to bring the concept into reality. The paper was available as an open source which was used by the companies to initiate their work with.

One of the companies responsible for development of Hyperloop is Virgin Hyperloop One (Marshall, 2018). The company started testing their Hyperloop model in 2016, and carried out a feasibility study to connect Helsinki in Finland to Stockholm in Sweden along with the Ramboll group (Sjodahl, 2018) to connect the two cities, 500 kms apart in less than 30 minutes. The group also was responsible for development of Hyperloop for transport of cargo to and from Dubai's Jebel Ali Port (Hyperloop-one.com, n.d.). The company also is responsible for DevLoop, which would be the "world's first full-scale Hyperloop test track" in Nevada, United States (Hyperloop-one.com, n.d.). The company has also been roped in to develop a Hyperloop track from Dubai to Abu Dhabi in U.A.E and from Mumbai to Pune in India. Furthermore, they have conducted similar feasibility studies in countries such as Netherlands, Finland and USA.

Another company working towards building of Hyperloop is Hyperloop Transportation Technologies. The company has signed agreements with the Government of Slovakia, Czech Republic, Indonesia, Republic of Korea, Ukraine and China (Hyperloop.global, n.d.). Additionally, they are conducting feasibility studies for routes between Abu Dhabi and Al Ain in U.A.E, Cleveland to Chicago in United States and Amravathi to Vijayawada in India (Hyperloop.global, n.d.). Similarly, Transpod is responsible for development of a fully developed test track for Hyperloop in Canada. It is also planning test tracks across Toronto and Montreal as well as other cities in Canada (Transpod.com, n.d.). Similarly, Hardt Hyperloop, is conducting feasibility studies in the Netherlands for the development of a fully functioning Hyperloop (Hardt.com, n.d.). The company was a spinoff from Technische Universiteit Delft, after winning the SpaceX competition held in California, Los Angeles (van de Weijer, 2017). Several other

[6] Refer (Alon Levy, 2013) for a detailed analysis.
[7] Refer (Interesting Engineering, 2017; Gastauteur 2018)

companies such as Arrivo in United States, DGW Hyperloop in India, Zeleros in Spain are attempting to build their own version of Hyperloop system.

Chapter 3. Methodology

In this chapter, the applied Q-methodology to answer the central research question is conducted. Q-methodology is designed to measure the perspective or opinion of a defined sample population on a particular subject (Brown, 1980). This allows the reader to understand the attempt of this research to measure the subjectivity on the topic of Hyperloop. This section will first explain each step of Q-methodology and simultaneously apply it for this study.

3.1 Q-methodology

In 1935, British physicist-psychologist, William Stephenson, invented Q-methodology in an attempt to apply an alternative technique to factor analysis (Raje, 2007). Stephenson intended to measure the subjectivity of the respondents, ideally representing the affected target population, quantitatively (Addams and Proops, 2000). The methodology was named 'Q' to distinguish itself from the more commonly used 'R' methodology, which measures similarities using variables such as age, gender, education and income level (McKeown, 1980). Q-methodology measures the correlations among a small sample of participants referred to for this study as respondents. These respondents are selected based on a predefined set of variables, who identify and arrange (or Q-sort) a set of statements depicting varied opinions in comparable manner (Watts and Stenner, 2005). Ideally, after Q-methodology is performed to explore perspectives, R method of factor analysis is applied to identify proportionate distribution or significance of each identified perspective and its generalizability (Webler, Danielson and Tuler, 2009).

Q-methodology has been extensively used in the field of psychology and political sciences (Barry and Proops, 1999). Other fields of studies using Q-methodology include studies of social perspectives in environmental research (Webler et al., 2011), selection of participants for stakeholder dialogue on biomass energy development (Cuppen et al., 2011), or identification of social discourses to design environmental policies (Adams and Proops, 2000). For this study, Q-methodology is intended to identify discourses on development of a large transport infrastructure project of Hyperloop. Studies such as (Raje, 2007 and Cools et al., 2012) used Q-methodology for identification of discourses that frame the public's view on transport modes, how each individual perceive their travel behavior, how they understand the environment they live in and to propose effective policy strategies. The domain of this study would include, apart from transport behavior, environmental concerns as well as infrastructure development.

3.1.1 Justification for use of Q-methodology

Another method that is widely used to measure perception on a particular topic is 'content and discourse analysis' (Brown and Yule, 1983) was considered for this research. However, this analysis is purely qualitative in nature. The perceptions in content and discourse analysis are identified through primary and secondary literature review, expert interviews as well as discussion with focus groups on a particular topic (Brown and Yule, 1983). However, purely qualitative study is not highly generalizable (Yin, 2003).

Purely quantitative methods to explore perspectives could also be used. Such methods would include measuring of such perspectives on a Likert scale for factor analysis. However, these methods have two drawbacks. It would require a high number of participants selected by segmentation of their demographic characteristics (Lourens, 2015), and it would take a long time to conduct and gather results. Given the exploratory nature of this research as well as the limited time period to conduct this research, it was seen fit to proceed with Q-methodology.

Q-methodology was chosen also because it offers the advantage of replicability and reliability (Watts, 2008). Q combines the qualitative nature of discourse analysis to gather varied opinions on a particular topic and quantitatively measure them through statistical analysis. The results of Q can also be used to test

the generalizability by performing 'R' methodology on the factors identified as results in Q (Ten Klooster, Visser and de Jong, 2008). Unlike content and discourse analysis and quantitative factor analysis for exploratory studies, Q methodology is based on the premise that only a limited number of perspectives exist on a particular topic (Brown, 1980). Thus, only a small number of respondents would suffice to conduct Q-methodology. Also, Q-methodology is used to explore the limited number of perspectives, and not its proportionate distribution. It is also not useful in proving hypotheses (Cools et al., 2012). Q-methodology however is useful for coherence of complex and socially contested answers (Watts and Stenner, 2005 as quoted in Cools et al., 2012).

3.2 Concourse

A concourse in Q-methodology is a set of all the possible viewpoints and statements made about the subject in hand (Cools et al., 2012). It should include all the relevant opinions and statements made on the topic (Brown, 1993). This concourse can be selected either from naturalistic or quasi-naturalistic types sources. Naturalistic source of information are those types of sources which were obtained either through literature, expert interviews or written answers specifically to create a concourse for the Q-sample (Cordingley et al., 1997). Quasi-naturalistic sources of information are external to the creation of the Q-sample, they were not written or recorded specifically for a particular study.

This study uses both naturalistic and quasi-naturalistic sources of information to collect data based on the adapted framework (fig.4). First, expert interviews were conducted as a source of naturalistic information. Furthermore, a literature review was conducted to source information from quasi-naturalistic sources, to complement the claims made by the experts on the topic of Hyperloop. The quasi-naturalistic sources of information were research papers, academic journals, newspaper articles, personal blogs on the internet, etc. The concourse for this research is tabulated in Appendix J. The list contains a set of 93 statements sourced from expert interviews and literature review. The final Q-sample was selected from this concourse, as explained in the next section.

3.3 Composing the Q-sample

To conduct a Q-methodology, a set of statements covering the concourse of the topic of Hyperloop is composed. This set is referred to as the Q-sample. The Q-sample must be tailored such that it addresses the variables identified in the framework for the research (Watts and Stenner, 2012). This Q-sample is structured on the adapted Political Economy Model for Transport Innovations (Fig: 4). A Q-sample based on a selected framework makes this research inductive in nature (Brown, 1996). For this research, a structured Q-sample, based on expert interviews and a detailed literature review on the topic of Hyperloop is composed. Structured nature of sampling of the Q-sample based on the framework is useful in reducing the subjective biases of the researcher (Akhtar-Danesh et al., 2008).

First, interviews were conducted with experts. An overview of these experts is presented in Table 1. These experts were approached via professional networking site LinkedIn, through academic, professional and personal circles. Interviews with four experts were conducted face to face. Interviews with two other experts (Maxime Lachaize, Transpod and Just Ruitenberg, Pro Rail) were conducted over phone calls and the interviews with Max Wink, Hardt Hyperloop and Ministry for Transport and Water infrastructure were received in writing. The transcription for these interviews is provided in Appendices B to I.

Table 1: Interviewees

#	Name	Position, Company	Interview Date

1.	Drs. C. (Kees) van Goeverden	Senior Researcher, Transport Planning, TU Delft	15/10/2018
2.	Maxime Lachaize	Business Analyst, Transpod	17/10/2018
3.	Just Ruitenberg	Strategy Consultant, ProRail	19/10/2018
4.	Dr. Ir. B.J.C.M (Ben) Rutten	Program Manager, Strategic Area Smart Mobility. TU Eindhoven	22/10/2018
5.	Rieneke van Noort	Team Leader, Delft Hyperloop	22/10/2018
6.	Max Wink	Head of Marketing, Hardt Hyperloop	22/10/2018
7.	Dr. J.W. (Rob) Konings	Senior Researcher, Faculty of Architecture, TU Delft	23/10/2018
8.	Anonymous	The Ministry for Infrastructure and Water Management	30/10/2018

The expert interviews were conducted to understand the developments in the Hyperloop technology, facts as well as opinions of experts from various viewpoints. The research used statements from experts to compose the Q-sample for the research.

Additional to this, the research conducted the second part of literature review. Since the topic is new, published articles and columns in newspapers and magazines, personal and public blogs and videos on the topic of Hyperloop were referred to for opinions and statements on the topic. Some of the keywords for the literature review through search engines were “Hyperloop”, “Hyperloop feasibility analysis”, “critical analysis of Hyperloop”, “public acceptance of transport innovations” and “problems with current transport sector”.

The case study on Hyperloop will address the variables as mapped in the theoretical framework selected for the research. The representation of the variables allows the section to structurally sort the statements covering the “concourse” of Hyperloop. These variables are schematically depicted in the framework. The perspectives of the experts and those mentioned in the literature covering each of the variables in the framework are thus noted structurally. These four variables are the 1.The Perceived Problem (in the transport sector, that Hyperloop intends to solve), 2.Suggested Innovation (Hyperloop), 3.Perceived Distribution of Benefits and Costs and 4. Perceived Effectiveness of Hyperloop. To ensure that there is no bias in the statements constituting the Q-sample, the variables 2,3 and 4 are further categorized as depicted in the table 2 below. Variable 1 is kept the same since it allows the research to detail all the perceived problem the Hyperloop aims to solve. This allows the research to find which problems are seen as important by the public groups to be solved immediately. It is to be noted that the variable ‘Sanctioned Discoursed’ was too early to be discussed, which was indicated by four of the interviewees. One of the interviewees stated that the early stage of its development made it hard to predict the ‘Sanctioned Discourse’ to positively affect its ‘Social Feasibility’. Thus, further interviews did not seek perspectives on the variable.

Table 2: Categories of Statements

Perceived Problems		
Suggested Innovation (Hyperloop)	Advantages	Disadvantages
Perceived Distribution of Benefits and Costs	Benefits	Costs
Perceived Effectiveness	Positive	Negative

The Q-set is filtered from a larger set of statements (Exel and Graaf, 2005). A Q-sample that consists of anywhere from 40-80 statements (Watts and Stenner, 2012). However, Q-methodology can also operate with a smaller Q-sample of 24-30 statements as done in various research papers (Raje, 2007; Cools et al., 2009) using Q-methodology.

The research first conducted expert interviews and then conducted the literature review. It was found that similar opinions were expressed on Hyperloop across expert interviews, research papers, various articles and blog posts. Thus, in the initial Q-sample, statements of a certain opinion from a particular source are included only if it presents a new opinion. The research first includes a large sample of statements as given in Appendix J. The statements are first mentioned as quoted in the literature or as quoted by the interviewee themselves. These statements are then summarized to shorter statements highlighting the key indicators in their statements. The statements for the Q-sample are selected such that, the different topics were covered by each statement, highlighting a distinct viewpoint. In case of two statements conveying the same message, the statement encountered first was selected. However, this was completely left to the researcher's discretion. Care was taken to keep the meaning of statements the same with the intended quotes on the topic. Also, they were chosen as such, that no two statements cover the same or a similar aspect on the topic.

The chosen statements for the Q sample are presented to the P-set as opinion based statements. This is done because it is assumed that some respondents of the P-set would not know anything about Hyperloop. Thus, the research will have to map out expert opinions as possible perspectives of the general public. The research intends to measure how the public would interact with the technology, based on statements from experts who know how the technology would work.

For this study, the research first identified 29 statements across four variables and seven categories covering the concourse of Hyperloop. However, after conducting a test Q-sort with the first 5 respondents, a further 4 statements were removed since they convey similar opinions. Thus, a final list of 25 statements were selected for Q-sort. The final Q-sample is denoted in the table below. The statements of the Q-sample will be analyzed further to answer the sub-question 3.

Table 3: Q-Sample

#	**Variable**	**Statement**	**Q#**
1.	Perceived Problems	I think Hyperloop could reduce high emissions of the current transport modes.	15.
2.	Perceived Problems	We need Hyperloop to address the infrastructure stress in urban areas due to growing population.	20.
3.	Perceived Problems	We need more sustainable transport modes for the NL, such	9.

		as the Hyperloop.	
4.	Perceived Problems	Current transport modes in the NL are very crowded, which Hyperloop could solve.	13.
5.	Perceived Problems	Transport modes should be more convenient and accessible in the NL.	3.
6.	Perceived Problems	Current transport modes for medium to long distance (>200 km) travel is inefficient.	7.
7.	Suggested Innovation - Disadvantage	I think Hyperloop has low capacity and thus will be expensive to travel in.	17.
8.	Suggested Innovation - Disadvantage	Implementation of Hyperloop will need more co-ordination among decision makers than for other transport modes.	24.
9.	Suggested Innovation - Advantage	Hyperloop is immune to human interference or external environment.	14.
10.	Suggested Innovation - Advantage	Hyperloop cannot provide a faster mode of door to door travel compared to air transport.	25
11.	Suggested Innovation - Disadvantage	I think travelling with Hyperloop will not be comfortable.	18.
12.	Suggested Innovation - Advantage	Hyperloop can provide an interoperable and efficient mode of freight transport.	11.
13.	Suggested Innovation - Advantage	It will be easier to convince people to travel in Hyperloop, compared to air travel.	1.
14.	Perceived Costs	Other modes of transport will incur costs with passengers opting to travel with Hyperloop.	23.
15.	Perceived Costs	Building of Hyperloop infrastructure through public spaces will face extensive opposition.	2.
16.	Perceived Costs	Hyperloop would have to be built outside the cities with high costs for dedicated infrastructure due to its technical requirements for high speed travel. It cannot be integrated with current transport modes.	12.
17.	Perceived Benefits	A fully electric Hyperloop can alleviate congestion & emissions of road and air travel.	8.
18.	Perceived Benefits	Hyperloop can enable governments to share investment costs and boost economic activity.	19.
19.	Perceived Benefits	Hyperloop R&D will be beneficial for NL to become technology leader in transport technologies.	4.

20.	Perceived Costs	Hyperloop will take a long time for development, certification & standardization.	22.
21.	Perceived Effectiveness – Negative	Hyperloop will allow larger spread of urban areas, thus leading to more emissions and congestion.	16.
22.	Perceived Effectiveness – Positive	R&D on Hyperloop will have positive knowledge spillover on other technologies.	6.
23.	Perceived Effectiveness – Negative	To achieve sustainability focus should rather be put on policies and not radical technologies.	21.
24.	Perceived Effectiveness - Positive	Even though High Speed Rail seems like a better alternative, Policymakers should continue to focus on Hyperloop R&D. By the time HSR is fully implemented, it will become outdated and Hyperloop can be made technically feasible	5.
25.	Perceived Effectiveness – Negative	Public won't support implementation of Hyperloop unless its feasibility for human travel is proved.	10.

3.4 P-Set

Q-methodology intends to measure the subjective opinions that exists within the general population. This could be done using a small number of participants representing the general population (Raje, 2007). These participants are referred to as P-set (Watts and Stenner, 2005). The participants in P-set are selected such that they are representative of all the diverse and discernible opinions existing within the population. A large set of participants is not conducive for the research due to the concept of "finite diversity" as used by (Barry and Proops, 1999). Finite diversity is the assumption that Q-methodology allows the researcher to identify all the possible subjective bias patterns existing within the required population without resulting in a 'chaotic multiplication' of the patterns (Cools et al., 2012). This is due to the fact that only a limited number of patterns are assumed to exist with the larger population. A smaller number of participants gives consistent pattern outcomes in a 'structured and interpretable' manner (Barry and Proops, 1999).

It is important to understand that the application of Q-methodology is to identify varied perspectives in the population, and not to test the proportional distribution of the subjective bias (Valenta and Wigger, 1997 as quoted by Raje, 2007). The participants are selected with certain determined characteristics in a nonrandom manner. This helps the research to identify the patterns existing in the P-set. As (Cools et al., 2012) describe, to test whether a particular method is reliable, it should be able to replicate the results. For Q-methodology to be a reliable test method, it should be able to produce "schematically reliable patterns of discourses across similarly structured yet a different Q-sample" when conducted with a P-set selected with the same characteristics but different participants (Cools et al., 2012). It is also important for the Q-sample to be highly structured and that the concourse duly covers the entire length of the topic. This assures that all the viewpoints existing about the topic is covered (McKeown and Thomas, 1998).

This research deals with a wide range of issues that could possibly affect the development of Hyperloop. These issues are not only limited to the viability of using a new technological solution, but also its effects on the non-users. Such possible concerns could be use of real estate in the vicinity of the residents' houses to the sound generated due to the operation of the technology. Examples of such studies are sound impact of Maglev (Chen et al., 2007) and environmental impact of high speed railways in China (He et al., 2015). Thus, to take into account a wide range of views on the topic, the research uses stratified random sampling as described in (Sekaran and Bougie, 2010). First, the research identifies the demographic characteristics of the required P-set. Since, obtaining a proportionate representative sample of respondents would have been time consuming a disproportionate stratified random sampling was done.

The research focuses on the perspectives of the general public on the development of Hyperloop in the Netherlands. Thus, the participants selected for the Q-sorting were residents of the Netherlands. An individual's travel behavior is highly determined by his/her demographic characteristics (Damm, 1981; Lu and Pas, 1999; Pas et al., 1995). The most common demographic characteristics taken across research studying travel behavior are age, gender, income, education level and employment. The variable 'age' is divided into 3 categories 1. 18-25, 2. 26-57 and 3. 58+ as per (Cools et al., 2012)'s study on travel behavior. As per (Cools et al., 2012) individuals below the age of 18 were excluded from the analysis as 18 is the minimum age for holding a valid driver's license. This age limit holds true for the Netherlands as well. The research further operates under the assumption that individuals above this age have similar options of using a particular transport mode, than compared to individuals below the age of 18, who cannot own individual automobiles (cars in particular).

Gender was divided into Male and Female. Income was divided into 1. 0-20k (low income), 2. 20-40k (average income) and 3.40k+ (high income), all measured in Euros. This was divided based on the statistics available for the Netherlands' income distribution available in (Statista.com, 2018). The research also records the employment status/ nature of the job of the respondents comprising the P-set. Further the 'Education Level' is divided into 3 categories 1. High School, 2. Undergraduate and 3. Graduate Degree. The geographical area of residence is also taken into account as it affects travel behavior (Cao, Mokhtarian and Handy, 2007). This is divided into 'Rural' and 'Urban' areas. As the variability of the outcomes is unknown, the research will select the participants disproportionately. The participant will also be requested to provide arguments for the ranking of the statements. The questionnaire is provided below in Appendix K. The research will try to get 32-36 participants for the Q-sorting.

3.5 Q Sort

Q-methodology requires participants to rank order the statements presented to them in a quasi-normal grid as explained in Figure 5 below. Although, the statements selected for Q-sorting convey varying opinions on a particular topic, it is important to note that the factor analysis provides a structured group of perspectives (Brown et al., 1986). Q-sorting requires participants to rank order the statements respective to other statements. This allows the researcher to measure which opinion the respondent prioritizes over others in a forced way (Prasad, 2001). Once the required number of Q-sorts are collected from the respondents, a factor analysis is conducted. This groups all the responses to a finite number of perspectives.

