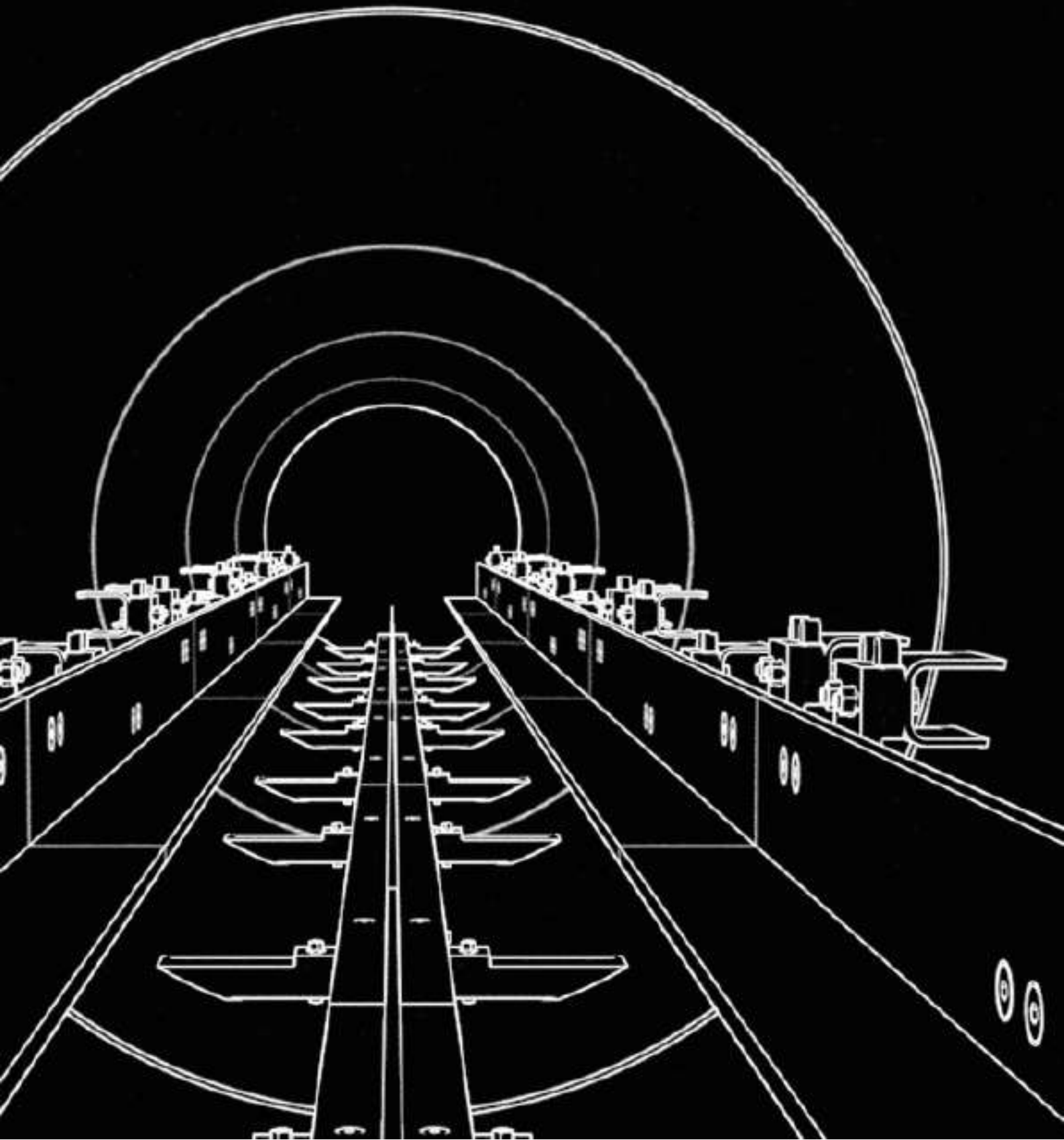
Final Research Submission

AI-based analysis of the public discourse of hyperloop and guidelines for optimal divulgation

HYPERLOOP **UPV**



Contents

List of Figures

List of Tables

Acknowledgements

Firstly, special thanks to Professors Paolo Rosso and Berta Chuilvi for sharing their knowledge of the fields of sociology and natural language processing. Their experience and interest on innovation boosted the research.

Thanks also to the whole team of Hyperloop UPV for their efforts on making the project of this year possible.