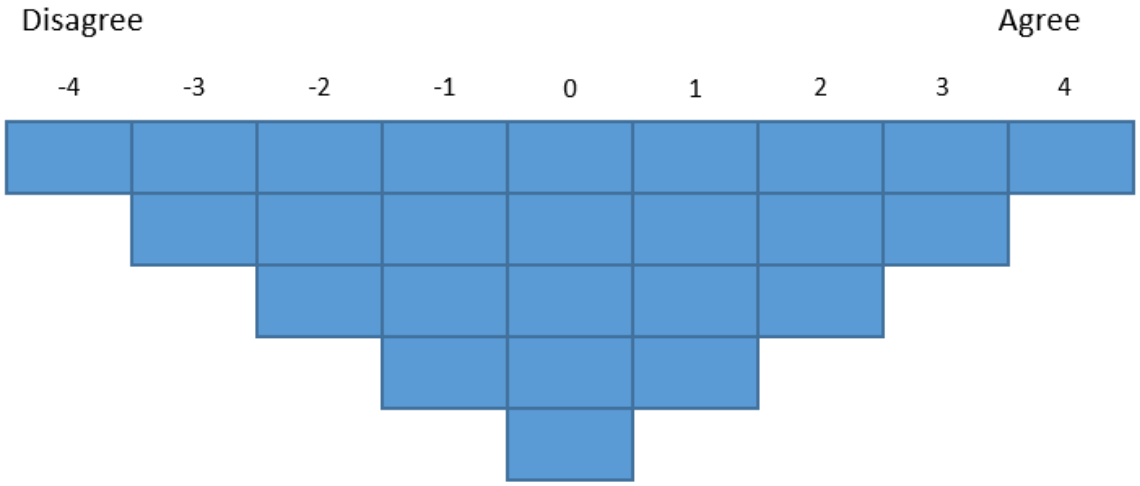

Fig 5: Q-Sorting Grid

The respondents for this study were provided a survey sheet, which recorded their demographics, and were presented with a list of 25 statements of the Q-sample. The respondents were then asked to be rank the statements on the grid as shown above. The grid shows a quasi-normal distribution. According to grid shown in (Watts and Stenner, 2005), the boxes can be arranged from '-5' to '+5'. However, this could be adjusted as the researcher sees fit.

The Q-sort for this research was done via face to face interviews. This allowed for the study to clarify respondents' doubts on any of the statements presented to them. First, the respondents were asked to tick whether they agree, disagree or remain neutral on a statement. The respondents were then asked to rank the statements from '-4' as the statement they most disagree with, to '+4' as the statement they most agree with. However, sometimes the respondents tended to agree with most of the statements presented to them. Therefore, they were asked to think about the topic on a more holistic view and rank the statements from the most they agree with as '+4' to the least they agree with as '-4', in case they agreed with all the statements.

After ranking of each of the statements, the respondents were further asked to motivate their reason of ranking the particular statement on '+4' and '-4'. Further, each respondent was asked to provide an additional opinion the development of Hyperloop if any. This could be used for further studies exploring further perspectives or testing the findings of this study. The face to face nature of this interview also allowed the respondents to ask any further questions regarding the survey or express concern with the design of the survey. Once all the responses were collected, they were analyzed using the software PQ Method.

Chapter 4. Analysis

The analysis section of the research will describe how the analysis was conducted, and provide the descriptive analytics of the respondents participating in the Q-sort. Additionally, the section will also look into the results analysis that is generated when the Q-sort is analyzed in PQ Method software. Individual Q-sorts are subjected to factor analysis in the software. This will help the research interpret the different patterns of perspectives on Hyperloop.

4.1 Conducting the Survey

Q-sorting requires the respondents to sort a deck of cards, each containing a statement on a quasi-normal grid as shown above. For this study, a sample set of 32 respondents were deemed sufficient to perform the Q-sorting. However, gathering a group of 32 respondents with the given characteristics would have been a time consuming experience. Instead, a survey sheet was designed with as given in Appendix K.

Since the respondents for the P-set should have been a sample of the population of the Netherlands, the recruitment for Q-sorting was done by randomly approaching people on the streets and public places. The first recruitment for the Q-sorting was done in Den Haag Centraal Station, where a total of 7 respondents were asked to do the Q-sorting. Given the success in recruiting respondents in an area close to public transport, a second recruitment process was followed in Rotterdam Centraal Station. Here, the researcher interviewed a total of 4 respondents. Selection of respondents was also done in Delft Centrum where a total of 8 respondents were requested to perform the Q-sorting. Additionally, 8 respondents were approached through personal network of friends and acquaintances residing in the Netherlands. The final 5 Q-sorts were performed by students of TU Delft in the faculties of Industrial Design Engineering, Technology, Policy & Management, TU Delft Library and Faculty of Applied Sciences.

4.2 Descriptive Analysis

The descriptive analysis provides a general overview of the respondents who participated in the Q-sorting process. This was recorded in the survey sheets provided to the respondents for the Q-sorting process.

The first demographic that is recorded in the survey sheet for Q-sorting was gender. Out of the 32 respondents that were recruited for Q-sorting, 18 were male, and 14 were females.

The next demographic characteristic that was recorded was the age bracket of the respondents. 11 of the respondents were of the age bracket 18-25, 18 of the respondents were from the age bracket of 26-57 and 3 respondents were from the age group of 57+.

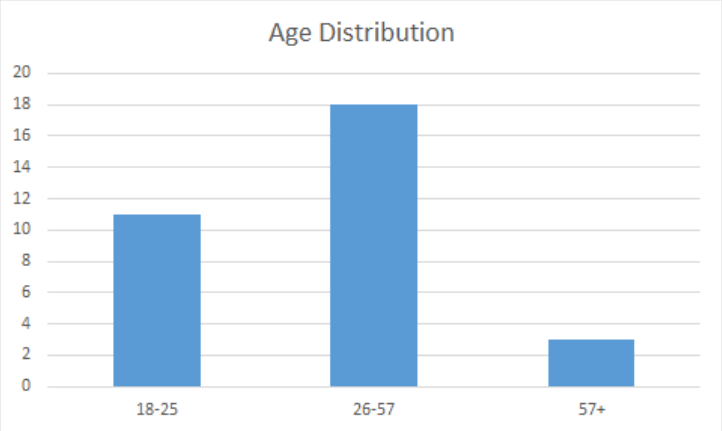

Fig 6: Age Distribution Graph in P-set

Next, the education level of the respondents was recorded. The following image gives the representation of the Education Level of the respondents of the P-set. Six of the respondents had only a High School Degree, 14 of the respondents were Undergraduates and 12 respondents had Graduate or more in educational qualification.

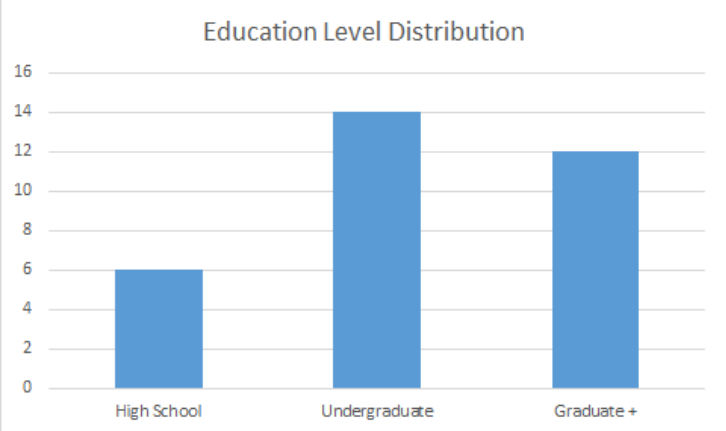

Fig 7: Education Level Distribution of the P-set

The respondents were also asked about their Geographical Area of Residence. Of the 32 respondents, 13 resided in Rural areas and 19 resided in Urban areas.

Finally, the income level of the respondents were recorded in the survey sheet for Q-sorting. 9 of the respondents were from the income bracket of 0-20k, 15 respondents were from the income bracket of 20-40k and 8 respondents were from the income bracket of 40k+. This is indicated in the figure below.

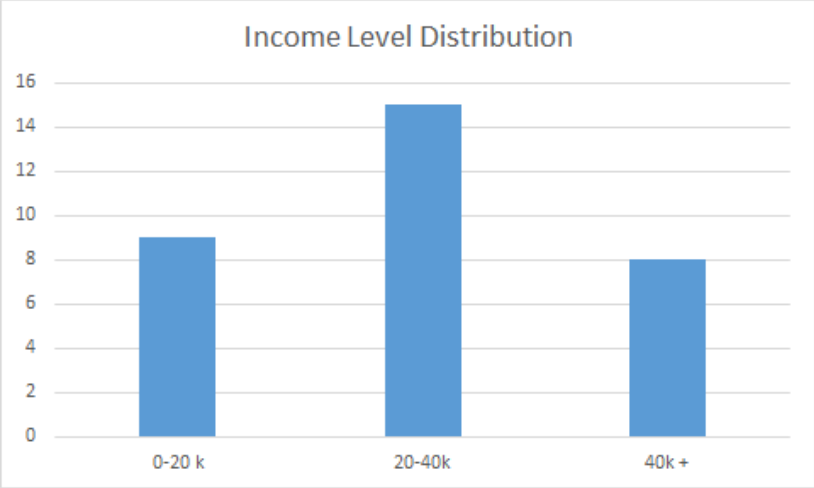

Fig 8: Income Level Distribution of P-set

The respondents were also asked to provide a short description of their jobs. Since the respondents were randomly recruited without defined space for recruitment, the description of jobs were varied and distinct. However, it should be noted that the largest group of respondents were students (4), followed by 2 PhD. candidates. The description of the jobs included NS Ticket Conductor, Software Engineer, Fish Shop Owner, Nurse, etc. as well as Unemployed.

Additionally, the respondents were asked if they had any knowledge about Hyperloop. To record this, the following question was asked and their response recorded.

Q. Do you know about the Hyperloop?

A. What is Hyperloop?
B. Just heard of it in Newspapers/internet/Television. My knowledge is rather shallow, but I am aware of its presence.
C. I have read about the concept of Hyperloop. My knowledge is not really deep, but I am fairly aware of the technology
D. I consider myself an expert in the topic of Hyperloop.

11 respondents selected option A as they weren't aware of the concept. They were then given a brief explanation followed by the video by Hardt Hyperloop uploaded on their website and on YouTube: https://bit.ly/2AzqMZi. The majority of the respondents constituting the P-set selected option B, with 15 respondents. 4 respondents selected option C and 1 respondent selected option D.

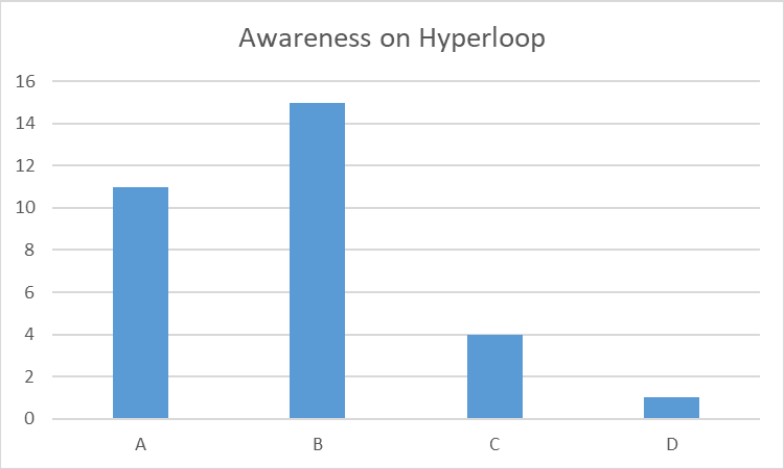

Fig 9: Awareness on Hyperloop in the P-set

4.3 Factor Analysis

By conducting factor analysis on all the individual Q-sorts gathered from the 32 respondents, the research derived the different perceptions that exist on Hyperloop. This was done using the PQ Method software. Every respondent from the P-sample might have different viewpoints on Hyperloop. Factor analysis helps in reducing the different viewpoints and group them into shared perspectives. Q-sorting helps determine the correlation between the 32 Q-sorts received for this research. This is given in Appendix L. Each respondent correlates perfectly with him/herself. This is denoted as 100. The strength of the correlation with other respondents can be gauged based on the value obtained in the analysis. Additionally, inverse factor analysis helps determine distinct factors based on which shared perspectives are interpreted.

4.3.1 Factor Extraction

PQ Method software analysis generates a limited number of factors. Every respondent correlated highly with a certain factor, which is referred to as 'loading' high (Watts and Stenner, 2005). The correlation matrix in Appendix L, shows that the highest correlation factor between two respondents is (73/100 = 0.73) and lowest correlation is (-39/100 = 0.39). The correlation matrix also showed positive and negative correlation of lesser magnitude between the respondents' Q-sorts. Positive correlations of lesser significance implied that even though some of the views are shared, their overall perspectives might not be the same (Watts and Stenner, 2005). The procedure of Q-sorting also forces the respondent to holistically rank their statements on a quasi-normal grid as described above. This results in 'mean' of 0.00 and a 'standard deviation' of 2.041 for all the Q-sorts.

A factor analysis was performed on the correlation matrix to generate the factors as mentioned above. There are two methods through which these factors could be generated – centroid method and Principal Component Analysis (PCA) method. Either of the two methods generate more or less the same results (Watts and Stenner, 2005). The only difference is PCA denotes a perfect correlation as 1, and centroid denotes it as 100. For this analysis, centroid method was chosen due to its popularity compared to PCA. The factor analysis generates a set of 7 factors. Each of the 7 factors' correlation with each respondent is also denoted. This is shown in Appendix M.

4.3.2 Factor Rotation

After factor analysis, factor rotation was performed on the derived factor matrix. This was used to optimize the separation of the derived factors (Kitzinger and R., 1985 as quoted in Lourens, 2015). Factor rotation can either be done by using manual hand rotation or Varimax rotation. Manual hand rotation is dependent on the judgement of the researcher. It is usually conducted to test any if any of the pre-formed hypothesis for a research holds relevance (Exel and de Graaf, 2005). Varimax rotation has greater mathematical superiority (Watts and Stenner, 2005). Varimax is advantageous compared to manual hand rotation since it maximizes the variance across fewest possible factors, which is reveal the range of viewpoints over fewer factors (Watts and Stenner, 2005).

Upon performing factor rotation through Varimax, a different point of view of looking at the data is obtained. According to (Watts and Stenner, 2005) only factors with Eigen Values of more than 1 are rotated, and the rest are discarded. The Eigen Values of factors 3, 5 and 7 are less than 1, and thus are discarded while performing the factor rotation.

Table 4: Factor matrix with an X Indicating a Defining Sort
&
% Expl. Variance

Respondent	Factor 1	Factor 2	Factor 3	Factor 4
P1	0.2841	**0.6266X**	0.2008	0.3324
P2	0.4625	0.2305	**0.6062X**	0.1169
P3	0.0909	**0.4889X**	-0.1094	0.1471
P4	0.3353	0.2748	**0.4919X**	-0.0195
P5	0.5454	0.3642	0.5181	-0.2645
P6	**0.7195X**	0.0834	0.2403	0.0907
P7	0.1288	0.0462	**0.6456X**	0.3113
P8	0.0263	0.2746	0.1746	**0.6777X**
P9	0.1379	0.0947	0.4008	**0.6740X**
P10	0.3116	0.1397	0.0559	**0.5265X**
P11	**0.7003X**	0.0177	-0.2707	0.1823
P12	0.4004	-0.4202	0.2644	-0.0734
P13	-0.0754	-0.2113	**0.7104X**	0.2395
P14	-0.0618	-0.1770	**0.7542X**	0.1824
P15	-0.1389	**0.7051X**	0.1585	0.1763
P16	0.3083	**0.5745X**	0.0919	-0.0454
P17	**0.6098X**	0.1480	0.2222	-0.0497

P18	-0.0905	**0.7240X**	-0.1845	0.1269
P19	**0.6716X**	-0.1627	-0.3753	0.1821
P20	0.0104	0.0038	**0.5138X**	0.0980
P21	0.3331	0.3613	0.0881	0.1702
P22	0.2409	0.2636	**0.5537X**	0.3770
P23	-0.1338	**0.4794X**	0.1283	0.1662
P24	0.1247	-0.0427	**0.9076X**	0.0048
P25	0.1963	0.0433	0.0699	0.3772
P26	0.1287	0.2405	0.2344	**0.6878X**
P27	**0.5513X**	-0.1012	0.1921	0.3193
P28	**0.6997X**	0.1316	0.1093	0.0737
P29	0.2399	**0.6874X**	-0.2812	0.2906
P30	0.1713	0.2941	0.2896	**0.6563X**
P31	**0.5041X**	-0.1013	-0.0326	0.2779
P32	-0.0977	0.1145	-0.0722	**0.4240X**
% expl. Var.	**14**	**12**	**15**	**11**

***X denotes the factor the respondent loads high on**

For each Q-sort, the factor with the highest loading is marked with an 'x'. This is known as 'flagging'. PQ Method allows the researcher to pre-flag these factors. Thus, for each factor, the number of defining variables are indicated in table below. It also denotes 'Average Rel. Coef.', 'Composite Reliability' and 'S.E. of factor Z scores'.

Table 5: Factor Characteristics

	Factors			
	1	**2**	**3**	**4**
No. of Defining Variables	7	7	8	6
Average Rel. Coef.	0.8	0.8	0.8	0.8
Composite Reliability	0.966	0.966	0.970	0.960
S. E. of Factor Z Scores	0.186	0.186	0.174	0.200

4.3.3 Factor Loadings

Any significant factor derived from factor rotation should have at least 2 Q-sorts respondents load significantly on that factor alone. Using the 'pre-flagging' option, allows the researcher to determine the highest loading factor for a certain Q-sort. The significance of a certain factor is assumed to be (>0.50), akin to the one used in R factor analysis. However, (Brown, 1980) in his research advises to calculate the

significance value as $(1/\sqrt{32})x2.5$, where N is the number of Q-sorts obtained. Thus, the significance value for this analysis is $(1/\sqrt{32})x2.5 = 0.44$.

The loading value of 0.44 theoretically should give maximum number of Q-sorts loading high on one factor only. However, with this value we also see, Q-sort 2 loading high on Factor 1 at 0.4625, which is not flagged in the software. Also, Q-sort 32 loads high on Factor4, albeit at a value lower than the calculated significance. Thus, to maximize the number of Q-sorts loading high on a single factor, the research assumes the significance value at 0.47. This helps the research assume Q-sort P2 loading high on Factor 3. Subsequently, Q-sort P32 does not load high on any of the 4 factors. Similarly, Q-sorts P12, P21 and P25 do not load high on any of the 4 factors. Q-sort P5 loads significantly high on Factors 1 and 3, thus correlating strongly with them. Since a clear distinction cannot be made, the Q-sort is not taken into consideration when interpreting results. Thus, the only change in the Factor Extraction table would be '5' respondents/defining variables loading high on Factor 4, instead of '6'.

Table 6: Affected Factor Loadings due to change in Loading Factor

Respondent	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
P2	0.4625	0.2305	**0.6062X**	0.1169
P32	-0.0977	0.1145	-0.0722	**0.4240X**

Chapter 5. Results Interpretation

In this chapter, the distinct perspectives on Hyperloop are explained based on the results obtained from the analysis. The factor matrix table indicates loadings of each of the 32 Q-sorts. These loading are further normalized into Z-scores. The factor Z-score table is given in Appendix N. The highest Z-score for each factor is likely to be ranked '+4' and the following two highest scores are ranked '+3'. Similarly, the lowest Z-scores are ranked at '-3' and '-4'. The complete list of statement ranking is provided in Appendix O, which provides Factor Q-sort values for each of the 25 statements.

5.1 Interpretation of Perspectives

Each factor is interpreted as a distinct perspective. These perspectives are interpreted based on the statements ranked highest for the corresponding factor. Based on the results obtained from the analysis, the following four perspectives were interpreted. For each perspective interpreted, the statements that are ranked the highest and the lowest are also indicated. Each perspective will also take into account the personal statements and justification given by the respondents who have ranked the highest loading factor on '+4' or '+3'.

5.1.1 Perspective 1: Would Support Research on Hyperloop

Perspective 1 was common to 7 of the 32 (21.87%) respondents of the P-set. This perspective identifies itself highly with statements 6, 7 and 11 from the Q-sample. Collectively statement 6 was ranked at '+4' and statements 7 and 11 were ranked at '+3'. Similarly, statement 20 was collectively ranked at '-4' and statements 18 and 25 were ranked at '-3'. It should be noted that 5 of the respondents loading high on Perspective 1 held a graduate degree and 2 of the respondents were undergraduate. Also, only 1 respondent of the 6 resided in a rural area and the rest in Urban areas. The gender distribution was equal with 4 male and 3 female respondents. Also, the age distribution was equal with 3 respondents from '18-25' group and 4 respondents from '26-57' group. Interestingly, all the respondents had heard about Hyperloop, with 4 respondents selecting option 'B', 2 respondents selecting option 'C' and 1 respondent selecting option 'D'.

This perspective is of the opinion that Hyperloop will be beneficial in one way or other, and thus support its research. It sees Hyperloop as a step in the right direction to improve the current transport modes. They perceive that research and development efforts on Hyperloop will certainly improve the current transport modes. They also support the notion that R&D on Hyperloop will help the Netherlands (the country chosen for this research) to become a technology leader (statement 4 ranked at '+1') and that efforts should continue to prove its viability for future needs (statement 5 ranked at '+2'). 1 respondent pointed out industries such as the aerospace sector and the civil/infrastructure sector could possibly benefit from research on Hyperloop.

The respondents loading high on this perspective are also of the opinion that the current transport modes are not efficient. A respondent cited the "*check-in*" and "*check-out*" times while travelling by airplanes as inefficient. Respondent 6 cited the heavy reliance on fossil fuels by the current transport modes (air and rail in particular) as contributing to this inefficiency. They see great promise in Hyperloop to improve this efficiency. Statements such as "*I think Hyperloop research will benefit efficiency of trains in switching to more eco-friendly fuels*" supported this view.

They also perceive that if not a transport mode for human transport, Hyperloop could still be helpful for freight and cargo transport. This was echoed by Respondent 28, citing that "*...even if Hyperloop is not viable for human transport, it could be used for transport of cargo. For example cargo and freight transport in Mars!*" Also, while pointing out the that it was too soon to predict its viability, another

respondent was hopeful, citing, "*...that while public perception is still a little early to predict, private investors like Elon Musk's company and the Dutch Government can test its viability of transporting cargo from the Rotterdam port to Groningen. This could help build an ecosystem of agents, markets and complementary goods around the technology. Eventually with the funds flowing in, technology can always be improved and made viable.*"

All the respondents disagreed on the negative aspects of Hyperloop pointed out by experts while composing the Q-sample. However, the respondents did not think Hyperloop was essential in addressing the infrastructure stress in Urban areas.

Table 7: Relevant Statements For Perspective 1

#	Statement	Ranking on Grid
6.	R&D on Hyperloop will have positive knowledge spillover on other technologies.	4
7.	Current transport modes for medium to long distance (>200 km) travel is inefficient.	3
11.	Hyperloop can provide an interoperable and efficient mode of freight transport.	3

Table 8: Irrelevant Statements For Perspective 1

#	Statement	Ranking on Grid
20.	We need Hyperloop to address the infrastructure stress in urban areas due to the growing population.	-4
18.	I think travelling with Hyperloop will not be comfortable.	-3
25.	Hyperloop cannot provide a faster mode of door to door travel compared to air transport.	-3

5.1.2 Perspective 2: Would Prefer Improvements in Current Transport Modes

7 respondents out of the 32 (21.87%) loaded high on Perspective 2. This perspective identifies itself highly with statements 17, 2 and 3 from the Q-sample. Collectively statement 17 was ranked at '+4' and statements 2 and 3 were ranked at '+3'. Similarly, statement 14 was collectively ranked at '-4' and statements 15 and 20 were ranked at '-3'. The demographic characteristics of this group were 5 males and 2 females, 1 respondent from the '18-25' age group, 4 respondents from the '26-57' group and 2 respondents from the '57+' age group. 2 of the respondents had 'High-School' only education and 4 respondents were 'undergraduates' and the 1 respondent held a 'graduate' degree. 5 of the respondents lived in 'Rural' areas and 2 respondents from 'Urban' areas. 5 of the respondents had never heard of Hyperloop (option A on Hyperloop awareness) and 2 respondents had chosen option B for awareness. Hence, most of the respondents here were made aware of the concept by showing them the video as mentioned above. Any questions were further clarified through one on one interaction during Q-sorting.

The perspective expresses that Hyperloop will be an expensive mode of travel due to its low capacity. The perspective also supports the arguments focus should rather be put on policies (statement 21 ranked at '+2') Also, this perspective states that Hyperloop travel won't be as comfortable. Other views that are coherent with this view is the fact that infrastructure for Hyperloop would have to be built outside cities and will take a long time to be built completely (statement 12 and 22 ranked at '+1').

One respondent also believed that even if Hyperloop has equivalent capacity compared to air travel and trains, it will be expensive since it is brand new. Respondent 10 mentioned that this was similar to how air travel was only focused on a premium segment when it started out. Other statements justifying this view were, "*costs for R&D, acquisition of new real estate will make it expensive regardless of capacity.*"

Also, respondents were pretty certain of the opposition that a project of such high infrastructural demands would face opposition from the public. This would translate to, "*...taxes, inconveniences caused due to construction, changing landscape of the cities.*" as pointed out by Respondent 29. This sentiment was echoed by 2 other respondents (18 and 23). This group further advocated for improvement in the current public transport modes in the Netherlands. They believed that current public transport modes were not convenient enough. They advocated for "*...a better infrastructure or increased frequency of the current transport modes available*" to them.

The respondents strongly opposed the idea that Hyperloop was immune to external interference. When indicated that the designers intend the system to be full automated, they still pointed out that natural disasters like earthquakes can disturb the system. Similarly, these respondents were doubtful of the benefits of Hyperloop being helpful in reducing emissions and infrastructure stress.

Table 9: Relevant Statements For Perspective 2

#	Statement	Ranking on Grid
17.	I think Hyperloop has low capacity and thus will be expensive to travel in.	4
2.	Building of Hyperloop infrastructure through public spaces will face extensive opposition.	3
3.	Transport modes should be more convenient and accessible in the NL.	3

Table 10: Irrelevant Statements For Perspective 2

#	Statement	Ranking on Grid
14.	Hyperloop is immune to human interference or external environment.	-4
15.	Hyperloop could reduce the high emissions of the current transport modes.	-3
20.	We need Hyperloop to address the infrastructure stress in urban areas due to the growing population.	-3

5.1.3 Perspective 3: Would Support Implementation of Hyperloop

Perspective 3 was loaded high by 8 of the 32 respondents (25%). This perspective identifies itself highly with statements 4, 5 and 8 from the Q-sample. Collectively statement 4 was ranked at '+4' and statements 5 and 8 were ranked at '+3'. Similarly, statement 7 was collectively ranked at '-4' and statements 1 and

14 were ranked at '-3'. Of the 8 respondents who loaded high on Perspective 3, 3 were 'Male' and 5 were 'Female' respondents. 5 of the respondents were from the '18-25' age group, and 3 respondents were from the '26-57' age group. One respondent had a 'High School' degree, 3 respondents had an 'undergraduate' degree and 2 respondents had a 'graduate' degree. 7 of the respondents were from 'Urban' areas and 1 respondent was from 'Rural' area. When questioned on their awareness on Hyperloop, 2 respondents chose option 'A', 5 respondents chose option 'B' and 1 respondent chose option 'C'.

This perspective believes that research on Hyperloop will generate positive knowledge spillover (statement 6 ranked at '+2') The perspective also expresses that Hyperloop could help reduce emissions and congestions of the current transport modes (statement 15 ranked at '+2') and that there is a need for more sustainable transport modes (statement 9 ranked at '+1'). The respondents loading high on Perspective 3 believe the research and development of Hyperloop will be beneficial for the Netherlands to become a technology leader in transportation technologies. These respondents believe that Hyperloop should be developed and fully implemented in the Netherlands. Respondent 24 supports this view by citing that, "*...becoming technology leader in Hyperloop will enable the Netherlands based companies to export or lead the way in Europe and world over to install and implement the technology.*" Respondent 14 further adds that, "*...owning technical intellectual property for a constantly tech hungry world will have immense benefits for the Dutch economy.*"

The respondents also believed that given enough resources, the Hyperloop could be made technically feasible. The governments and private players should invest themselves in working towards large scale implementation of the technology. They believe that the current available technologies might get outdated by the time Hyperloop could be realized and would not be able to satisfy the demands of the future needs in travel. Thus, Hyperloop is a step in the right direction. However, none of the respondents ranked in at '+4' and thus no justifying statements were available from the respondents.

The respondents also believe that Hyperloop will be beneficial in reducing the congestions and emissions of road and air travel. Thus, Hyperloop is perceived to be a very sustainable mode of transport compared to the current transport modes. This is also reflected by the positive ranking of statements 9 and 11 at '+1', highlighting the importance of the promise of sustainability provided by Hyperloop.

Interestingly, the respondents also believe that current transport modes are efficient, or constantly getting more efficient as time has passed by. Respondent 13 justifies this view by stating, "*Even the smallest of villages are connected by bus services, especially in the Netherlands.*" Also, these respondents believe that Hyperloop will face the same challenges in convincing people to travel by it, as faced by airplane travel.

Table 11: Relevant Statements For Perspective 3

#	Statement	Ranking on Grid
4.	Hyperloop R&D will be beneficial for NL to become technology leader in transport technologies.	4
5.	Even though High Speed Rail (Thalys) seems like a better alternative, Policymakers should continue to focus on Hyperloop R&D. By the time HSR is fully implemented, it will become outdated and Hyperloop can be made technically feasible.	3
8.	A fully electric Hyperloop can alleviate congestion & emissions of road	3

	and air travel.	

Table 12: Irrelevant Statements For Perspective 3

#	Statement	Ranking on Grid
7.	Current transport modes for medium to long distance (>200 km) travel is inefficient.	-4
1.	It will be easier to convince people to travel in Hyperloop, compared to air travel.	-3
14.	Hyperloop is immune to human interference or external environment.	-3

5.1.4 Perspective 4: Skeptical of Hyperloop Development

From the Q-analysis on the PQ Method software, the research received 6 respondents (18.75%) that loaded high on Perspective 4. However, due to adjustment in loading values to determine a single perspective as explained in section 4.3.3, only 5 respondents remained loaded high on Perspective 4. Collectively statement 10 was ranked at '+4' and statements 2 and 22 were ranked at '+3'. Similarly, statement 3 was collectively ranked at '-4' and statements 13 and 20 were ranked at '-3'. 2 of the respondents were 'Male' and 3 of the respondents were 'Female'. Also, 1 respondent was from '18-25' group, 3 respondents were from '26-57' group and 1 respondent from '57+' group. 2 respondents had attended 'High School', 2 respondents had 'undergraduate' degree and 1 respondent had a 'graduate' degree. 1 respondent resided in 'Urban' area and 4 respondents resided in 'Rural' area. When questioned on the awareness on Hyperloop, 3 respondents selected option 'A' and 2 respondents selected option 'B'.

Perspective 4 is a bit skeptical of the development of Hyperloop. The respondents loading high on this perspective had little to no awareness and thereby had little opinion on the technology itself. However, they identified with the problems this innovation/technology might face, especially given the scale of infrastructure development and radicalness of the technology itself. This perspective expresses that travelling with Hyperloop will be expensive due to its small capacity (statement 17 ranked at '+2'). Also, that infrastructure for Hyperloop would have to be built outside cities which would not lead to faster door-to-door travel times (statements 12 and 25 ranked at '+2'). The perspective further reiterates its perception by expressing that Hyperloop travel won't be comfortable (statement 18 ranked at '+1'). Also, that focus should rather be put on policies and not one technologies and development of Hyperloop would need more co-ordination among stakeholders than other infrastructural and transport projects (statements 21 and 24 ranked at '+1').

The respondents here are not sure if the transport modes will be practical for human transportation given the small space and high speed. One respondent cited that, "*Proof of concept isn't enough in itself, studies on safety, environmental and societal consequences will have to prove its feasibility*." Another respondent stated that the enclosed nature of the pod will make her feel claustrophobic and without knowing safety measures, she wouldn't travel in it.

Respondents of this perspective also point out the opposition that the project might face in implementation. This is similar to the respondents identifying themselves with Perspective 2. Also, the

time taken to fully develop the technology as well as certification and standardization in transport modes will take a long time according to the respondents of this perspective. The perceived barriers to this by the respondents were aspects such as radicalness of technology, decision making procedure by the governments, and coordination among stakeholders. One respondent stated, "*The conservative attitude (especially in Europe) in developed, wealthy regions towards integration of new technologies will delay the test and validation process of Hyperloop.*"

The respondents here also believe that transport modes are not as crowded compared to other European countries, and were thus content with them. Also, they do not see the need for Hyperloop to address the infrastructure stress in urban areas due to growing population.

Table 13: Relevant Statements For Perspective 4

#	Statement	Ranking on Grid
10.	Public won't support implementation of Hyperloop unless its feasibility for human travel is proved.	4
2.	Building of Hyperloop infrastructure through public spaces will face extensive opposition.	3
22.	Hyperloop will take a long time for development, certification & standardization.	3

Table 14: Irrelevant Statements For Perspective 4

#	Statement	Ranking on Grid
3.	Transport modes should be more convenient and accessible in the NL.	-4
13.	Current transport modes in the NL are very crowded, which Hyperloop could solve.	-3
20.	We need Hyperloop to address the infrastructure stress in urban areas due to the growing population.	-3

5.2 Disagreement vs Consensus in Perspectives

When interpreting perspectives or perceptions based on statements, it was found that certain statements are common to two distinct perspectives. For example, statement '2' is ranked highly for perspectives 2 and 4. Thus it is important to examine the correlation between perspectives and the importance provided to each statement in every perspective.

The table below denotes the correlation between the factor scores between each of the four factors. Every factor correlates perfectly with itself. This is denoted by the value '1'. The highest correlation is between factors 1 and 2 of '0.4699'. Thus, respondents who would favor research on Hyperloop (Perspective 1) correlate highly with respondents who would prefer improvements in current transport modes (Perspective 2). Also, the lowest correlation is between factors 3 and 4 is '-0.0051'.

Table 15: Correlation Between Factor Scores

Factors	1	2	3	4
1	1	0.4699	0.1751	0.2854
2	0.4699	1	0.3688	-0.0051
3	0.1751	0.3688	1	0.1486
4	0.2854	-0.0051	0.1486	1

The high correlation between Factors 1 and 2 means that both Perceptions see the need for improvement in current transport modes. However, respondents who load high on Factor 1 see it primarily through research on Hyperloop, whereas respondents in Factor 2 would prefer working to improve current transport modes. The low correlation between Factors 2 and 4 mean that even though both the groups are a bit skeptical on the development of Hyperloop, respondents of Factor 2 view Hyperloop a little more positively then respondents of Factor 4.

In the table below, the statements that load highly on one factor have been included. The relative ranking given to each factor in these statements are also provided. In this way the differences in each factor are justified.

Table 16: Disagreement and Consensus Statements on all 4 Factors

		Factors			
#	**Statements**	**1**	**2**	**3**	**4**
4.	Hyperloop R&D will be beneficial for NL to become technology leader in transport technologies.	1	0	4	0
6.	R&D on Hyperloop will have positive knowledge spill over.	4	2	2	0
10.	Public won't support implementation of Hyperloop unless its feasibility for human travel is proved.	0	1	0	4
11.	Hyperloop can provide an interoperable and efficient mode of freight transport.	3	0	1	0
13.	Current transport modes in the NL are very crowded, which Hyperloop could solve.	-2	-1	0	-3
14.	Hyperloop is immune to human interference or external environment.	-2	-4	-3	-1
16.	Hyperloop will allow larger spread of urban areas, thus leading to more emissions and congestion.	-1	-1	-1	-2
17.	I think Hyperloop has low capacity and thus will be expensive to travel in.	0	4	0	2
19.	Hyperloop can enable governments to share investment costs and boost economic activity.	1	0	1	1
20.	We need Hyperloop to address the infrastructure stress in urban areas due to growing population.	-4	-3	0	-3
22.	Hyperloop will take a long time for development, certification & standardization.	1	1	2	3
23.	Other modes of transport will incur costs with passengers opting to travel with Hyperloop.	-1	-1	-2	-2
24.	Implementation of Hyperloop will need more co-ordination among decision makers than for other transport modes.	0	1	0	1

5.2.1 Consensus Statements

All the perspectives agree to varying degrees with statement 22 which states that Hyperloop will take a long time for development, certification and standardization. This indicates that the common belief that Hyperloop will take a long time to be developed despite positive or negative view towards it.

Similarly, Perspectives 1, 2 and 3 believe that R&D on Hyperloop will have positive knowledge spillover on other industries (statement 6). Perspectives 2 and 3 both rank it at '+2' and have a high correlation of '0.3688'. Thus, both perspectives agree on the nature of the problem with current transport modes, but envisage different solutions.

Also, all the perspectives, except Perspective 2 think Hyperloop development can help government collaboration for joint economic development across borders as statement 19 is ranked at '+1' for Perspectives 1, 3 and 4. The correlation between Perspectives 1 and 3 is '0.1751', Perspectives 1 and 4 is '0.2854' and Perspectives 3 and 4 is '0.1486'. Thus, it could be interpreted that both sets believe that economic co-operation due to Hyperloop would be beneficial for collaborating governments. Although, it could be pointed that for Perspective 4 this could mean another large infrastructural project built across borders, as it is not particularly favorable to development of Hyperloop in itself. Further, Factor 2 and 4, both of whom are slightly negative towards Hyperloop rank statement 25 at '+1', indicating one of the barriers to the development of Hyperloop.

5.2.2 Statements of Disagreement

All the perspectives disagree on statement 14 that, Hyperloop is immune to human interference or external environment with varying degrees. This should be taken into account by the technology developers when designing for values.

Further, all the perspectives also disagree on statements 16 which states that, "Hyperloop will allow larger spread of urban areas, thus leading to more emissions and congestion.". Although, this statement requires a macroscopic view of the domino effect of the development of Hyperloop on human settlements, none of the perspectives agreed on this. Also, statement 23 states that other modes of transport will incur costs due to Hyperloop, which was disagreed by all the perspectives. This is coherent with the fact that all the perspectives (except Perspective 4 at '0') think, that R&D on Hyperloop would be beneficial for other transport modes with positive knowledge spillover.

Perspectives 1, 2 and 4 believe that current transport modes in the Netherlands are not crowded (statement 13). Although Perspective 1 favors R&D on Hyperloop, it foresees its benefits of Hyperloop in other areas of improvement, such as sustainability or economic benefits of inter government co-operation. Similarly, statement 20 which states that Hyperloop could help alleviate the infrastructure stress due to growing population is not agreed upon by Perspectives 1, 2 and 3. The same line of reasoning could be used to explain the disagreement between perspectives.

Chapter 6. Discussion & Conclusion

This research was an attempt to explore the perspectives around the development of Hyperloop in the Netherlands. The results obtained from this research could be used to increase general awareness on the topic of Hyperloop among the residents of the region where its development will be planned. This chapter will first discuss the results that were obtained from the analysis. Further, limitations to the research as well as areas of further research arising from such limitations will also be noted. The chapter will then conclude the research with author's reflection on the topic.