Chapter 1

General

1.1 Description of the Team & Development Environment

Hyperloop UPV is a student team born and raised in Valencia, Spain, and headquartered at the Universitat Politècnica de València (UPV). The team has consistently demonstrated a steady commitment ‘ over its nine-year trajectory, focusing on intensive research and innovation within the realm of hyperloop technology.

As a diverse team consisting of 48 members from all the faculties of the university, it adopts a multidisciplinary and collaborative approach to problem-solving. The team is organized into specialised working groups, referred to as subsystems, each dedicated to addressing specific facets of hyperloop development. This approach allows the team to efficiently confront the current challenges by leveraging diverse areas of expertise. The team boasts a comprehensive skill set spanning multiple disciplines, including engineering and operations management, ensuring a holistic and well-rounded approach to finding solutions.

The primary objectives of Hyperloop UPV are to develop a scalable and functional vehicle capable of levitating within a vacuum-sealed tube, always focusing on three main aspects: safety, scalability, and sustainability.

Hyperloop UPV benefits from the support of over 90 entities, both private and public. This support enables the team to translate the project into reality year after year through invaluable in-kind and/or monetary contributions.

With this research titled ”AI-based analysis of the public discourse of hyperloop and guidelines for optimal divulgation”, developed by Hugo Albert, Claudia Lara, Marcos Pérez, Ángel Lova, Álvaro Pérez, Stefan Costea, and María García, Hyperloop UPV is applying for the Full-Scale Award: Socio-Economic Aspects of Hyperloop Systems.

The total word count is 13,438 words.

Chapter 2

Abstract

The social acceptance of hyperloop, as a revolutionary innovation, significantly relies on the way it is transmitted to the audience. Moreover, the complexity of the technology involved creates rejection when not understood properly, difficulting the diffusion process. Therefore, the objective of this research is to guide the public discourse around hyperloop to its best, avoiding the creation of misunderstandings due to incorrect information spreading. To achieve solid guidelines, statistical and deep learning techniques have been applied to the extraction of hyperloop-related arguments and their analysis and comparison.

Chapter 3

Introduction

3.1 Motivation

In the ever-evolving landscape that is transportation technology, hyperloop stands as a beacon of innovation, promising to revolutionize the way that we move and redefine the concept of proximity.

Over the years, history has shown us that progress in technology is always accompanied by challenges and uncertainties. From the invention of the wheel to the exploration of outer space, innovation has always had to navigate the unknown and the sense of fear that comes with it.

Hyperloop is no exception. As it transitions from concept to reality, it is facing numerous obstacles, including technical hurdles, financial constraints, regulatory issues and public scepticism. We conducted an expert panel survey involving personalities associated with communicating this new mode of transportation, confirming a significant challenge in the diffusion of hyperloop.

In this context, a good communication strategy is essential in order to ensure that the communicator's messages reach their intended audiences in the best possible way.

By analyzing the emotions and the frequency of the words present in arguments in favour of and against hyperloop from different sources - news outlets and YouTube videos - we aim to understand the discourse surrounding hyperloop in order to uncover the most effective communication strategies for presenting this technology to different audiences.

Effective communication can help bridge the gap between innovation and public acceptance, addressing fears and uncertainties while highlighting hyperloop's transformative and revolutionary potential.

Ultimately, our motivation lies in contributing to the successful advancement and adoption of the hyperloop technology. By fostering informed dialogue and facilitating a better, deeper understanding of the issues at play, we hope to pave the way for hyperloop's integration into our lives, ensuring that it meets societal needs and expectations while overcoming the inherent challenges that groundbreaking innovation brings.

3.2 Related Work

A review of prior research and existing literature was conducted to better understand the discourse surrounding hyperloop and the public's perception of it.

In 1962, Everett M. Rogers published his book Diffusion of Innovations, which introduced a comprehensive theory on how, why and at what rate new ideas and technology spread through cultures. Over the years, Rogers has expanded the book, although the foundational concepts of his theory have remained unchanged and still hold true to this day.

The Diffusion of Innovation (DOI) Theory explains how, over time, an innovative idea or a product is communicated through different channels among the members of a social system. The adoption of an innovation is a process in which certain people are more willing to adopt the idea than others. Therefore, when promoting an innovation to a target population, understanding the audience's characteristics and attitude is crucial in order to develop an optimal communication strategy.