6.1 Discussion

Answering the Sub-Questions

The academic gap this study aimed to fulfill is the determination of the perspectives that exist among the public, when proposed a large scale infrastructural project to provide a radically new public transport mode, Hyperloop. This was done with the intention to understand which factors would be detrimental to the development and subsequent adoption of Hyperloop. After a thorough literature review on factors affecting travel mode choices, it was found they could be categorized under socio-demographic variables such as age, gender, education levels, income, rural area of residence were widely considered as determinants of transport mode choice. Also factors such as safety, comfort, accessibility, convenience, flexibility, costs, timeliness and reliability affected the choices in determining a transport mode. It was observed that environmental concern is increasingly a determinant of transport mode. However, further research on travel mode determinants also revealed psycho-sociological factors also played a very important role in the adoption of a travel mode. Research by (Anable, 2005) revealed that psycho-sociological factors or perceptions can be common across the socio-demographic factors as mentioned above. Thus, it was important for this research to study the perceptions of the public to predict the drivers and barriers to adoption of Hyperloop. It was also found that infrastructural changes, affect in lifestyle patterns as well as other effects due to change in urban landscapes, environmental concerns, lack of transparency in decision implementation and lack of dialogue with public as a stakeholder had caused opposition to similar projects of transport development. Thus, it was found important to study the perceptions affecting public transport modes.

Since Hyperloop is a project which needs co-ordination among multiple stakeholders and industries, and its adoption would not be a product of individualistic decision making, an appropriate theoretical model had to be selected. Since, adoption of Hyperloop would not be a result of individualistic decision making, it was important for the model to include the appropriate stakeholders. Thus the 'Political Economy Model for Transportation Innovations' was chosen. Also, since the literature on Hyperloop was limited in nature, the framework was used to interview experts in academia and industry to generate a set of well-rounded opinions for Q-analysis. A final sample of 25 well rounded statements (Table 3) were selected from a larger sample of 93 statements (Appendix J)

Based on this set of statements, a Q-analysis performed on 32 randomly selected respondents helped the research identify the distinct perspectives.

The process description is given in section 3.5. The analysis led to interpretation of four distinct perspectives on the development of Hyperloop. This answered the research's main research question, "***What are the different public perspectives on the development of Hyperloop as a mode of transport?***". The four perspectives are tabulated below.

#	Perspectives
1.	Would Support Research on Hyperloop
2.	Would Prefer Improvements in the Current Transport Modes

3. Would Support Implementation of Hyperloop
4. Skeptical of Hyperloop Development

6.1.1 Empirical Contribution

Perspectives '1' and '3' express a positive opinion on the development of Hyperloop. Perspective 1 expresses support on the R&D efforts on Hyperloop. They are of the opinion that the R&D efforts on Hyperloop would generate positive results, through knowledge spillover, technology ownership and future readiness. Although, a clear underlying reason is hard to pinpoint, this perspective presumes positive results due to R&D on Hyperloop such as at least a viable mode of cargo and freight transport could be looked at. Another respondent pointed out its usefulness for freight transport in Mars explorations as well. Perspective 3 supports the view that Hyperloop needs to be implemented. This perception is influenced by the fact that transport modes need to be more sustainable and options such as Hyperloop could reduce the congestions and emissions of the current transport modes. Clearly, this perspective sees the need for innovations to achieve sustainability.

Two perspective that express a negative tone about the development of Hyperloop are '2' and '4'. For Perspective 2, the reason is dissatisfaction about the current public transport modes. Perspective 2 is sceptical about whether the technical promises of Hyperloop could be delivered such as integration with current transport modes or comfortability and safety at such high speeds and enclosed tubes. It also expresses its scepticism in development of such a radical technology in the near future. For Perspective 4, the scepticism could be interpreted as lack of participation or opinion towards any large scale infrastructural projects. Also, Perspective 4 expresses similar scepticism about development of infrastructure inside cities, without public opposition and good co-ordination between stakeholders of the project.

Most of the perceptions agreed that R&D on Hyperloop would be beneficial with varying degrees of agreement. None of the perspectives loaded negatively on statements '4' and '6'. Also, Perspectives 1, 2 and 3 agreed that Hyperloop could at least be developed for cargo and freight transport, for different applications. All the perspectives agreed positively on the fact that Hyperloop would take a long time for development. Similarly, none of the perspectives thought Hyperloop would be immune to external influence. Most of the respondents supporting this questioned its imperviousness in case of terrorist attack and/or earthquake or floods. This argument was also put forth in Hyperloop Alpha (Musk, 2013). Also, all the perspectives collectively disagreed that Hyperloop would not lead to more emissions. This claim was put forth by Dr. Ir. B.J.C.M (Ben) Rutten. Furthermore none of the perspectives also believed that other transport modes will incur costs due to development of Hyperloop.

Although, certain groups tend to align themselves more with a particular perspective, it was found that no two groups were similar. Also, no particular group consisted respondents of a particular demographic in itself. This highlights the importance of studying transport behaviour according to the perceptions held. The perspectives affecting travel behaviour are thus highly contextual and can change according to the existing situation (Farrington and Farrington, 2005). This is important to note for decision makers and policy designers. To overcome this barrier, a more active participation should be sought from eventual adopters, which in this case are the public of the country where Hyperloop is to be implemented.

Though, not generalizable, the study could be replicated for social, cultural and political differences. This could have been achieved by a qualitative approach of interviewing individuals of similar characteristics as chosen for this research. However, this would take a longer time, and it would not have been possible to articulate the varied perspectives into a group with shared pattern as done in Q-methodology. Further, R factor analysis depends on hypotheses formulated by the researcher before the start of the analysis.

However, since the technology is non-existent, it was found appropriate to conduct an exploratory research. Identification and addressing of concerns and questions regarding Hyperloop would help the stakeholders expedite the process as well as find increasing acceptance of the technology. The study could also be replicated to find perceptions on public transport mode alternatives other than Hyperloop. It was also found that the study was helpful in increasing awareness among the participants representing the general population of the country the study was conducted in.

6.1.2 Scientific Contribution

6.1.2.1 Adoption/Perception Model for Transport (or Infrastructure) Innovations

This study explored the role of perspectives affecting the development of Hyperloop. In research studying travel behaviour, the process of adoption is looked at as an individualistic decision. To design and implement Hyperloop, would require co-ordination of multiple stakeholders. Stakeholders include technology developers, government bodies, urban and civic planners, transport industry players, policy designers, etc. These stakeholders are unaccounted for in traditional adoption literature models such as TAM, TPB, TRA, Motivation Models, etc. as also mentioned earlier. The list of stakeholders mentioned is certainly not exhaustive. However, these stakeholders are accounted for in groups of three active stakeholders (Experts, Industry Interests and Public Groups) in the Political Economy Model for Transport Innovations (Feitelson and Salomon, 2004).

Also, through the study it was found that Public Groups can have varied opinions on a certain topic, which for this study was the development of Hyperloop. Thus, any decision to adopt or implement the building of Hyperloop infrastructure would require large scale consensus building among Public Groups. The Political feasibility as denoted in the Political Economy Model for Transport Innovations take into account the Social Feasibility of the Public Groups. However, to implement a certain innovation on full scale would require a clear consensus from the Public Groups in making a decision. Upon further research this was also found consistent with (Innes, 1996)'s three step approach when planning a public infrastructure progress. This includes establishing stakeholder groups, encourage discussion among these groups and identify broad perspectives or opinions of consensus.

Therefore, the study concludes that the relationship between variables 'Social Feasibility' and stakeholder group 'Public Groups' (Figure 4) is bi-directional. The hypothesis rests on the premise that 'Social Feasibility' isn't achieved until a clear consensus is agreed upon. Achieving 'Social Feasibility' is an iterative process. Also, stakeholder groups 'Experts' and 'Industry Interests' should influence the public in order to achieve the 'Social Feasibility'. The study thus proposes the model as shown below.

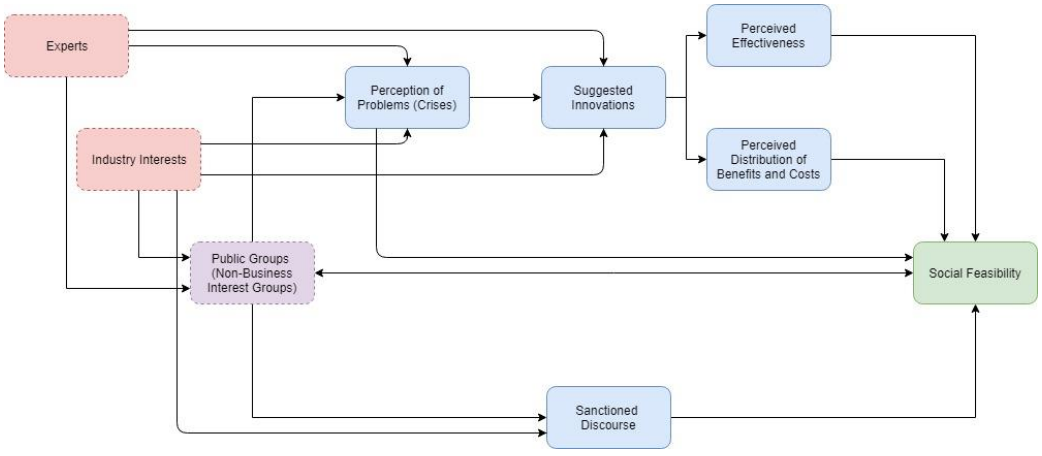

Figure 10: Recommended Model for Building Consensus for Social Feasibility

6.1.2.2 Use of Q-methodology

The model proposed above could be used to build consensus among the 'Public Groups'. This study should be interpreted as the first iteration towards achieving 'Social Feasibility'. The high replicability of Q-methodology helps in subsequent iterations. Also, results obtained from Q analysis helps in backing any claims via statistical results. Thus, Q-methodology helps in achieving broad consensus among stakeholder groups as proposed by (Innes, 1996). The use of qualitative methods or R-factor analysis helps in identifying several distinct perspectives, but achieving consensus or identification of any is lacking in these methods.

6.2 Limitations and Areas of Further Research

In chapter 3 it is stated that Q-methodology is not viable to determine the perspectives existent in the wider society or its proportional distribution. It only helps the reader understand the different perspectives that exist in general. Further research could be done to test if these perspectives hold true for the whole society. The research could also be used to formulate certain hypotheses on the development of Hyperloop, or any similar large scale infrastructure project.

The limitations the research faced while conducting Q-sorting were varied and distinct. Q-methodology requires a small number of respondents when compared to, for example, R factor analysis. However, given the nature of the data to be collected, a small number of respondents can be challenging. This was mainly due to the fact that sorting of statements in the quasi-normal grid for this research at least took 15-20 minutes. This was due to the fact that the majority of the respondents were forced to think about the topic holistically and arrange the statements accordingly. Thus, compared to a typical R factor analysis, Q-sorting was more mentally challenging for the respondents. This also led to quite a few respondents abandoning the Q-sorting process midway citing that it was too exhaustive. Also, justification was requested and opinions were asked to be expressed on the topic of Hyperloop, making the nature of data collection more like personal interviews. Given the characteristics of the desired respondents for the research and the number of respondents required, it made sense to conduct this offline due to the limitations in diversity of the respondents obtained online.

The research was conducted in the Netherlands. Also, 20 of the 32 respondents for Q-sorting were from the Randstad area of the Netherlands. Hence, the perspectives that were uncovered on the development of Hyperloop could be biased according to the experiences of the people living in these areas. The experience of the respondents in terms of transport modes available, transport infrastructure, the relative density of the areas where these respondents reside in and the number of existing alternatives could differ when the same study is conducted in a different region of the same country. Similarly, additional to the variables affecting the results of the study in different regions of the same country, transport policies of different countries might manifest to uncovering of different perspectives altogether in different countries. This is important to consider since Hyperloop is also considered for cross border transport between two cities in different countries. However, this study provides a good initiation of studies related to policy and decision making around Hyperloop. Similar studies could be considered to be undertaken in cities or regions where developers plan to build Hyperloop infrastructure. Determination of similarities and differences between perspectives across these regions could help governments make effective decisions for implementation. Q-methodology is thus replicable but not effective in generalizing results.

It should also be taken into account that perceptions of respondents exist due to their level of knowledge on the technology itself. When recorded it was found that only 5 of the respondents were comfortable with the topic of Hyperloop. The majority of the respondents were either only aware of the existence of a technology like Hyperloop and had a vague understanding or did not know about it at all. The perceptions are thus subject to change depending on the level of knowledge of these respondents over time. Thus, further research could be done to test any change in the perceptions of a similar group of respondents with similar characteristics. This could be done to test if efforts taken by a particular stakeholder, such as technology developer such as Hardt Hyperloop, HTT or the Dutch Government (ARUP et al., 2017) to educate the general public about Hyperloop changes the already existing perception of the public.

The section on criticism on Hyperloop was done based on the technological constraints existing at the time of the research. Given the fast pace of developments and several companies, private players as well as governments expressing interest in the technology, some of the critique topics might be rendered obsolete. Regardless, it provides the developers of Hyperloop a first insight into what the public already thinks about the technology. Addressing some of the fears and criticism through educational efforts could help expedite the process of adoption through widespread support for its development.

Further areas of research using this study could also be to test the validity of the theoretical framework adapted for this thesis from the 'Political Economy Model for Transportation Innovations'. Further studies could test perceptions of the public derived from answers to questions addressing variables of a different theoretical model. Once there is enough literature on the topic of Hyperloop, statements could also be derived in quasi-naturalistic way, where statements for the Q-sample are derived from sources external to the study. The effects of registering a Q-study on a large sample of respondents with a bigger Q-sample might also derive insights necessary for decision making and increasing general awareness of the public. Also factors that are considered important for the development of Hyperloop in the research could be tested for significance using models such as Technology Acceptance or Roger's Model of Innovation Diffusion, where onus lies on individual decision making.

6.3 Conclusion

The research was also an attempt for an inclusive product/technology development effort of a large scale infrastructural project which could radically change the travel behaviour of the respondents. It was an interesting research topic, given that literature on the topic of Hyperloop as well as studies regarding perspectives on upcoming transport innovations were limited.

Reflecting on the nature of research, it was interesting to see how respondents outside the domain of transportation would react to a radical innovation such as Hyperloop. The reaction of respondents differed, as observed only for this research, based on their area of residence. Majority of respondents from the rural areas preferred improvement in the current public transport modes or were sceptical of the development of Hyperloop. However, this cannot be generalized to a wider population residing in the rural areas. Reaction also differed on a more implicit manner when respondents were somehow affiliated to technical studies. Students, noticeably from TU Delft, as well as respondents such as engineers in multiple fields would critically question the researcher on the specificities of Hyperloop. Thus, it was important for the researcher to keep abreast of the knowledge on Hyperloop.

Also, care was taken such that researcher's bias would not creep in during the process of interviewing the experts as well as the respondents while conducting Q-sorting. This was important for the determination of the results. The statements chosen for Q-sorting were thus equally distributed as favourable towards and against Hyperloop. Also, during Q-sorting, whenever the respondent asked for clarification of a statement, two distinct arguments were presented. One supporting the claim of the statement and second

arguing the claim of the statement. The relative ranking of the statement was thus left at the researcher's discretion. However, a certain discussion always followed after the process of Q-sorting with most of the respondents. The research thus makes an inference that conducting similar Q-studies on a wider scale can increase the general awareness on the topic.

6.4 Recommendations

The research recommends certain measures to garner support for the development of Hyperloop. However, the results of this study are not exhaustive and certainly not generalizable on a wider context. However, the results of this study are replicable and could be used as a framework towards the efforts to influence stakeholders to actively participate in the process on its development.

It is important for policymakers around transport innovations and infrastructural projects to take into account the underlying reasons for every interpreted perspective. This can help them to adopt measures to work towards the acceptance of the desired measures. This could differ for the desired policies by different stakeholders. Personally, since I think that the research and development efforts on any radical innovation could be beneficial for future, the research would recommend measures to help developers of Hyperloop gather support for their efforts.

The interviewees and the respondents both indicated the need for better efficiency in the current transport modes. This efficiency translated to waiting times, sustainability in the current and desired future transport modes, accessibility and convenience. These should be taken into consideration when developing or improving the current and future transport modes. Also, particularly for Hyperloop, the aspects of safety and comfort are of prime importance to be addressed. During Q-sorting, certain respondents explained how the concept of a vehicle being propelled at more than 1000 km/hr makes them feel uncomfortable. Also, since the tubes and pods are enclosed, it would make them feel claustrophobic. Thus, it is important for developers to take these perspectives or incorporate them into their design policies. Developers of Hyperloop could help mitigate these psycho-social barriers to travelling by Hyperloop. The Hyperloop system could be designed for better comfort and safety values. Also, since any infrastructure for Hyperloop would change the landscape of the region, engagement with and incorporating opinion of the locals would greatly reduce any opposition.

Also, it would help to engage the current transport industry in the development efforts towards Hyperloop. The integration of all transport sectors towards achievement of desired objectives would be the best way forward. The R&D efforts of Hyperloop could look at increasing accessibility and convenience of the public transport modes and where Hyperloop could position itself in the transport infrastructure to increase this. Also, Hyperloop could help connecting two destinations travelling between which, by airplanes or trains, would lead to more emissions, than travelling in Hyperloop would (as predicted).

Similar studies done elsewhere could help generalize factors that are considered important for the development of Hyperloop. However, one inference that could be generalised is that education or awareness about the technology is limited. It should be seen as a priority by the primary stakeholders to include the general public as a secondary stakeholder in their decision making process. The involvement of public in decision making at various stages of its development is termed as 'democratic experimentalism' (Dorf and Sabel, 1998). Parallels could be taken from the development of the French Mediterranean High Speed Rail which included tenets of such 'democratic experimentalism', where active public participation was sought for 'consultative and participatory decision making' (De Carlo, 2006; He et al., 2015). The government bodies as well as technology developers should orient themselves with a more open communications approach to addressing public concerns about Hyperloop development.

An open communications guideline or nudges like soft advertising could help shape a positive perception. Measures like these are known as nudging, and have generally helped product adoption efforts. The communication could be enabled by local municipal bodies to national governments to enable a better flow of communications from all stakeholders.

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Appendices

Appendix A: Interview Questions

Background

1. Could you give us a brief overview of you and on your research on Hyperloop?

Problems

2. What in your view are the current problems in the transport modes which Hyperloop could solve?
3. Which areas of current transport modes need improvement in which Hyperloop could play a role?

Suggested Innovation

4. What are the advantages and disadvantages of Hyperloop according to you?

Perceived Costs and Benefits

5. What are the costs of developing and building Hyperloop according to you?
6. What do you perceive as benefits of developing Hyperloop?

Perceived Effectiveness

7. How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?

Appendix B: Drs. C. (Kees) van Goeverden, TU Delft

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

Here (Civiele Techniek en Geowetenschappen, TU Delft) we have a cluster on sustainability. Part of the cluster is involved research on Hyperloop. As a group of four researchers, I have published 2 publications. The first publication is on the performances of Hyperloop system. My part was to calculate the financial costs and capacity of the system. Second publication was for conference on sustainability of transportation. We investigated how use of Hyperloop will lower energy use in long distance travel.

2. **What is your view are the current problems in the transport modes which Hyperloop could solve?**

The predominant problem is air pollution and energy consumption. The concept of Hyperloop is to move through tubes and that would not take much energy. However, at the conclusion of our research paper it is a bit different. However, in principle the energy use is very low and energy consumption is a real problem. This could be solved.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

Faster provision of transport for travellers. Hyperloop as defined by Elon Musk travels at more than 1200 km/hr. This would make it the fastest mode of travel and would improve travel times.
Regarding energy consumption, it is much more efficient compared to airplane. However, it is not that efficient compared to a train. You could build a more efficient system for long distance travel compared to an airplane which currently dominates long distance travel.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

The main advantage is travelling consumes less energy. Thus it is more sustainable.
Disadvantages are that Hyperloop pods have low capacity of people. We found that, building hyperloop network around Europe could transport only 1/5th of the people that would like to travel with Hyperloop. In other words, the Hyperloop could only fulfill 20% of the demand for the travel at any given time. Also Hyperloop, is very expensive to travel. It is expensive because capacity is too low. You can make the travel cheaper by increasing the capacity. This would require parallel lines on a tube. However, this would make the development costs more expensive, and thus it does not address the requirement for cheaper travels.

5. **What are the costs of developing and building Hyperloop according to you?**

One of the main costs according to us, is building of infrastructure. It also depends on certain circumstances. You can build it in a tunnel, but it is very expensive. You can build it tubes above ground on pillars, which is cheaper. But it depends on the nature of the land. The more stable the land underneath, the cheaper it will be to build the tube above ground. In the Netherlands, At least in the west it is more expensive to build than in Austria. Of course, building through mountains is even more expensive.

6. **What do you perceive as benefits of developing Hyperloop?**

The benefits are shorter travel times for passengers. And less energy.

7. **How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?**

There are still unproven technical problems for Hyperloop to solve. Also, Elon Musk says that the pod can travel more than 1200 kms/hr. However, certain people say it is not possible. There are problems in movement through curves. To be honest, I don't know how effective it would be in solving the problems, unless the technology is proven. However, I have read that there will be a fully operational track in Abu Dhabi to Dubai. So it remains to be seen.

Appendix C: Maxime Lachaize, Transpod

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

I've been working for Transpod for 2.5 years. I was mainly looking at cost benefit analysis for accessing the economic benefits of Hyperloop. On that case study I looked at Toronto to Montreal route in Canada and all the different benefits and costs. I've been doing that case study along with Transpod as a Business Analyst. My research is based more on the economic side and little less with stakeholder management. My research is mainly based on environmental benefits, safety benefits, travel time savings, profitability, financial savings. I've also looked at the economic impact of building infrastructure such as input/output models, value added GDP, etc.

2. **What in your view are the current problems in the transport modes which Hyperloop could solve?**

There are 2 main issues. One, the global warming caused due to transport sector. Transportation contributes to about a 1/3rd or 1/4th of the global warming. So it is pretty substantial. Also we depend a lot on fossil fuels. Electric substitution is going to rise, but it will still take a while, obviously depending on the country. So really reducing those carbon footprint. Air traffic is becoming more and more widespread. Mainly due to the rise of e-commerce and affordable prices. That's the emission part.

On the efficiency side, we see population rise in urban areas. We see huge urbanization factor that we see in big cities and the infrastructure nowadays are not prepared to sustain the stress that is going to come up in the future years. If you look at road congestion for example, it is starting to become a real problem in a lot of urban areas, not only in developing countries but also developed countries. This is really difficult for cities to sustain their economic growth. So we need to have more flexible transportation that can accommodate greater capacity and is green.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

Historically, if a government/country would want to achieve great technological milestone, it has been feasible. The key area for improvement is to make transport more cost effective and convince polls to recommend it as well. That's the trickiest part, the biggest hurdle. Technologically, the biggest challenge is to make it affordable. As long as it is marketable, it is going to be applied to many car drivers around the world. This will result in high market penetration and will be accepted widely in society.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

The main advantages, I'd say is frequency and speed. So obviously if the mode of transport has more frequency, it would divert a lot of people to that mode. Stimulate the economic activity and reduce carbon emissions. Now when it comes to these advantages, the infrastructure costs are high. Some people would argue it would look ugly as well? So you have to be careful on how to design things and how do you implement it. I wouldn't say safety is a disadvantage actually. I'm pretty sure safety standards will become pretty drastic. Infrastructure could be complex given the magnitude of the project. It is not an easily implementable technology. It's much like high speed railways, it needs coordination with government bodies and private players. It would take time to convince people to build the technology.

5. **What are the costs of developing and building Hyperloop according to you?**

High capital investments. But I think it's the same with developing every other technology. I don't see that it'll exceed to a large extent compared to other similar technologies.

For implementing it, there will be costs for other modes of transport. For example, If we build a line between two cities that are actively involved in air transport, it can disrupt the industry. If the pricing point is good enough. Likewise for car manufacturers a little bit. Trains will likely suffer probably. There will be a bit of costs involved when it is implemented, because the mode of transports will shift.

The energy costs depends on the block of grid. If your grid is coal powered there will high environmental costs. If it is solar powered, nuclear or hydro then to a lesser extent.

6. **What do you perceive as benefits of developing Hyperloop?**

First thing that comes to mind is travel time savings. People would divert to a new mode of transport and achieve greater speed. Also for cargo, e-commerce and food products that are time sensitive could be transported faster and could have inventory savings for companies with that kind of freight. Therefore, if you have a high speed line between two cities, you would probably require less inventory, because there is much more flexibility on the mode of transport side. So you would make your organization a little more neat and save a lot on warehousing costs.

Travel time savings, environmental friendly and fewer accidents as well (although that one I'm not too sure). Probably it will simulate all the sectors of the economy. It's going to impact all the suppliers, household income, it will increase economic activities of the region with Hyperloop as well. That is what we perceive although nothing concrete yet.

7. **How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?**

For most companies it is really early to predict since it is a high capital intensive project. However, companies are getting a good amount of technological understanding about where to innovate in. So there is good knowledge spillover. Also, more companies are getting motivated by the idea in other parts of the economy. They reflect more on the transit and on the infrastructure. Maybe it is not going to a Hyperloop system, but there may be room of improvement in air travel or highway infrastructure.

Appendix D: Just Ruitenberg, ProRail

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

I work with ProRail. I work in the strategy department, where we are currently developing and implementing a new strategy which centers around a lot of Dutch companies. We see the need for mobility growing in the coming years. We believe that rail is necessary to ensure that there is enough mobility in the future.

2. **What in your view are the current problems in the transport modes which Hyperloop could solve?**

I think one of the problems is congestion. You see that at railway stations that it gets busier and busier. I don't think we have reached a limit yet, however we have to work hard to make sure that the stations don't congest. Also within trains you see that it gets busier and busier. Since people in the Netherlands like to sit, it is also important that we create more places to sit.
Also, if you look internationally, sustainability is a very big challenge. Modes of travel such as airplane is not very sustainable. We also see that climate goals of UN and the Paris Climate Accord are very strict. So that is a challenge.
So I think congestion on one hand and climate on the other hand and the third thing what you see is that people and travelers want to be carefree. So they just want to go from the door of their house to their destination. They also want to work and travel in a more fluid way.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

Of course the transport area is very broad. So we have people transport and cargo and then you have all these different types of mobility. So you have mobility by car, mobility by public transport. Within the public transport you have buses, trains, shipping and airplanes. So, for every sector there are specific challenges. But I can say that since the need for mobility is growing, one of the challenges for the complete transport sector is to work together really well to ensure we can accommodate the growth of the mobility needs.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

If I understand correctly, a fully functioning Hyperloop system will cover distances of 300 kms to 1200 kms per hour. In the case of Netherlands, there aren't many travelers who travel that kind of distances. Already, if you are going to look at the advantages of Hyperloop, they really have to cover international destinations. And also, if you build the system in a sustainable way, use sustainable materials, and then if you use green energy, it can be a very sustainable way of transport.
I'd say that one its disadvantages is that it would probably be difficult to find space in Europe to build infrastructure in big cities. And also the investment would be quite big. So you need the government to invest a lot in its development, and that of course is difficult.

5. **What are the costs of developing and building Hyperloop according to you?**

I think that the costs of the development would be high on one hand. But i think on the other hand, Hardt Hyperloop received 5 million EUR I believe. So research and development of Hyperloop is not going to cost much money I think, but building a full-fledged track would cost a lot of money. But also, people can just invest in the company. This could be a state owned/supported business. It's also high risk because it's a completely new technology.

6. **What do you perceive as benefits of developing Hyperloop?**

The benefits of the technology is that it would be a clean alternative to air travel if you find some space to build it. It could also benefit, through its research to its adjacent technologies. So what you saw in the 1960's is they were building all these rockets, and what you still see is that NASA does really a great deal of inventions and that they have several patents due to this. So one of the benefits of working on such a new technology may be useful in other sectors, or might start other technologies.

7. **How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?**

I think the current rate of development is quite high. I feel that a lot of people like the idea and that they like to invest in it. So the rate is really high. But I don't think now is the right time to judge its effectiveness. Also, you need a really good proof of concept. I think it depends on who will first order the first fully functioning system,

which will be crucial step in judging its effectiveness. If it really work, it would help greatly to improve sustainability in medium/long range travel distances.
I don't think development is an issue. However, I think the political decision making behind implementing it is the challenge that Hyperloop faces. Also, to change people's perspectives of travelling in a closed tube is quite challenging. So it would be similar to people not liking travel in submarines for example.

Appendix E: Dr. Ir. B.J.C.M (Ben) Rutten, Strategic Area Smart Mobility (TU Eindhoven)

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

Is one of the societal areas of TU Eindhoven university, besides energy and health we have mobility. It has two assignments, one is getting better recognition, getting more and integrated research proposal. So we are working with over 200 researchers in the university and 7 different faculties and 20 research groups. We make connections when needed within university, industry and government. We get requests from outside university, for instance Horizon 2020 program where we provide expertise through our consortium by directing it to the correct research group.

2. **What in your view are the current problems in the transport modes which Hyperloop could solve?**

I think that in general, we have the tendency to make transport faster and faster, but that will not really help us in solving the mobility problem we have as a society. It is quite well known that on average an individual spends an hour to 1 hour six minutes as researched by McCarthy. This has been the same for hundreds of years. So, when you make transport faster, only the distances of the commutes will grow, but the mobility patterns remain the same. Adding new high speed technologies to the system, we doubt whether it would really help from a societal point of view.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

Addressing urbanization is very important for transport sector. We have seen tendency in the past and the forecast of the future that more and more people will live in very crowded areas/urban areas/big cities. The cities are growing. More people from rural areas are moving to the cities. This is happening also in the Netherlands. In France, we see that there are some rural areas where nobody is living anymore. So the big challenge is the infrastructure in cities.
We also have to address the interconnection between cities. We can do it by car, train or airplanes. We see that from the automotive world we will get electric transport. We see that these are very sustainable transport systems. Automation will come which will last for some years. Also, it is very thinkable that electric/automated buses can be used for intercity transport. These will have lower emissions than a train. We see that trains however are unsustainable. Due to technology advancements in automotive sector, the benefits from train will disappear. And the train is very expensive transport mode. It's quite safe', because it has been separated from other transport infrastructure. We once joked, that we should put concrete on all train rails and just put buses there. It'll be much cheaper and better for the environment. We can address the capacity issues by increasing the frequency of the buses. So this problem should be solved, however it is a very political area.
Also, aircraft traffic is exploding. It's a very cheap system, because it has very minimum infrastructure. You have only the airports. That's the only physical infrastructure you need. That is why it is so cheap. We also have the taxation. But there are already studies done that the taxation is similar to other modes of transport. We think that technology can help a lot. We already see electric aircrafts that can carry 1-4 persons. We (transport industry) are also focusing on energy transition, where we have energy coming from solar panels and windmills. Ten years ahead, we will have so much energy from that it will become cheaper and cheaper and we will be able to make synthetic fuels out of it. When we put this fuel in aircrafts, there won't be any more carbon release problem. So i think combinations with new technology and the whole change in energy production will help out the energy transition in transport sector for air.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

Theoretically, physically it has the big advantage of needing no fuel consumption, no noise and no pollution in the environment through the physical infrastructure. Of course, it depends on how you build up the system.
I think there are many disadvantages to the system. So it is quite doubtful if it will ever breakthrough. It is nice to study it however. Also from a policy view. Because we see that the Dutch Government is tending to open a test infrastructure. They are trying to be aware of the technology. They are trying to gain insights and avoid the same mistakes that they made with maglev. There were huge discussions in the past. It was really pushed by the industry, Siemens in particular. I think it is more or less comparable with Hyperloop. We have completely new infrastructure. Building network connections is not easy. It is very difficult to combine two tubes travelling to and from different directions. However, I think everything in the end it is technically possible. But it will cost a lot of money and study! Hyperloop is for more point to point service. So there is this question of what does it get to the transport society. Since it is more point to point, completely new stations would have to be built. People then have to shift from one

line to other. For long distances it could work, but I think it will be so expensive to build up, that it will never win against air travel. You can also find many parallels for Hyperloop with maglev system.
Technically, it is very nice to find out all kinds of problem that it could possible solve, but from transport/societal point of view I have big doubts about it.

5. What are the costs of developing and building Hyperloop according to you?

In crowded areas like in the Netherlands, you will have to build completely new infrastructure. Also, in the Netherlands, it is not possible to build it underground. So you have to put it above the field. And then you build up a system of connections. This is a cost that the society has to bear because, it uses the space available. There would be discussions with the society for topics such as open view. This is similar to the construction of windmills in the Netherlands. The windmills were built on the North Sea, due to the strong winds from the sea. They are more expensive to build there. However, it is more difficult to get agreements with the regions to build windmills there, because people were really opposing it. They don't like building windmills in their backyard. I think it's the same with infrastructure for Hyperloop. We have already quite some debate on adding small pieces on motorway network or even expand it. Also, in our Delft there is a road stretch (A4) of 5-7 kms which they want to expand. But since the public wants it to be a silent area between the cities of Rotterdam and the Hague, there is a debate on it for 40 years! The government had also decided for the stretch to be a silent area and give space for nature, they decide to build the motorway underground. Also it is the most expensive motorway in the Netherlands. This will also happen with Hyperloop. Because you have to build these tubes through rural areas and there will be pipeline infrastructure. People might not accept it.
Also, although I am not sure about this aspect yet, the safety of the system. Hyperloop can prove valuable for goods transport, however for passenger transport if something goes wrong, how will they come out? What will happen? You are travelling at very high speeds. Might be a little uncomfortable. Also the lines should be on straight lines. The pods might not be able to travel on high curve radius. You can also see this with High speed train, which travels at 300 km/hr. There was a discussion in the Netherlands on where to build this High Speed rail line, and it was decided that it will be built underground the rural areas in the heart of Randstad area. There was also another proposal, to concentrate along the motorways. For example, A13 in Delft or A4 to Schiphol airport. This was an alternative. But one of the disadvantage, That as you come to the curve along the Hague, it was very sharp. This would require too much space for the High Speed Rail to travel comfortably. With Hyperloop and High Speed Rail you cannot follow every contour of the land. This was the discussion around comfort. At 1000 km/hr it would need a very straight line.

6. What do you perceive as benefits of developing Hyperloop?

I think very low energy consumption is the benefit. Although, we will have to keep it low pressure. So not sure how much energy that will cost.
I am not really a believer in travel time savings. When you have lower travel times, society will move to longer distances. That is what always happened in the past, and that will also happen with newer systems. Now, for instance when you are living in Delft, you have the ability to work in Brussels or Eindhoven or Amsterdam. When you have the Hyperloop, you can work maybe in Paris or Frankfurt, because you can reach in half an hour maybe. People will consume the distance either way. So the only thing with Hyperloop, is it will enable bigger spread of people living in urban areas. Like any travel technology, it will help in changing travel patterns, but it will not help in solving the mobility problems in the cities with regards to emissions and congestion. It is much more important to solve that then building high speed technology.

7. How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?

I don't think it would be much effective. The major problems with transport sector is to reduce emissions. Hyperloop can reduce some pressure but not eliminate it entirely.

Appendix F: Rieneke van Noort, Delft Hyperloop

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

As a team, we are working on the Space X Hyperloop Pod competition, which will be held next summer. Our main goal for that is to build a pod as fast as possible and win the competition. We use the knowledge and the machines obtained from TU Delft. But we need a lot of partners to help us design, and to help us produce. Most of us do not have the experience to produce, and the materials we use are very expensive. We are also looking at the Hyperloop concept. So developing what it will look like and to get people to understand what Hyperloop is.

2. **What in your view are the current problems in the transport modes which Hyperloop could solve?**

I think that each transport mode has its own problems. For example that airplanes obviously is very environmentally unfriendly, unsustainable and really consumes a lot of energy. Furthermore, they are not comfortable. You have to wait certain hours before you actually board the plane. And you get really cramped seats. So I think that is something that could be improved.
Cars and trains are prone to external influences. When it snows or rains you cannot travel anymore for example. And it takes a long time.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

I think that people should consider their environmental impact. What we are doing right now is not really environmentally sustainable. History, has shown that people do not accept changes. People like to keep the things the way they are. But the way things are right now, it's not sustainable. We can't keep doing this, and people need to accept the changes.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

I think the advantages are pretty clear. I think there will be more sustainable, environment friendly and also more comfortable mode of transport with Hyperloop.
The disadvantages are that you will have to build whole new infrastructure. This takes a lot of time and money, and before you see the revenue of the invested money, it takes a while. I think this is the disadvantage and the government will have a problem with that.
But I think the pros do weigh out the cons.

5. **What are the costs of developing and building Hyperloop according to you?**

The costs I perceive is the problem of the spread of wealth. So that the areas where stations are located, people might travel easily, but if you are not in the neighborhood of the station, you cannot travel with Hyperloop easily.

6. **What do you perceive as benefits of developing Hyperloop?**

The benefits are that you are connected to bigger cities in Europe. In a more easy way. We will become a larger unity that not only goes through Europe, but other countries. Because you can reach the other side of the country faster.

7. **How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?**

I think very effective. I think the way we are developing right now is very modern, it's really creating a new standard with many companies. We are aligning our development with the approach similar to other companies. And I think what is also really good is how we can present Hyperloop to the world, so get people to understand the concept and basically accept it.

Appendix G: Max Wink, Hardt Hyperloop

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

My role in the development of Hyperloop is the role of a Technical Business Developer. This means that my primary goal is to research technical companies and their business activities and create win-win situations based on this information. The goal of Hard Hyperloop is to realize the Hyperloop and all of its systems it consists of. Therefore, if we can make this goal interesting for other technical businesses we will make it happen!

2. **What in your view are the current problems in the transport modes which Hyperloop could solve?**

Currently, aviation is a major contributor to the global CO2 budget. Hyperloop as a replacement for short haul flights would reduce this contribution drastically and will create a better future for our generation and generations to come. Furthermore, one of the things that can annoy me the most is the inefficiency of the current traffic systems, in particular road traffic. There are too many people that are traveling alone and are using their multi-seat car, only based on their expectation of this once in a year long distance road travel vacation they have in mind. With Hyperloop we connect all the major cities for a low price, due to the low operational costs, and less people will have to travel by car.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

This question has already been answered in my previous answer. Road transport could use a huge refurbishment and air transport has an exhaust problem.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

The biggest advantage might also be the biggest disadvantage, being the closed environment. The closed environment, when well implemented, leaves few random effects from the environment to contaminate the transport system. These random effects will either be: pilots of the hyper craft, that will not be there and act illogically; and in the most literal sense: trees or leaves or water falling on the road that affect the capabilities of the human pilot. In short: the tube environment creates the lossless transport AND a vehicle without pilot. The biggest disadvantage of the tube is that it will probably induce a lot of fear during the first stages of public acceptance and that many people tend to be reluctant to the possibility that the environment can actually be created in an energy efficient way.

5. **What are the costs of developing and building Hyperloop according to you?**

This is extremely difficult to say and will depend highly on all the technologies that will be used to create the Hyperloop infrastructure. If major steps in technology development can be taken, such as: cheap tunnel boring and swift standardization and legislation, together with competent project management the costs can be drastically reduced. I simply cannot answer the question with regards to development. Building… well a first estimate. depending on how long of a route you envision. All in all, our goal would be to develop it for < 3M / km. The low speed test facility in Delft had approximate costs of 300 000 for 30 m hence 10 k/ m so that would be 10 M / km.

6. **What do you perceive as benefits of developing Hyperloop?**

The additional benefits of developing Hyperloop is that this innovation opens up an enormous platform for technology development. Currently, a small army of people in the world is now looking at new options to build infrastructure more efficient and swiftly instead of just focusing on the status quo. We have to be innovators to get the world forward and not accept that our current ways are good enough. I expect that Hyperloop will open up a lot of future ways of building.

7. **How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?**

If the world population is increasing and the level of average wealth and technological development per capita will do the same, then we are sure to head to only bigger congestion problems. Hyperloop can alleviate the pressure on current transport modes. On the effectiveness of the Hyperloop in "solving" a problem I cannot add much. It depends a lot on the perspective to view something as a problem or to view something as not- a problem. Hyperloop will surely alleviate a part of the pressure on global transport. New opportunities to the transport system is that we can connect the world even better. Eventually continents will become one big city and that leaves many opportunities to people. It creates freedom in the sense that people can and will be more able to do whatever they want, since everything you want to try is nearby.