The DOI Theory also defines different stages by which a person adopts an innovation - awareness, decision to adopt the innovation, initial use and continued use - and the five main factors that influence said process.

The aforementioned factors can be applied to the context of hyperloop to better understand the elements that may influence the public perception of and willingness to accept the technology:

- **Relative advantage**: this refers to the degree to which an innovation is perceived as better than what it supersedes. It is therefore important to highlight how hyperloop has the potential to improve and revolutionise the way we travel.
- **Compatibility**: this refers to how consistent the innovation is with the values, experiences and needs of its potential adopters, which emphasizes the need to correctly understand what the target audience feels and perceives.
- **Complexity**: the more difficult to use and understand an innovation is, the more difficult it will be for the public to adopt it. Therefore, it is crucial to ensure that hyperloop is communicated in a simple and easy-to-comprehend way.
- **Trialability**: the extent to which the innovation can be experimented with. This indicates the importance to find ways to allow the public to experience the hyperloop technology as firsthand as possible.
- **Observability**: it refers to the extent to which the results of the innovation can be seen by others. In the context of hyperloop, this could be addressed by successful case studies and demonstrations.

Over the years, different studies have examined the public perception of transportation technologies and the effectiveness of various communication strategies. For example, Hilgarter and Granig (2020) [3] studied the public perception of autonomous vehicles, and Sochor and Nikitas (2016) [5] studied vulnerable user's perceptions of transport technologies.

Moreover, in recent years the development of Artificial Intelligence (AI) has significantly enhanced our ability to understand and analyse these issues. AI-based tools allow for the gathering

and analysis of large volumes of data, thus providing deeper insights into public perceptions and attitudes and helping identify emerging trends and concerns. These AI-driven insights are crucial for developing targeted and effective communication strategies that resonate with a given audience.

In summary, the combination of traditional diffusion theories and modern AI tools provides a framework for understanding and shaping public perception. The integration of these two approaches will be the foundation on which our research will be conducted, ensuring that our recommendations are based on a comprehensive and trustworthy analysis and ultimately aiding communicators in effectively promoting hyperloop technology.

3.3 Research Objectives

In this Section, the objectives of the conducted research are presented.

The primary aim of the research is to provide clear guidelines on the essential topics that communicators should address in order to maximize their success. To achieve this, the key themes and topics that dominate the discourse on hyperloop across different platforms will be discussed through different analyses.

The emotional and rhetorical strategies used in different arguments will be examined to understand how they influence public perception. Furthermore, the disparities in communication styles between the analyzed sources - YouTube videos and news outlets - will be identified to assess the impact of different audience and platform characteristics on the reception of the content.

The information mentioned previously will be analyzed and synthesized to contribute valuable insights into the ongoing conversation about hyperloop, thus contributing to the successful development of the technology.

Chapter 4

Methodology

4.1 Overview

This section aims to delve into the methodology followed during the research, from the data extraction to the drawn conclusions. The research is based on artificial intelligence and statistical techniques, mainly developed using Python programming language, to ensure the reliability of the results obtained.

The first step consisted of extracting a representative sample of hyperloop-related news and social media appearances. The data extraction program browsed across the internet storing every hyperloop-related piece of news, changing the search location to build a varied and representative sample.

Having a substantial sample is crucial to ensure the significance of the results obtained, as it allows for the development of useful statistical inference based on reliable information.

The following stage of the process was to employ an artificial intelligence model capable of detecting argumentation within each document in the collection. With the aim to ensure the best model for this objective is used, a comparison between custom and state-of-the-art models has been performed.

After every hyperloop-related argument was extracted from the document collection, extra features were added to the database to draw relevant conclusions to guide the public discourse of hyperloop companies and institutions. Said features include word frequencies, emotions expressed by the arguments, names of entities, and argument groups.

Once every feature was properly extracted from textual data, a deep analysis of the arguments and the relation between their features was carried on. The mentioned analysis led to generalized conclusions from which the team of Hyperloop UPV has deduced a set of guidelines to follow as a hyperloop company or institution while promoting the transport of the future.

4.2 Data Extraction

4.2.1 Considered & Selected Sources

For the data extraction, various social media platforms have been mined to obtain different textual information spread regarding hyperloop technology. Said data is crucial for understanding the public discourse around the transport of the future and for enhancing a positive image and vision of hyperloop.

The data was extracted through an automated process through the Selenium web scrapping tool and the rest of APIs, collecting comments, news articles and videos from different social media platforms.

The social media platforms visited were:

- **Google News and Bing News**: extracting every search result from the locations of United Kingdom, Switzerland, the Netherlands, United States, and Spain. The extracted news were then evaluated to select the final sample utilized, including pieces of news both in English and Spanish.
- **Reddit**: from this platform, hyperloop-related user posts and answers were stored. In this case, mainly English videos were obtained, also accomplishing to store an insignificant amount of Spanish videos which were discarded.
- **YouTube**: on this platform, the team collected several videos referencing the topic. In contrast to the previous group of data, only English posts were obtained.

Additionally, other social media platforms related to hyperloop technology were initially selected as information sources. Nevertheless, not enough results were stored from the following platforms:

- **Instagram**: hyperloop is scarcely mentioned in comments, which was the main aspect which allowed for topic search. Therefore, it was discarded due to lack of data.
- **X**: the application X –formerly known as Twitter– did not provide an ethical mean to obtain data, and unethical methods were immediately discarded.
- **TikTok**: contrary to the previously mentioned ones, 120 English videos related to hyperloop technology were found. These videos were analyzed, but the lack of argumentation in their transcriptions led to the refusal of this data source.

4.2.2 Description of the Data Extracted

At this point, we will describe the number of documents and tokens –think about a token as a word or relevant symbol– obtained from the analyzed social media platforms.

- **Google News and Bing News**: the largest source of information, with a total of 295 news articles analyzed in English and 319 in Spanish, amounting to 32,836 and 199,063 tokens respectively.

- **Reddit**: provided a substantial amount of data, with 8,914 posts in English totalling 425,299 tokens, and 4 posts in Spanish which were initially considered but eventually discarded due to lack of substantive content.
- **YouTube**: this platform also offered a considerable amount of interesting data, exclusively in English. YouTube provided 165 videos, with a total of 188,058 tokens.

Additionally, TikTok provided 120 videos with 15,739 tokens.

The extraction and analysis of data from various social media platforms allow to obtain general results, avoiding bias in the research. Although platforms like Google News, Bing News, Reddit, and YouTube provided useful and extensive data, other social media platforms like Instagram and X did not yield relevant results. On TikTok, despite the availability of content, the lack of coherence in the results hinders its usefulness.

These findings underscore the importance of focusing the analysis on sources with robust and coherent data to improve the image and perception of hyperloop among the public.

All the extracted data enables a comprehensive analysis of the argumentation within the expansive world of hyperloop in terms of social communication.

4.3 Argument Extraction

4.3.1 Argument & Stance Detection

The process of argument extraction consists of storing all the arguments from the sources selected to analyse them later. The extraction of arguments from document collections is a complex task which is divided into argument detection and stance detection.

The task of argument detection refers to classifying a sentence to detect whether it is an argument or not. The Cambridge Dictionary defines the word "argument" as "a reason or reasons why you support or oppose an idea or suggestion, or the process of explaining these reasons" [1]. As the definition states, an argument can support or oppose an idea, and that is when the stance is brought to the table. The second task, the stance detection, consists of detecting whether the argument is in favour or against a certain topic.

Having both tasks in mind, the objective of this step of the methodology is to create, train, and test a model able to detect both the existence or absence of argumentation in a sentence and the stance in case it really is an argument. The aim of this section is to describe the process followed to accomplish said model and the results obtained.

4.3.2 Database Description

The reliability of a classification model deeply relies on the dataset utilised during the training and testing process. Therefore, the dataset from Cross-topic Argument Mining from Heterogeneous Sources [6] was selected for this process, an argument labeled dataset from investigators such as Iryna Gurevych.

The dataset (Stab et al. 2018) consists of sentences extracted from a series of debates and labeled as ARGUMENTS –around 11k– that either support or oppose a topic if it includes a relevant reason for supporting or opposing a topic, or as a NON-ARGUMENT –around 14k– if it does not include reasons. The dataset focuses on controversial topics, for example, topics that include "an obvious polarity to the possible outcomes" and compile a final set of eight controversial topics: abortion, school uniforms, death penalty, marijuana legalization, nuclear energy, cloning, gun control, and minimum wage. Table 0.3.1 shows the number of arguments and non-arguments for each language depending on the topic.