Appendix H: Dr. J.W. (Rob) Konings, TU Delft

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

My work so far with Hyperloop has been with a research paper (Analysis and modelling of performances of the HL (Hyperloop) transport system) jointly with Kees van Goeverden, Milan Janic and Dimitris Milakis. But also I did research with other transport technologies such as electric buses. But they are probably not that innovative anymore because they are already a lot of them running on the roads today. I've done some studies on new logistic concepts. Also on foldable containers, which could enable savings on container transport. This also gives the benefit of less pollution in transporting these containers. Mostly my research was on freight transport.
I have also conducted research on ULS (Underground Logistic System). This was an idea very similar to Hyperloop. Very popular about 10-15 years ago. We looked at possibilities of where to implement that system. We looked mainly at transport from Schiphol airport as well as using existing system for such a technology.

2. **What in your view are the current problems in the transport modes which Hyperloop could solve?**

The issue of sustainability is a major problem. I think every mode has to deal with that. Some are already improving a lot. Road transport was really bad. But now e-mobility is coming up.
Also, the efficiency of every transport mode is a problem.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

In general there is a lot of congestion in road transport. Especially in the Randstad area. That is why now, they (government) are coming up with a policy to shift from road to rail transport.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

The biggest advantage is of course its sustainable performance. The solar panels (mounted on the tubes) can give the energy to the system. There is no pollution (emission), which is very good. Regarding noise, it is a closed system. So the environment doesn't have any impact of the noise. We do not yet know about the safety of the system, but from what I know it seems reliable. It is automated and its closed. If there is an accident of course the passengers in the tube might get injured. But it does not affect people external to the system (like an incident in the Netherlands, where some children were crossing the rail line on an electric bike and got injured).
To be honest, I'm a bit skeptical about the concept of Hyperloop. I don't think it'll ever be implemented. That is because it is very expensive. A bit comparable to the problem of Superbus. The capacity of the pods is very small. Only 28 people can fit in a Hyperloop pod. And if you look at the total capacity of the system, it is not that high. It needs very huge investments. So that means the cost per trip is very high. So it can only focus on a premium market.

5. **What are the costs of developing and building Hyperloop according to you?**

It seems to be that land use is very limited, because it is built on pillars. But I think what you should do is try to combine it with existing infrastructure. Building the line along the highways and rail lines. So the impact on land use is even lower than if you do it independently somewhere else. But the problem is of course the speed of the Hyperloop is very high, so it cannot take sharp curves. So that means, it'll be very difficult to put it along the existing infrastructure because roads and rail lines are curved.
Also, when you think of integrating how do you implement it? Of course a train can travel to the center of the city. But if a Hyperloop track, which is elevated, I have doubts if it could be made to travel to the center. I would expect that it is built at the edge of the cities. But then you need another system to get people quickly to the Hyperloop station. So it is really a dedicated system. And thus it is very difficult to integrate it with other systems.

6. **What do you perceive as benefits of developing Hyperloop?**

Well of course, it is less polluting compared to all other modes. In the end, car transport can also become very environmentally friendly if we use Hydrogen based fuel cells and battery and electric cars which is now the trend. But you will still have lots of cars even if it is electric, which will lead to congestion. So I think it is a good development in solving the problems of sustainability, but not accessibility.
But of course, since it very high speed, it makes sense only to travel long distances. And then you have the problem that you have to invest a huge amount of money to build the infrastructure. I think it is around the figures of 25 million EUR/ km. So that means 100 km is too short a distance. I don't know how long it will take to accelerate.
The infrastructure will have to be cross border. So there is the problem of who will finance.

7. **How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?**

Honestly, in a limited way. I think it is meant to be an alternative to air transport and maybe high speed rail transport for mid to long distance travels. Let's say from 500-1500 kms. There is no more perspective on developing traditional rail lines. But that is also because of the history. There is already a network of high speed lines. And I think, Hyperloop is more an alternative to air transport than rail transport. Because air transport as you notice rates are so cheap. Everyone is flying today. It is terrible in terms of sustainability. It's so polluting. Also, sea transport is very polluting but that is a different case.

In terms of sustainability, it is better to increase the rate of air transport. It is too cheap, it should be 3 or 4 times the current rates. Probably the demand for it will decrease. Rail transport will become more popular - high speed rail. I think it should be more of a policy perspective. For example, less than 300 kms, you are not allowed to fly anymore. It's a very radical decision and it very difficult to implement because of different interests. Because for 300 kms, people can use the rail. If I have to go to Paris, I can use Thalys. Also, because if I have to fly I would still have to take transport to the city center, whereas if I travel with High speed, I directly reach the city center.

So for me, I see more potential in high speed rail than Hyperloop. For me it is still unclear which market they want to cover, so probably the users of air travel.

Appendix I: The Ministry for Infrastructure and Water Management

1. **Could you give us a brief overview of you and on your research on Hyperloop?**

The Ministry of Infrastructure and Water Management is committed to improving quality of life, access and mobility in a clean, safe and sustainable environment. The Ministry strives to create an efficient network of roads, railways, waterways and airways, effective water management to protect against flooding, and improved air and water quality. Within the ministry Unit Innovation is looking for new ways of transportation and the added value for the mobility of the Netherlands. The Hyperloop concept is promising and therefore we conducted a research with TNO into the feasibility of a Hyperloop test track in the Netherlands. The report is publicly available.

2. **What in your view are the current problems in the transport modes which Hyperloop could solve?**

We still need a lot of technological development before we can actually use a Hyperloop system. However, the features of the system are promising. In the Netherlands, we face the capacity limits of our current infrastructures. The Hyperloop might be a fast and sustainable alternative for the current transport modes. Key is to connect the Hyperloop with existing means of transportation.

3. **Which areas of current transport modes need improvement in which Hyperloop could play a role?**

For innovation in mobility we focus on five different goals; accessibility, safety, sustainability, economy and social inclusion. Every mode of transport needs to improve on those factors.

4. **What are the advantages and disadvantages of Hyperloop according to you?**

Advantages: fast and sustainable transport mode, could also be flexible
Disadvantages: uncertainties: a lot of development is still needed. Questions on safety, capacity and costs need to be answered. After that implementation and the costs of new infrastructure are a big challenge.

5. **What are the costs of developing and building Hyperloop according to you?**

It is hard to estimate the costs upfront. For the development certification, safety requirements and standardization will take a lot of time. The costs of developing a Hyperloop may be comparable with the development of a new plane (2-7 billion euro). TNO estimates that a test track of 5 km will cost 119 million euro.

6. **What do you perceive as benefits of developing Hyperloop?**

- Strengthens the knowledge on Smart Mobility and may give spill-overs to other interesting developments, such as extreme sensible sensors for the self-driving car.
- Strengthens the economy due to extra employment and investments of different sectors

7. **How effective would Hyperloop be to solve problems or add new opportunities to the transport system at the current estimates of development according to you?**

Estimates show that transport by plane, car and train will grow in the coming decades. The Hyperloop could be a sustainable alternative for long distance transport of people and freight.

Appendix J: List of Quotes on Hyperloop

Table 17: List of Quotes on Hyperloop

#	Source	Quote	Statement	Variable	Q-Sample
1.	Interview (van Goeverden, 2018)	The predominant problem is air pollution and energy consumption.		Perceived Problems	Yes
2.	Interview (Lachaize, 2018)	Global warming caused due to transport sector. Transportation contributes to about a 1/3rd or 1/4th of the global warming. So it is pretty substantial. Also we depend a lot on fossil fuels.	Current transport modes are highly responsible for global warming.	Perceived Problems	No
3.	Interview (Lachaize, 2018)	On the efficiency side, we see population rise in urban areas. We see huge urbanization factor that we see in big cities and the infrastructure nowadays are not prepared to sustain the stress that is going to come up in the future years.	We need to address the infrastructure stress (transport infrastructure) on urban areas due to growing population.	Perceived Problems	Yes
4.	Interview (Lachaize, 2018)	We need to have more flexible transportation that can accommodate greater capacity and is green.	We need sustainable and flexible transport modes with more capacity.	Perceived Problems	No
5.	Interview (Lachaize, 2018)	Technologically, the biggest challenge is to make it affordable.	We need cheaper public transport modes.	Perceived Problems	Yes
6.	Interview (Ruitenberg, 2018)	I think one of the problems is congestion.	Current transport modes are very congested.	Perceived Problems	Yes
7.	Interview (Ruitenberg, 2018)	Sustainability is a very big challenge. Modes of travel such as airplane is not very sustainable.	Transport modes should be more sustainable.	Perceived Problems	No
8.	Interview (Ruitenberg, 2018)	Travelers want to be carefree. So they just want to go from the door of their house to their destination. They also want to work and travel in a more fluid way.	Transport modes should be convenient and accessible.	Perceived Problems	Yes
9.	Interview (Rutten, 2018)	Addressing urbanization is very important for transport sector. We have seen tendency in the past and the forecast of the future that more and more people will live in very crowded areas/urban areas/big cities. The cities are growing. More people from rural areas are moving to the cities…So the big challenge is the infrastructure in cities.	We need to accommodate the transport infrastructure needs of growing urban areas.	Perceived Problems	No
10.	Interview (Rutten, 2018)	We also have to address the interconnection between cities. We can do it by car, train or airplanes. We see that from the automotive world we will get electric transport. We see that these are very sustainable transport systems. Automation will come which will last for some years. Also, it is very thinkable that electric/automated buses can be used for intercity transport. These will have lower emissions than a train. We see that trains however are unsustainable. Due to technology advancements in automotive sector, the benefits from train will disappear.	We need sustainable transport modes to interconnect nearby cities.	Perceived Problems	No

11.	Interview (van Noort, 2018)	People should consider their environmental impact. What we are doing right now is not really environmentally sustainable.	Current Transport modes are not sustainable.	Perceived Problems	No
12.	Interview (Wink, 2018)	The inefficiency of the current traffic systems, in particular road traffic. There are too many people that are traveling alone and are using their multi-seat car, only based on their expectation of this once in a year long distance road travel vacation they have in mind.	Private modes of travel/travel by car is inefficient.	Perceived Problems	No
13.	Interview (Konings, 2018)	The issue of sustainability is a major problem. I think every mode has to deal with that.	Current transport modes are unsustainable.	Perceived Problems	No
14.	Research Paper (Decker et al., 2018)	Currently, flying is the fastest and cheapest way for commercial passengers to travel long distances. However, for shorter routes the efficiency of air transport erodes quickly. The inherent upfront inefficiencies of air travel (e.g. arriving at the airport early, taxi time, climbing, descent, holding patterns) can take up more time than the actual flight. Additionally, many commercial aircraft are designed to accommodate much longer missions, and therefore, are not optimized for shorter trips.	Current transport modes, especially air travel is inefficient for shorter distances and unsustainable.	Perceived Problems	Yes
15.	Published Interview (Earle, 2017)	We spend a significant portion of our lives stuck in transit. And as the population grows, so do problems.	Urban areas need to accommodate greater transport capacity.	Perceived Problems	No
16.	Published Interview (Earle, 2017)	Incremental improvements are not enough to solve our current and future transportation problems. We need disruptive innovation that transforms the travel experience to fit the world we live in: more connected, faster, and on demand.	We need radical and disruptive innovations to solve the current transport problems.	Perceived Problems	No
17.	Research Paper (Regeringskansliet, 2017) as quoted in (Magnusson and Widegreen, 2018	The overall transport policy goal is to ensure a socio-economically efficient and long-term sustainable transport supply for citizens and industry throughout the country	We need socio-economic efficient and long-term sustainable modes of transport.	Perceived Problems	No
18.	Interview (van Goeverden, 2018)	The main advantage is travelling consumes less energy. Thus it is more sustainable.	Hyperloop will provide a sustainable mode of transport due to low energy consumption.	Suggested Innovation - Advantage	No
19.	Interview (van Goeverden, 2018)	Disadvantages are that Hyperloop pods have low capacity of people. We found that, building Hyperloop network around Europe could transport only 1/5th of the people that would like to travel with Hyperloop. In other words, the Hyperloop could only fulfill 20% of the demand for the travel at any given time. Also Hyperloop, is very expensive to travel. It is expensive because capacity is too low. You can make the travel cheaper by increasing the capacity. This would require parallel lines on a tube. However, this would make the development costs more expensive, and thus it does not address the requirement for cheaper travels.	Hyperloop has low capacity. It will be expensive to travel in.	Suggested Innovation - Disadvantage	Yes
20.	Interview (Lachaize, 2018)	The main advantages, I'd say is frequency & speed. So obviously if the mode of transport has more frequency, it would divert a lot of people to that mode. Stimulate the economic activity and reduce carbon	High frequency of Hyperloop will attract people towards it. This will be helpful in stimulating economic activity.	Suggested Innovation - Advantage	No

		emissions.			
21.	Interview (Lachaize, 2018)	Now when it comes to these advantages, the infrastructure costs are high.	Hyperloop has high infrastructure costs.	Suggested Innovation - Disadvantage	No
22.	Interview (Lachaize, 2018)	Some people would argue it would look ugly as well? So you have to be careful on how to design things and how do you implement it.	Hyperloop needs care in design and implementation of the technology.	Suggested Innovation - Disadvantage	No
23.	Interview (Lachaize, 2018)	Infrastructure could be complex given the magnitude of the project. It is not an easily implementable technology. It's much like high speed railways, it needs coordination with government bodies and private players. It would take time to convince people to build the technology.	Implementation of Hyperloop will need extensive coordination among decision makers.	Suggested Innovation - Disadvantage	Yes
24.	Interview (Ruitenberg, 2018)	If you build the system in a sustainable way, use sustainable materials, and then if you use green energy, it can be a very sustainable way of transport.	Hyperloop can be a sustainable mode of transport if built with sustainable materials and operated with sustainable energy.	Suggested Innovation - Advantage	No
25.	Interview (Ruitenberg, 2018)	I'd say that one its disadvantages is that it would probably be difficult to find space in Europe to build infrastructure in big cities. And also the investment would be quite big. So you need the government to invest a lot in its development, and that of course is difficult.	It would be difficult to find space for building infrastructure and would require high investments for the governments to implement.	Suggested Innovation - Disadvantage	Yes
26.	Interview (Rutten, 2018)	Theoretically, physically it has the big advantage of needing no fuel consumption, no noise and no pollution in the environment through the physical infrastructure. Of course, it depends on how you build up the system.	Hyperloop could provide a mode of transport with no fuel consumption and with no air and noise pollution.	Suggested Innovation - Advantage	No
27.	Interview (Rutten, 2018)	Because we see that the Dutch Government is tending to open a test infrastructure. They are trying to be aware of the technology. They are trying to gain insights and avoid the same mistakes that they made with maglev.	It is useful for governments to research on the topic of Hyperloop to gain insights.	Suggested Innovation - Advantage	Yes
28.	Interview (Rutten, 2018)	We have completely new infrastructure. Building network connections is not easy. It is very difficult to combine two tubes travelling to and from different directions. However, I think everything in the end it is technically possible. But it will cost a lot of money and study!	Building new infrastructure would cost a lot of research study and money.	Suggested Innovation - Disadvantage	No
29.	Interview (Rutten, 2018)	Hyperloop is for more point to point service. So there is this question of what does it get to the transport society. Since it is more point to point, completely new stations would have to be built. People then have to shift from one line to other. For long distances it could work, but I think it will be so expensive to build up, that it will never win against air travel.	Since Hyperloop is for more point to point transport and would require additional connectivity to reach final destinations. This will be expensive and will not be as efficient as air travel for long distance commutes.	Suggested Innovation - Disadvantage	No
30.	Interview (Wink, 2018)	The biggest advantage... ...being the closed environment. The closed environment, when well implemented, leaves few random effects from the environment to contaminate the transport system. These random effects will either be: pilots of the hyper craft, that will not be there and act illogically; and in	Hyperloop can provide an autonomous mode of transport without affecting or getting affected by its external environment.	Suggested Innovation - Advantage	Yes

		the most literal sense: trees or leaves or water falling on the road that affect the capabilities of the human pilot. In short: the tube environment creates the lossless transport AND a vehicle without pilot.			
31.	Interview (Wink, 2018)	The biggest disadvantage of the tube is that it will probably induce a lot of fear during the first stages of public acceptance and that many people tend to be reluctant to the possibility that the environment can actually be created in an energy efficient way.	Public will need convincing to travel with Hyperloop.	Suggested Innovation - Disadvantage	No
32.	Interview (Konings, 2018)	The biggest advantage is of course its sustainable performance. The solar panels (mounted on the tubes) can give the energy to the system. There is no pollution (emission), which is very good. We do not yet know about the safety of the system, but from what I know it seems reliable.	Hyperloop can provide a sustainable mode of transport with no emissions.	Suggested Innovation - Advantage	No
33.	Interview (Konings, 2018)	Regarding noise, it is a closed system. So the environment doesn't have any impact of the noise.	Hyperloop will provide a mode of transport with no noise pollution.	Suggested Innovation - Advantage	No
34.	Interview (Konings, 2018)	And if you look at the total capacity of the system, it is not that high. It needs very huge investments. So that means the cost per trip is very high. So it can only focus on a premium market.	Hyperloop has low capacity and will be expensive to travel in.	Suggested Innovation - Disadvantage	No
35.	Interview (Konings, 2018)	It is automated and its closed. If there is an accident of course the passengers in the tube might get injured. But it does not affect people external to the system.	Hyperloop will not affect public external to the system.	Suggested Innovation - Advantage	No
36.	Interview (Dutch Ministry for Infrastructure and Water Management, 2018)	Advantages: fast and sustainable transport mode, could also be flexible.	Hyperloop can provide fast, sustainable and flexible mode of transport.	Suggested Innovation - Advantage	No
37.	Interview (Ministry for Infrastructure and Water Management, 2018)	Disadvantages: uncertainties: a lot of development is still needed.	A lot of research and development is needed for Hyperloop.	Suggested Innovation - Disadvantage	No
38.	Research Paper (Decker et al., 2018)	"...estimates of energy consumption, passenger throughput, and mission analyses all support Hyperloop as a faster and cheaper alternative to short-haul flights [of 250 to 500 miles]"	Hyperloop can provide a faster, cheaper and more sustainable mode of transport compared to air transport.	Suggested Innovation - Advantage	Yes
39.	Research Paper (Decker et al., 2018)	Hyperloop can be optimized for passenger throughput, door-to-door travel time, and energy efficiency for open and level travel corridors spanning highly populous cities. The combination of these technologies allows the vehicle to spend more time operating under optimal conditions and avoids releasing carbon emissions into the upper atmosphere.	Hyperloop can provide a flexible and mode of transport .	Suggested Innovation - Advantage	Yes
40.	Research Paper (Decker et al., 2018)	The Hyperloop offers a compelling opportunity to offset this congestion by offering a faster and lower cost transportation option for a large portion of short-haul aviation routes	Hyperloop can provide faster, cheaper mode of transport reducing congestion.	Suggested Innovation - Advantage	No
41.	Research Paper (Decker et al., 2018)	Traveling at speeds above Mach 0.8 (>950 km/hr) is likely not practical.	Travelling with Hyperloop at the suggested speed will not be comfortable.	Suggested Innovation - Disadvantage	Yes

42.	Published Interview (Earle, 2018)	The peak speed of the Hyperloop will be twice that of today's fastest bullet train, but our true time savings will be five to six times greater compared with typical high-speed rail, depending on the route, because every journey is nonstop to your destination, and departures are continuous.	Hyperloop will provide a continuous and high speed mode of travel compared to High Speed Railway.	Suggested Innovation - Advantage	No
43.	Published Interview (Earle, 2018)	Hyperloop can transport passengers, freight, and cars simultaneously.	Hyperloop can provide freight and car transportation.	Suggested Innovation - Advantage	No
44.	Published Interview (Earle, 2018)	Interoperability is vital. We're designing the system to accept any autonomous vehicle (AV) that is summoned to pick people up from their home or office, travel long distances, and then complete the last mile of the journey. AVs and drones could do same-day delivery across vast distances without distributed warehousing. Freight could work the same way. One investment collapses separate networks into a single, more efficient network. That creates an explosion of productivity and mass disruption of business models.	Hyperloop can provide an interoperable and efficient mode of transport. This will be useful for freight transportation. This will be helpful in productivity explosion and business model disruption.	Suggested Innovation - Advantage	Yes
45.	Published Interview (Lawyers of Setterwalls, 2018) as quoted in Research paper (Magnusson and Widegreen, 2018)	Airplanes are much more dangerous than Hyperloop due to the high altitude and the fact that there is fuel surrounding the passengers. Hyperloop operates at ground level without hazardous ignitable liquids. Air travel is widely accepted today, so there is no reason for Hyperloop to be deemed to unsafe for commercial practice .	It will be easier to convince people to travel in Hyperloop, while comparing to air travel. Hyperloop operates at ground level and without hazardous ignitable liquids.	Suggested Innovation - Advantage	Yes
46.	Interview (van Goeverden, 2018)	The benefits are shorter travel times for passengers.	Shorter travel times for passengers are beneficial	Perceived Benefits	No
47.	Interview (van Goeverden, 2018)	One of the main costs according to us, is building of infrastructure.	Infrastructure costs of Hyperloop will be high	Perceived Costs	No
48.	Interview (Lachaize, 2018)	...there will be costs for other modes of transport. For example, If we build a line between two cities that are actively involved in air transport, it can disrupt the industry. If the pricing point is good enough. Likewise for car manufacturers a little bit. Trains will likely suffer probably. There will be a bit of costs involved when it is implemented, because the mode of transports will shift.	Other modes of travel will incur costs with passengers opting to travel with Hyperloop.	Perceived Costs	Yes
49.	Interview (Lachaize, 2018)	...for cargo, e-commerce and food products that are time sensitive could be transported faster and could have inventory savings for companies with that kind of freight. Therefore, if you have a high speed line between two cities, you would probably require less inventory, because there is much more flexibility on the mode of transport side. So you would make your organization a little more neat and save a lot on warehousing costs.	Hyperloop could be used for freight transportation of products that are time sensitive. This will be beneficial for flexible organization and saves warehousing costs.	Perceived Benefits	No
50.	Interview (Lachaize, 2018)	Travel time savings, environmental friendly and fewer accidents as well	Hyperloop will be beneficial for travel time savings, environmental benefits and fewer accidents.	Perceived Benefits	No

51.	Interview (Ruitenberg, 2018)	...one of the benefits of working on such a new technology may be useful in other sectors, or might start other technologies.	Knowledge spillover due to research and development of Hyperloop on development of other technologies will be beneficial .	Perceived Benefits	No
52.	Interview (Rutten, 2018)	There would be discussions with the society for topics such as open view... They don't like building windmills in their backyard. I think it's the same with infrastructure for Hyperloop… ...Also, in our Delft there is a road stretch (A4) of 5-7 kms which they want to expand. But since the public wants it to be a silent area between the cities of Rotterdam and the Hague, there is a debate on it for 40 years! The government had also decided for the stretch to be a silent area and give space for nature, they decide to build the motorway underground. Also it is the most expensive motorway in the Netherlands. This will also happen with Hyperloop… ...Because you have to build these tubes through rural areas and there will be pipeline infrastructure. People might not accept it.	Building of Hyperloop infrastructure through open views or through rural areas, silent areas or spaces dedicated to nature might face extensive debate or public opposition.	Perceived Costs	Yes
53.	Interview (Rutten, 2018)	I am not really a believer in travel time savings. When you have lower travel times, society will move to longer distances. People will consume the distance either way. So the only thing with Hyperloop, is it will enable bigger spread of people living in urban areas. Like any travel technology, it will help in changing travel patterns, but it will not help in solving the mobility problems in the cities with regards to emissions and congestion. It is much more important to solve that then building high speed technology.	Hyperloop's travel time savings benefits will extend travel distances. It will enable larger spread of people in urban areas. Thus, the real problem of emissions and congestion will not solved.	Perceived Effectiveness - Negative	Yes
54.	Interview (van Noort, 2018)	The costs I perceive is the problem of the spread of wealth. So that the areas where stations are located, people might travel easily, but if you are not in the neighborhood of the station, you cannot travel with Hyperloop easily.	Hyperloop might not be conveniently accessible to all.	Suggested Innovation - Disadvantage	Yes
55.	Interview (van Noort, 2018)	The benefits are that you are connected to bigger cities in Europe. In a more easy way. We will become a larger unity that not only goes through Europe, but other countries. Because you can reach the other side of the country faster.	Hyperloop will be beneficial in connecting big cities.	Perceived Benefits	No
56.	Interview (Wink, 2018)	If major steps in technology development can be taken, such as: cheap tunnel boring and swift standardization and legislation, together with competent project management the costs can be drastically reduced.	Development of Hyperloop will be cheaper cheap tunnel boring techniques can be achieved. Standardization, legislation and competent project management skills should help reduce development costs.	Perceived Benefits	No
57.	Interview (Wink, 2018)	The additional benefits of developing Hyperloop is that this innovation opens up an enormous platform for technology development. Currently, a small army of people in the world is now looking at new options to build infrastructure more efficient and swiftly instead of just focusing on the status quo. We have to be	The development of Hyperloop can help achieve great technological progress through knowledge spillover. Such radical innovation will be useful to develop new technologies in the future	Perceived Benefits	No

		innovators to get the world forward and not accept that our current ways are good enough. I expect that Hyperloop will open up a lot of future ways of building.			
58.	Interview (Konings, 2018)	It seems to be that land use is very limited, because it is built on pillars. But I think what you should do is try to combine it with existing infrastructure. Building the line along the highways and rail lines. So the impact on land use is even lower than if you do it independently somewhere else.	Hyperloop as a mode of transport would not use much land. To minimize this impact it could be integrated with the existing transport infrastructure.	Perceived Benefits	Yes
59.	Interview (Konings, 2018)	But the problem is of course the speed of the Hyperloop is very high, so it cannot take sharp curves. So that means, it'll be very difficult to put it along the existing infrastructure because roads and rail lines are curved.	It will be difficult to integrate Hyperloop with existing infrastructure, as it cannot travel through sharp curves.	Perceived Costs	No
60.	Interview (Konings, 2018)	Also, when you think of integrating how do you implement it? Of course a train can travel to the center of the city. But if a Hyperloop track, which is elevated, I have doubts if it could be made to travel to the center. I would expect that it is built at the edge of the cities. But then you need another system to get people quickly to the Hyperloop station. So it is really a dedicated system. And thus it is very difficult to integrate it with other systems.	Hyperloop needs a dedicated system. Due to the elevated tracks, the infrastructure cannot be built inside the city, and will require additional means of transport to access it.	Perceived Costs	Yes
61.	Interview (Konings, 2018)	Well of course, it is less polluting compared to all other modes. In the end, car transport can also become very environmentally friendly if we use Hydrogen based fuel cells and battery and electric cars which is now the trend. But you will still have lots of cars even if it is electric, which will lead to congestion. So I think it is a good development in solving the problems of sustainability, but not accessibility.	Hyperloop is less polluting and is beneficial for achieving sustainability and less congestion. However, it won't be helpful in achieving accessibility.	Perceived Benefit and Costs.	No
62.	Interview (Konings, 2018)	But of course, since it very high speed, it makes sense only to travel long distances. And then you have the problem that you have to invest a huge amount of money to build the infrastructure. I think it is around the figures of 25 million EUR/ km. So that means 100 km is too short a distance. I don't know how long it will take to accelerate.	Since Hyperloop travels at high speed, it makes sense to build it for long distances which will have high investment costs. It might not be technically feasible for distances up to 100km. This would require high investment costs	Suggested Innovation - Disadvantage	Yes
63.	Interview (Konings, 2018)	The infrastructure will have to be cross border. So there is the problem of who will finance.	The infrastructure for Hyperloop will have to be cross border. This would require high coordination among various governments/stakeholders.	Perceived Costs	No
64.	Interview (Dutch Ministry for Infrastructure and Water Management, 2018)	It is hard to estimate the costs upfront. For the development certification, safety requirements and standardization will take a lot of time. The costs of developing a Hyperloop may be comparable with the development of a new plane (2-7 billion euro). TNO estimates that a test track of 5 km will cost 119 million euro.	The costs of development of Hyperloop is unpredictable. It will take a long time for development certification, standardization and safety standards.	Perceived Costs	Yes

65.	Interview (Dutch Ministry for Infrastructure and Water Management, 2018)	Strengthens the knowledge on Smart Mobility and may give spill-overs to other interesting developments, such as extreme sensible sensors for the self-driving car.	Strengthens the knowledge on Smart Mobility and may give spill-overs to other technological developments.	Perceived Benefits	No
66.	Newspaper Article (The Guardian, 2017)	Even though a Hyperloop in cloudy Germany could not run solely on solar power, it could still avoid emitting up to 140,000 tons of carbon dioxide each year, according to the study, as well as up to 0.2% of Germany's entire production of air pollutants like methane, nitrous oxides and dust.	Although Hyperloop cannot operate entirely on solar power, it will still be beneficial in reducing a significant amount of transport emissions.	Perceived Benefits	No
67.	Research Paper (Werner, Eissing & Langtonk, 2016)	Our results show that Hyperloop creates significant shared value. In the least case, Hyperloop NG's higher speeds create value worth €400 million yearly. By reducing the number of accidents, it creates €150 million yearly in shared value. In total, the eight shared value factors examined here represent €660 to €900 million of shared value likely to be created yearly by constructing Hyperloop NG. Given Hyperloop NG's calculated performance and the rule of three governing pollutants, one-third of an investment of €2.7 billion would be recouped in shared value creation.	Hyperloop could help save costs through reduced pollution, congestion and avoided accidents.	Perceived Benefit	No
68.	Research Paper (Decker et al., 2018)	The fully-electric Hyperloop is designed for high traffic corridors, where its high upfront cost can be offset by cheaper, faster, and cleaner commercial travel on large scales. The Hyperloop is intended to alleviate billions of commuter car passenger miles, as well as free up airspace, reducing congestion and travel times for flights that are well suited for the national airspace system.	A fully electric Hyperloop can be beneficial in alleviating billions of commuter car passenger miles and free up airspace, thereby saving costs in emissions, congestion and travel times.	Perceived Benefits	Yes
69.	Personal Blog (Sinclair, 2018)	Good amount of land would be needed just for your basic station services. If you have a pod leaving every 30 seconds, you also need quite the stacking area.	Hyperloop infrastructure needs a large amount of land including stacking of pods.	Perceived Costs	Yes
70.	Personal Blog (Levy, 2013)	The real cost of constructing civil infrastructure for Hyperloop is ten times as high as advertised	Hyperloop would cost much more than what is estimated or advertised.	Suggested Innovation - Disadvantage	No
71.	Personal Blog (Levy, 2013)	So it's the same cost as standard HSR. It's supposedly faster, but since it doesn't go all the way to Downtown Los Angeles it doesn't actually provide faster door-to-door trip times.	Even if Hyperloop costs the same as High Speed Railway, it will cost extra to reach the final destination, since it does not travel inside the city.	Suggested Innovation - Disadvantage	No
72.	Published Interview (Earle, 2017)	You can build greener cities, and you can shift manufacturing plants and warehouses far outside the city, where costs are lower. It would have dramatic effects on the way people work and their quality of life.	Hyperloop can allow building of greener cities. It would be possible to build manufacturing plants and warehouses. This would have major effects on the way quality of life of the public.	Suggested Innovation - Advantage	No
73.	Published Interview (Earle, 2017)	Based on the costs we have seen in building our working prototype, we expect capital expenditure per mile to be less than two-thirds that of high-speed rail—and in many cases much less than that. Operational costs will be significantly lower than high-speed rail as we only use motor power for 10 percent of a journey; after that, the vehicle glides in the near vacuum	Hyperloop would be beneficial since it would cost significantly less money than the development of High Speed Railway.	Suggested Innovation - Advantage	No

		environment for the rest. And with no friction in the system, total lifetime costs, including maintenance, will be much less than that of high-speed rail.			
74.	Published Interview (Earle, 2017)	The value a Hyperloop system unlocks could give governments the ability to reduce their share of the cost. Consider land value capture: the differences in the cost for land and housing inside and outside the city can be up to ten times. That creates tremendous opportunities for private real estate investment (and a broader tax base) in remote locations, as well as opportunities to build smart cities from scratch, on sites that are not constrained by prior construction. The more you consider the wider economic benefits, the more you realize the significant business opportunities possible—and that attracts both public and private investment.	Hyperloop allows the governments to share the land costs. This would also make housing outside the cities cheaper. This would be boost private real estate investments, broader tax bases and opportunities to build smart cities from scratch, on areas which aren't constrained by prior construction. This has enormous potential for economic activities.	Perceived Benefits	Yes
75.	Research Paper (Magnusson and Widegreen, 2018)	Cross-border, benefits with a Hyperloop system. This could further enable universities to share expensive and unique lab equipment, the accessibility of hospitals (including expensive and rare equipment and competence) could be increased and hence utilized more efficiently.	Cross border benefits of Hyperloop can help in knowledge sharing across universities and hospitals.	Perceived Benefits	No
76.	Research Paper (ARUP et al., 2017)	The development of a Hyperloop test facility in The Netherlands contributes to R&D and innovation related to Smart Mobility. It offers opportunities in strengthening the Dutch innovation and production ecosystem (with a first-mover position) and benefits in terms of jobs and contribution to social challenges.	Development of Hyperloop in the Netherlands could help it become a technology leader, generate knowledge, attract investments and boost the economy.	Perceived Benefits	Yes
77.	Interview (van Goeverden, 2018)	There are still unproven technical problems for Hyperloop to solve.	There are still unproven technical problems for Hyperloop to solve.	Perceived Effectiveness - Negative	No
78.	Interview (Lachaize, 2018)	For most companies it is really early to predict since it is a high capital intensive project.	It is difficult to predict the effectiveness of Hyperloop for the organizations, since it requires high investments.	Perceived Effectiveness - Negative	No
79.	Interview (Lachaize, 2018)	..companies are getting a good amount of technological understanding about where to innovate in. So there is good knowledge spillover.	A good amount of knowledge spillover can help companies achieve the intended effectiveness of Hyperloop	Perceived Effectiveness - Positive	No
80.	Interview (Lachaize, 2018)	Also, more companies are getting motivated by the idea in other parts of the economy. They reflect more on the transit and on the infrastructure.	Other parts of the economy reflect more on the transit and infrastructure due to development efforts/knowledge spillover in Hyperloop. This should be effective in mitigating problems in transport sector.	Perceived Effectiveness - Positive	Yes
81.	Interview (Ruitenberg, 2018)	I think the political decision making behind implementing it is the challenge that Hyperloop faces.	Political decision making may limit its effectiveness in achieving objectives.	Perceived Effectiveness - Negative	No
82.	Interview (Ruitenberg, 2018)	to change people's perspectives of travelling in a closed tube is quite challenging. So it would be similar to people not liking travel in submarines for example.	It will be difficult to convince people to travel in Hyperloop	Perceived Effectiveness - Negative	No
83.	Interview (Rutten, 2018)	I don't think it would be much effective. The major problems with transport sector is to reduce emissions. Hyperloop can reduce some pressure but not eliminate	The major problems in transport sector is to reduce emissions. Hyperloop can alleviate a part of it, but won't be fully effective.	Perceived Effectiveness - Negative	No

		it entirely.			
84.	Interview (van Noort, 2018)	I think very effective. I think the way we are developing right now is very modern, it's really creating a new standard with many companies. We are aligning our development with the approach similar to other companies.	Hyperloop will be very effective in solving the problems in transport sector. It is being developed with shared standards among all Hyperloop companies.	Perceived Effectiveness - Positive	No
85.	Interview (van Noort, 2018)	And I think what is also really good is how we can present Hyperloop to the world, so get people to understand the concept and basically accept it.	Shared standards of development is effective in making public accept the innovation.	Perceived Effectiveness - Positive	No
86.	Interview (Wink, 2018)	If the world population is increasing and the level of average wealth and technological development per capita will do the same, then we are sure to head to only bigger congestion problems. Hyperloop can alleviate the pressure on current transport modes.	With growing population and income, the problems of congestion and emissions will grow. Hyperloop can alleviate the pressure on current transport modes.	Perceived Effectiveness - Positive	No
87.	Interview (Konings, 2018)	Honestly, in a limited way. I think it is meant to be an alternative to air transport and maybe high speed rail transport for mid to long distance travels. Let's say from 500-1500 kms.. ...And I think, Hyperloop is more an alternative to air transport than rail transport. Because air transport as you notice rates are so cheap. Everyone is flying today. It is terrible in terms of sustainability. It's so polluting. Also, sea transport is very polluting but that is a different case.	Hyperloop will effective in a limited way. It will be a sustainable alternative to air travel for mid to long distance travels (500 - 1500 kms).	Perceived Effectiveness - Negative	Yes
88.	Interview (Konings, 2018)	In terms of sustainability, it is better to increase the rate of air transport. It is too cheap, it should be 3 or 4 times the current rates. Probably the demand for it will decrease...I think it should be more of a policy perspective.	To achieve the sustainability in the transport sector, focus should rather be put on policies and not radical technologies.	Perceived Effectiveness - Negative	Yes
89.	Interview (Dutch Ministry for Infrastructure and Water Management, 2018)	Estimates show that transport by plane, car and train will grow in the coming decades. The Hyperloop could be a sustainable alternative for long distance transport of people and freight.	Hyperloop can be effective in offering a sustainable mode of freight and public transport in the near future.	Perceived Effectiveness - Positive	No
90.	Published Interview (Flyvbjerg, 2017) as published in Newspaper article, The Guardian	"Nobody has been able to deliver this kind of infrastructure in a way where it's profitable, so subsidies have always been needed," "I wouldn't bet my money on being able to make something like the Hyperloop financially viable," says Flyvbjerg. "But that's OK. We subsidize all sorts of other infrastructure so why not the Hyperloop, if we think there's an environmental or business case for it?"	It would require high investments and subsidies to achieve a profitable mode of transport.	Perceived Effectiveness - Negative	No
91.	Research Paper (Mclean, 2016)	It is important to emphasize that although High Speed Rail seems like the better design choice at the time of writing, as shown in this report, this may not be the case in the coming years. Policy makers should continue to develop the Hyperloop and investigate its feasibility before committing themselves to a large-scale high speed rail project which may be archaic by the time it is operational.	Although High Speed Rail seems like a better alternative at current time period, policy makers should continue to support research & development of Hyperloop and investigate its feasibility before committing to large scale implementation of HSR which might be archaic by the time it it fully implemented.	Perceived Effectiveness - Positive	Yes
92.	Personal Blog	Small things can possibly be fixed; the cost problems,	Although, technological problems can be fixed,	Perceived Effectiveness -	No

	(Levy, 2013)	the locations of the stations, and the passenger comfort issues given cost constraints can't. Industry insiders with ties to other speculative proposals meant to replace conventional rail, such as maglev, are in fact skeptical of Hyperloop's promises of perfect safety.	industry insiders are still concerned about its safety.	Negative	
93.	Research Paper (Magnusson and Widegreen, 2018)	When introducing the concept of Hyperloop to new people, there is, as common when presenting a new technology, variations in how it is received. There is always so called early adopters, or innovators, that are positive to the idea and see the benefits with it. However, the majority usually remain skeptical and question the concept (Representative of Hyperloop Sweden, 2018). The majority often look for errors or shortcomings in the design and are generally hard to persuade before the concept has been commercially proven. Moreover, Head of Technology and Railway at ST-Agency (2018) identifies that it might be some inertia in attracting passengers to the mode. The acceptance of the public might be delayed as concerns regarding if the system really is safe make the public less open minded to the diffusion of new disruptive systems and this transition can take time (Head of Technology and Railway at ST-Agency, 2018).	Hyperloop will not be fully accepted by public unless its technical feasibility is proved.	Perceived Effectiveness - Negative	Yes

Appendix K: Survey Sheet

Interviewee Reference:

Questions on Demographics:

Please indicate your Gender	Male (Man)	Female (Vrouw)	
Please indicate your age group	16-35	35-59	60 +
What is your highest level of Education	High School	Undergraduate	Graduate+
Geographical Area of Residence	Rural	Urban	
Income Level	0-20k	20-40k	40k+

Table: Characteristics of the P-Set

Could you provide us with a short description of your job: _____

Miscellaneous:

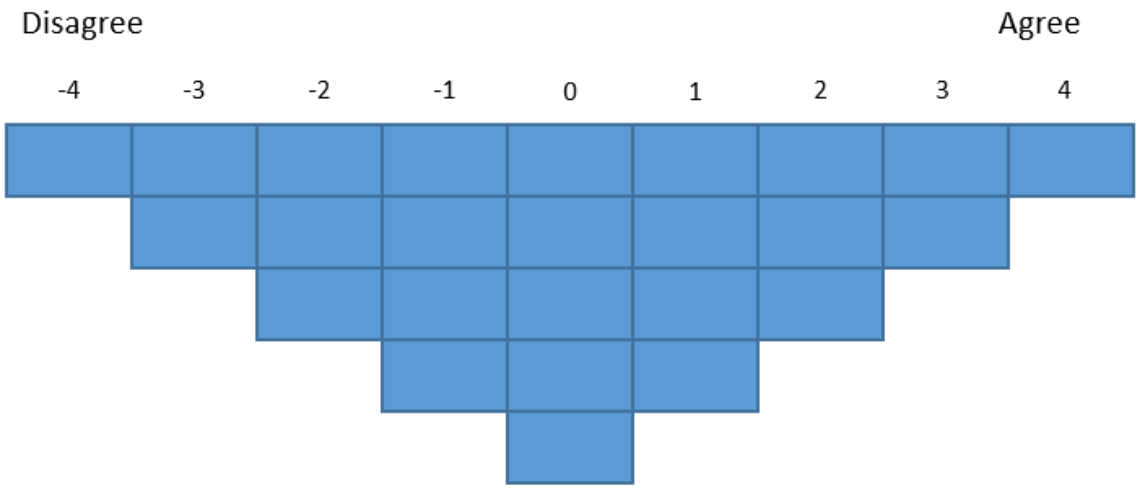
Q. Do you know about the Hyperloop?