Topic	Argument	Non-argument
abortion	1,482	2,405
school uniforms	1,531	1,493
death penalty	1,553	2,702
marijuana legalization	1,434	1,883
nuclear energy	1,201	1,256
cloning	1,116	1,342
gun control	1,451	2,109
minimum wage	1,264	1,712

Table 0.3.1: Argument and non-arguments depending on the topic

Moreover, as the purpose of the model is to serve as a multilingual classifier able to perform both in English and Spanish, the observations from the dataset have been machine-translated to Spanish with a model from the Language Technology Research Group at the University of Helsinki. Thus, the number of observations has been duplicated.

Apart from the fact of being an argument or not, each argument is classified in terms of stance. From the 11k arguments, around 6k are arguments against the topic they are referring to and 5k are in favour of it.

4.3.3 Model Creation

The first option considered was dividing the task into two models, one for each subtask –argument and stance detection–. With this aim, several models were tested, including classical models like Random Forests preceded by the embedded encoding of the sentences or Deep Learning models. From the experimentation, Deep Learning models demonstrated a clear superiority.

Nevertheless, given the capabilities demonstrated by the Deep Learning models –reaching an accuracy of 0.82 and an F1-score of 0.81 [2]–, both subtasks were combined in a single model. The first layers of the neural network consist of the encoder layers of a Transformer model based on RoBERTa. Transformers are the current state-of-the-art in Deep Learning for Natural Language Processing, and RoBERTa [4] is one of the most relevant models with this architecture, right after the Large Language Models.

These layers are followed by two convolutional layers to extract features from the matrix of word embeddings. A word embedding is vector encoding a word given the signification of the word itself and the relation with the sentence in which it appears. Convolutional Neural Networks are usually applied to image processing in tasks like classification or segmentation. However, as the word embeddings from the first layers are a 2D matrix with shape n_words x n_dimensions, they can be treated as images. Each convolutional layer is followed by a MaxPooling layer to reduce the dimension of the data.

Finally, a top model consisting of a Flatten layer and a Feed-Forward layer with ReLU as the activation function is used. The flatten layer transforms the matrix into a 1D array, which is then processed through the fully-connected layer for the final classification. The output of the neural network consists of three neurons with a softmax activation function, representing the probability of being an argument in favour of the topic, an argument against the topic, or neither of them. The formula of the softmax function is shown hereunder.

$$s\left(x_i\right) = \frac{e^{x_i}}{\sum_{j=1}^{n} e^{x_j}}$$

Figure 0.3.1: Softmax function

Figure 0.3.2 depicts the structure of the model.

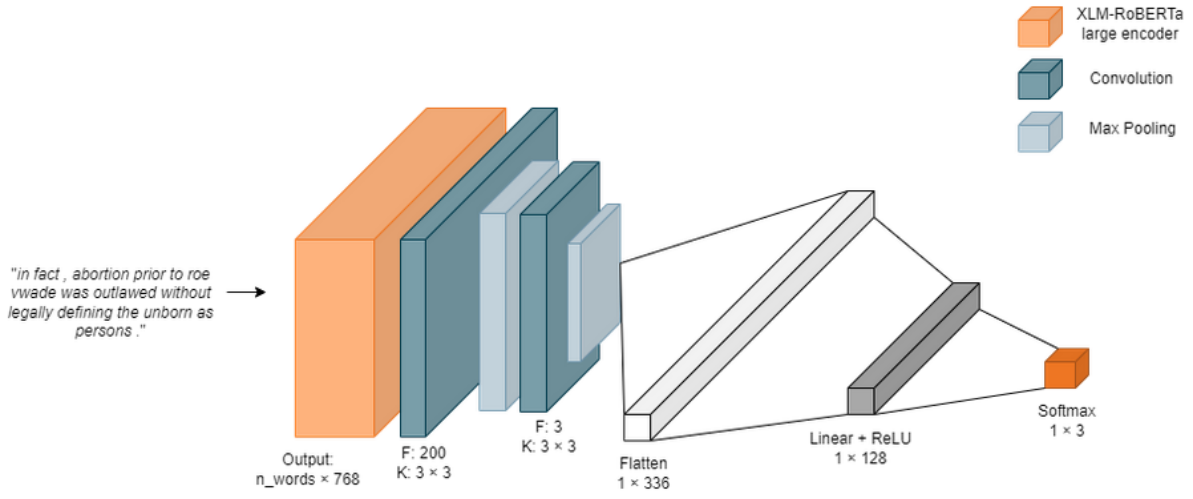


Figure 0.3.2: Structure of the model

The optimizer selected was Adam, with a learning rate of 1e-5.