1. Just heard of it in Newspapers/internet/Television. My knowledge is rather shallow, but I am aware of its presence.
2. I have read about the concept of Hyperloop. My knowledge is not really deep, but I am fairly aware of the technology
3. I consider myself an expert in the topic of Hyperloop.
4. What is Hyperloop?

#	Statements	Agree	Neutral	Disagree
1.	It will be easier to convince people to travel in Hyperloop, compared to air travel.			
2.	Building of Hyperloop infrastructure through public spaces will face extensive opposition.			
3.	Transport modes should be more convenient and accessible in the NL.			
4.	Hyperloop R&D will be beneficial for NL to become technology leader in transport technologies.			
5.	Even though High Speed Rail (Thalys) seems like a better alternative, Policymakers should continue to focus on Hyperloop R&D. By the time HSR is fully implemented, it will become outdated and Hyperloop can be made technically feasible			
6.	R&D on Hyperloop will have positive knowledge spillover on other technologies.			
7.	Current transport modes for medium to long distance (>200 km) travel is inefficient.			
8.	A fully electric Hyperloop can alleviate congestion & emissions of road and air travel.			
9.	We need more sustainable transport modes for the NL, such as the Hyperloop.			
10.	Public won't support implementation of Hyperloop unless its feasibility for human travel is proved.			
11.	Hyperloop can provide an interoperable and efficient mode of freight transport.			
12.	Hyperloop would have to be built outside the cities with high costs for dedicated infrastructure due to its technical requirements for high speed travel. It cannot be integrated with current transport modes.			
13.	Current transport modes in the NL are very crowded, which Hyperloop could solve.			
14.	Hyperloop is immune to human interference or external environment.			
15.	Hyperloop could reduce the high emissions of the current transport modes.			

16.	Hyperloop will allow larger spread of urban areas, thus leading to more emissions and congestion.			
17.	I think Hyperloop has low capacity and thus will be expensive to travel in.			
18.	I think travelling with Hyperloop will not be comfortable.			
19.	Hyperloop can enable governments to share investment costs and boost economic activity.			
20.	We need Hyperloop to address the infrastructure stress in urban areas due to growing population.			
21.	To achieve sustainability focus should rather be put on policies and not radical technologies.			
22.	Hyperloop will take a long time for development, certification & standardization.			
23.	Other modes of transport will incur costs with passengers opting to travel with Hyperloop.			
24.	Implementation of Hyperloop will need more co-ordination among decision makers than for other transport modes.			
25.	Hyperloop cannot provide a faster mode of door to door travel compared to air transport.			

Please Rank Order the statements in the Grid below:



1. Could you please provide the justification for the statements categorized at '+4 Agree'?

_____
_____

1. Could you please provide the justification for the statements categorized at '-4 disagree'?

_____
_____

1. Is there an personal opinion that you would like to express on the topic of Hyperloop?

_____
_____

1. Do you have further questions regarding the survey?

Appendix L. Correlation Matrix Between Sorts

Table 18: Correlation Matrix Between Sorts

Sorts	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**
1	**100**	41	44	17	51	48	21	50	50	34	28	-17	5	11	52	48	29	46	9	25	44	55	26	17	11	50	10	24	44	52	21	13
2	41	**100**	3	52	59	52	54	25	35	48	21	26	25	32	18	26	68	18	3	60	33	50	10	54	31	29	48	35	22	31	0	-12
3	44	3	**100**	26	8	22	-21	16	13	18	31	-27	1	6	63	31	-2	21	4	-10	3	23	15	-12	-6	16	-11	12	56	38	-17	16
4	17	52	26	**100**	58	18	36	11	6	25	20	-4	47	44	37	30	18	4	2	14	18	33	24	49	-4	16	35	59	15	29	2	18
5	51	59	8	58	**100**	45	32	7	23	12	12	19	24	17	33	36	45	1	24	37	42	40	8	52	-16	10	27	46	9	25	26	-24
6	48	52	22	18	45	**100**	14	17	31	22	50	44	19	14	-2	23	69	-2	36	27	29	48	-8	27	30	26	29	58	16	23	45	-21
7	21	54	-21	36	32	14	**100**	35	55	21	-6	26	44	50	3	37	32	-4	-16	34	32	47	24	63	26	44	42	13	-10	29	26	4
8	50	25	16	11	7	17	35	**100**	74	62	6	-11	26	17	24	18	-4	36	-2	26	41	44	10	8	29	51	10	19	23	54	28	16
9	50	35	13	6	23	31	55	74	**100**	47	-4	18	36	28	23	17	25	6	7	37	30	54	9	33	26	54	31	6	12	67	37	16
10	34	48	18	25	12	22	21	62	47	**100**	41	-6	8	16	8	17	13	18	31	26	9	18	5	11	32	38	28	23	42	42	9	22
11	28	21	31	20	12	50	-6	6	-4	41	**100**	6	-15	1	-12	17	20	-5	68	-19	2	8	-20	-13	16	19	43	53	37	4	36	18
12	-17	26	-27	-4	19	44	26	-11	18	-6	6	**100**	20	2	-30	-20	49	-45	25	23	19	21	-30	24	9	8	41	6	-38	11	26	-33
13	5	25	1	47	24	19	44	26	36	8	-15	20	**100**	82	5	-18	-13	-37	-24	26	-2	41	1	67	-5	31	21	18	-39	37	-6	18
14	11	32	6	44	17	14	50	17	28	16	1	2	82	**100**	0	-3	-7	-31	-30	38	-27	49	1	73	8	19	12	15	-29	27	-2	22
15	52	18	63	37	33	-2	3	24	23	8	-12	-30	5	0	**100**	23	-6	44	-15	18	19	37	39	-3	-5	35	-9	2	50	51	-20	32
16	48	26	31	30	36	23	37	18	17	17	17	-20	-18	-3	23	**100**	36	38	-1	-13	50	14	33	13	8	10	14	29	38	16	30	5
17	29	68	-2	18	45	69	32	-4	25	13	20	49	-13	-7	-6	36	**100**	17	19	19	38	38	7	25	27	15	44	27	16	15	36	-33
18	46	18	21	4	1	-2	-4	36	6	18	-5	-45	-37	-31	44	38	17	**100**	-21	4	33	10	34	-30	29	24	3	-6	52	14	-5	5
19	9	3	4	2	24	36	-16	-2	7	31	68	25	-24	-30	-15	-1	19	-21	**100**	-19	3	-17	-12	-15	-4	7	39	42	19	7	53	12
20	25	60	-10	14	37	27	34	26	37	26	-19	23	26	38	18	-13	19	4	-19	**100**	-4	36	-13	54	28	1	8	-5	-9	23	-19	-20
21	44	33	3	18	42	29	32	41	30	9	2	19	-2	-27	19	50	38	33	3	-4	**100**	33	23	10	26	29	25	37	31	26	28	-14
22	55	50	23	33	40	48	47	44	54	18	8	21	41	49	37	14	38	10	-17	36	33	**100**	26	48	22	55	22	28	22	57	30	2
23	26	10	15	24	8	-8	24	10	9	5	-20	-30	1	1	39	33	7	34	-12	-13	23	26	**100**	24	5	50	-9	5	33	24	-3	34
24	17	54	-12	49	52	27	63	8	33	11	-13	24	67	73	-3	13	25	-30	-15	54	10	48	24	**100**	18	13	22	21	-20	24	7	-4

25	11	31	-6	-4	-16	30	26	29	26	32	16	9	-5	8	-5	8	27	29	-4	28	26	22	5	18	**100**	25	29	16	40	20	16	17
26	50	29	16	16	10	26	44	51	54	38	19	8	31	19	35	10	15	24	7	1	29	55	50	13	25	**100**	38	17	31	61	19	38
27	10	48	-11	35	27	29	42	10	31	28	43	41	21	12	-9	14	44	3	39	8	25	22	-9	22	29	38	**100**	36	17	39	32	15
28	24	35	12	59	46	58	13	19	6	23	53	6	18	15	2	29	27	-6	42	-5	37	28	5	21	16	17	36	**100**	26	28	46	11
29	44	22	56	15	9	16	-10	23	12	42	37	-38	-39	-29	50	38	16	52	19	-9	31	22	33	-20	40	31	17	26	**100**	37	2	17
30	52	31	38	29	25	23	29	54	67	42	4	11	37	27	51	16	15	14	7	23	26	57	24	24	20	61	39	28	37	**100**	18	34
31	21	0	-17	2	26	45	26	28	37	9	36	26	-6	-2	-20	30	36	-5	53	-19	28	30	-3	7	16	19	32	46	2	18	**100**	4
32	13	-12	16	18	-24	-21	4	16	16	22	18	-33	18	22	32	5	-33	5	12	-20	-14	2	34	-4	17	38	15	11	17	34	4	**100**

Appendix M: Unrotated Factor Matrix

Table 19: Unrotated Factor Matrix

	Factors						
	1	**2**	**3**	**4**	**5**	**6**	**7**
Sorts							
1	0.7004	-0.3204	0.0495	-0.1511	0.0155	0.1605	0.0196
2	0.7297	0.2932	0.0511	-0.0063	0.0001	0.2465	0.0442
3	0.2691	-0.3847	0.0735	-0.2235	0.0324	0.0717	0.0047
4	0.5452	0.2070	0.0261	-0.0702	0.0040	0.3243	0.0759
5	0.5701	0.3534	0.0737	0.0445	0.0700	0.4413	0.1434
6	0.6071	0.3484	0.0717	-0.2987	0.0569	-0.1147	0.0058
7	0.5693	0.1894	0.0221	0.3810	0.0786	0.1596	0.0194
8	0.5535	-0.3673	0.0665	0.3007	0.0469	-0.1674	0.0141
9	0.6566	-0.1018	0.0038	0.4107	0.0926	-0.1640	0.0135
10	0.5339	-0.1411	0.0081	-0.3314	0.0004	-0.2987	0.0510
11	0.3292	0.0935	0.0061	-0.4659	0.1409	-0.5012	0.1628
12	0.1134	0.6205	0.2408	0.0362	0.0003	-0.1973	0.0204
13	0.3074	0.3111	0.0573	0.6081	0.2258	0.1401	0.0155
14	0.3234	0.3406	0.0685	0.5816	0.2032	0.2119	0.0332
15	0.3650	-0.5181	0.1416	-0.0120	0.0003	0.3823	0.1060
16	0.4312	-0.1792	0.0138	-0.3835	0.0940	0.2727	0.0538
17	0.4906	0.3038	0.0547	-0.3363	0.0721	0.0259	0.0010
18	0.1908	-0.6393	0.2295	-0.2405	0.0375	0.1975	0.0289
19	0.1645	0.1455	0.0135	-0.4217	0.1143	-0.6590	0.3205
20	0.3074	0.1923	0.0227	0.3000	0.0467	0.2239	0.0367
21	0.4786	-0.1133	0.0048	-0.2158	0.0303	0.0375	0.0016
22	0.7273	0.0345	0.0013	0.2116	0.0219	0.1613	0.0198
23	0.2654	-0.3806	0.0718	0.0457	0.0004	0.2628	0.0501
24	0.4742	0.4928	0.1457	0.4134	0.0940	0.4101	0.1227
25	0.3591	-0.0630	0.0010	0.0845	0.0026	-0.2177	0.0255
26	0.6391	-0.2763	0.0359	0.2845	0.0416	-0.1845	0.0176
27	0.5272	0.2752	0.0450	-0.0367	0.0014	-0.3130	0.0566
28	0.5392	0.2501	0.0375	-0.3806	0.0926	-0.1473	0.0105
29	0.4017	-0.5822	0.1846	-0.3980	0.1015	-0.0744	0.0019
30	0.7034	-0.2522	0.0295	0.2485	0.0310	-0.1162	0.0060
31	0.3599	0.1636	0.0168	-0.1398	0.0134	-0.4033	0.0992
32	0.1602	-0.3271	0.0517	0.1908	0.0174	-0.2044	0.0221

Eigen Values	7.4418	3.4497	0.2383	2.9701	0.2015	2.3628	0.2120
% expl. Var	23	11	1	9	1	7	1

Appendix N: Factor Z-Scores

Table 20: Factor Z-Scores

#	Statements	Factors 1	2	3	4
1.	It will be easier to convince people to travel in Hyperloop, compared to air travel.	0.76	-0.72	-1.60	-0.58
2.	Building of Hyperloop infrastructure through public spaces will face extensive opposition.	1.38	1.53	-0.45	1.47
3.	Transport modes should be more convenient and accessible in the NL.	-0.21	1.52	-0.56	-2.09
4.	Hyperloop R&D will be beneficial for NL to become technology leader in transport technologies.	0.59	-0.04	1.73	-0.08
5.	Even though High Speed Rail (Thalys) seems like a better alternative, Policymakers should continue to focus on Hyperloop R&D. By the time HSR is fully implemented, it will become outdated and Hyperloop can be made technically feasible	0.96	-1.06	1.51	-0.09
6.	R&D on Hyperloop will have positive knowledge spillover on other technologies.	1.65	1.03	1.25	-0.06
7.	Current transport modes for medium to long distance (>200 km) travel is inefficient.	1.58	-0.06	-1.72	-0.79
8.	A fully electric Hyperloop can alleviate congestion & emissions of road and air travel.	-0.72	-1.27	1.65	-0.64
9.	We need more sustainable transport modes for the NL, such as the Hyperloop.	0.17	-0.27	0.26	-0.25
10.	Public won't support implementation of Hyperloop unless its feasibility for human travel is proved.	0.00	0.00	0.05	1.83
11.	Hyperloop can provide an interoperable and efficient mode of freight transport.	1.55	-0.04	0.25	0.12
12.	Hyperloop would have to be built outside the cities with high costs for dedicated infrastructure due to its technical requirements for high speed travel. It cannot be integrated with current transport modes.	-0.33	0.14	0.21	1.05
13.	Current transport modes in the NL are very crowded, which Hyperloop could solve.	-0.70	-0.62	-0.09	-1.85
14.	Hyperloop is immune to human interference or external environment.	-1.29	-1.52	-1.39	-0.60
15.	Hyperloop could reduce the high emissions of the current transport modes.	0.44	-1.34	1.15	-0.51
16.	Hyperloop will allow larger spread of urban areas, thus leading to more emissions and congestion.	-0.68	-0.49	-0.55	-0.64
17.	I think Hyperloop has low capacity and thus will be expensive to travel in.	-0.17	1.85	0.19	1.13
18.	I think travelling with Hyperloop will not be comfortable.	-1.70	1.13	-0.73	0.19
19.	Hyperloop can enable governments to share investment costs and boost economic activity.	0.21	-0.08	0.54	0.40
20.	We need Hyperloop to address the infrastructure stress in urban areas due to growing population.	-1.81	-1.41	0.15	-0.90
21.	To achieve sustainability focus should rather be put on policies and not radical technologies.	-0.26	1.45	-0.69	0.25
22.	Hyperloop will take a long time for development, certification & standardization.	0.46	0.46	1.06	1.40
23.	Other modes of transport will incur costs with passengers opting to travel with Hyperloop.	-0.22	-0.46	-1.04	-0.85
24.	Implementation of Hyperloop will need more co-ordination among decision makers than for other transport modes.	-0.06	0.12	-0.15	1.03
25.	Hyperloop cannot provide a faster mode of door to door travel compared to air transport.	-1.58	-0.23	-1.03	1.40

Appendix O: Factor Q-Sort Values for Statements sorted by Consensus vs. Disagreement (Variance across Factor Z-Scores)

Table 21: Factor Q-Sort Values for each Statement

		Factors			
#	**Statements**	**1**	**2**	**3**	**4**
1.	It will be easier to convince people to travel in Hyperloop, compared to air travel.	2	-2	-3	-1
2.	Building of Hyperloop infrastructure through public spaces will face extensive opposition.	2	3	-1	3
3.	Transport modes should be more convenient and accessible in the NL.	0	3	-1	-4
4.	Hyperloop R&D will be beneficial for NL to become technology leader in transport technologies.	1	0	4	0
5.	Even though High Speed Rail (Thalys) seems like a better alternative, Policymakers should continue to focus on Hyperloop R&D. By the time HSR is fully implemented, it will become outdated and Hyperloop can be made technically feasible	2	-2	3	0
6.	R&D on Hyperloop will have positive knowledge spillover.	4	2	2	0
7.	Current transport modes for medium to long distance (>200 km) travel is inefficient.	3	0	-4	-2
8.	A fully electric Hyperloop can alleviate congestion & emissions of road and air travel.	-2	-2	3	-1
9.	We need more sustainable transport modes for the NL, such as the Hyperloop.	0	-1	1	0
10.	Public won't support implementation of Hyperloop unless its feasibility for human travel is proved.	0	1	0	4
11.	Hyperloop can provide an interoperable and efficient mode of freight transport.	3	0	1	0
12.	Hyperloop would have to be built outside the cities with high costs for dedicated infrastructure due to its technical requirements for high speed travel. It cannot be integrated with current transport modes.	-1	1	1	2
13.	Current transport modes in the NL are very crowded, which Hyperloop could solve.	-2	-1	0	-3
14.	Hyperloop is immune to human interference or external environment.	-2	-4	-3	-1
15.	Hyperloop could reduce the high emissions of the current transport modes.	1	-3	2	-1
16.	Hyperloop will allow larger spread of urban areas, thus leading to more emissions and congestion.	-1	-1	-1	-2
17.	I think Hyperloop has low capacity and thus will be expensive to travel in.	0	4	0	2
18.	I think travelling with Hyperloop will not be comfortable.	-3	2	-2	1
19.	Hyperloop can enable governments to share investment costs and boost economic activity.	1	0	1	1
20.	We need Hyperloop to address the infrastructure stress in urban areas due to growing population.	-4	-3	0	-3
21.	To achieve sustainability focus should rather be put on policies and not radical technologies.	-1	2	-1	1
22.	Hyperloop will take a long time for development, certification & standardization.	1	1	2	3
23.	Other modes of transport will incur costs with passengers opting to travel with Hyperloop.	-1	-1	-2	-2
24.	Implementation of Hyperloop will need more co-ordination among decision makers than for other transport modes.	0	1	0	1
25.	Hyperloop cannot provide a faster mode of door to door travel compared to air transport.	-3	0	-2	2