4.3.4 Results

Once the model was trained, it needed to be tested on an unseen proportion of the dataset to validate its proper functioning. To maximise the robustness of the model, the validation consisted of a five-fold cross-validation from which the evaluation metrics of precision, recall, accuracy, and F1-Score were extracted.

The evaluation technique of five-fold cross-validation consists of shuffling the dataset and then dividing it into five different groups of observations. After that, once for each fold the model is evaluated on the selected fold after being trained on the rest of them. This technique allows to ensure no subgroups are biasing the process, being able to then train the model on the complete set of observations. Figure 0.3.3 illustrate the functioning of five-fold cross-validation.

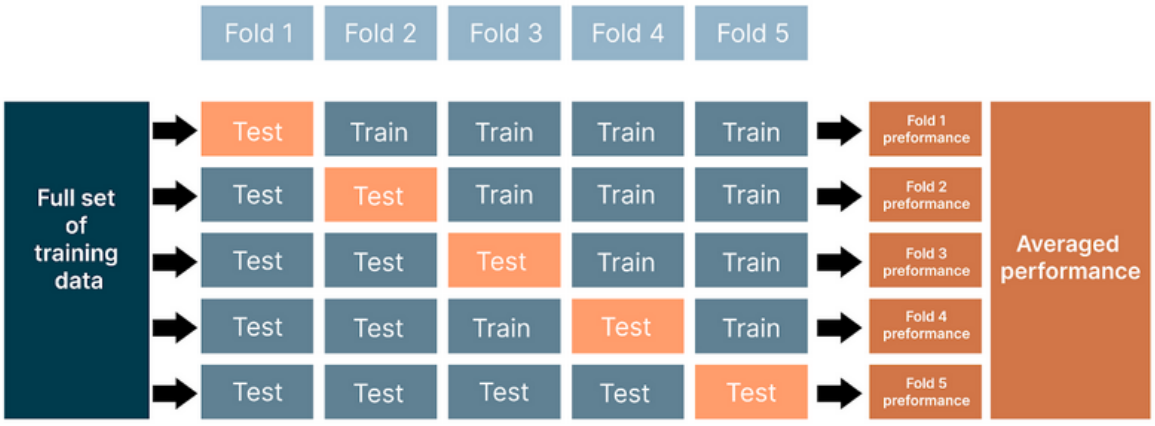


Figure 0.3.3: Cross-validation

The resulted performance metrics are shown in Table 0.3.2.

Model	Acc	F1	Rnon	R+	R-	Pnon	P+	P-
XLMRoBERTArgumentMulti	0.71	0.71	0.73	0.69	0.79	0.81	0.68	0.65

Table 0.3.2: Performance metrics

Note that the number of possible ground truths has been increased to three –argument in favour, argument against, and not an argument– and that the process of evaluation is a five-fold cross-validation, thus being 0.71 a truly satisfactory result for a multilingual model.

4.3.5 Model Comparison & Selection

With the aim to double-check the reliability of the model and to select the best possible argument extractor, three different models were compared in the task of extracting arguments about hyperloop; GPT 3.5 Turbo, GPT 4, and the model of Hyperloop UPV.

The process of comparison of the model consisted of a human evaluation of the performance of the models for a sample of the document collection. The group of people in charge of judging the performance of the three models was composed by an NLP Professsor, a Sociology Professor, and a group of members from Hyperloop UPV.

For the news example of Appendix A, **GPT 3.5 Turbo** finds the following arguments:

" *The idea was conceived by Elon Musk, the owner of Tesla, but it failed.*

The T-Flight project by China Aerospace Science and Industry Corporation (CASIC) is promising.

The Hyperloop has already completed three successful tests.

During the tests, the important components operated correctly.

Hyperloops work by combining certain advanced technologies.

The Hyperloop is a faster and safer means of transportation.

The Hyperloop uses electrical energy and has a low environmental impact.

There are no arguments against/in favor of Hyperloop mentioned in the given text."

GPT 4 returns the following response:

"*Arguments in favor of Hyperloop:*

The system is intended to cover large distances at a speed of up to 1,000 km/h, implying the advantage of high-speed travel.

During the tests in China, the most important components operated correctly and as planned, including the superconductor magnet, electrical systems, artificial intelligence safety controls, sensors, and wireless communication devices, which demonstrate the functional viability of the concept.

Hyperloop operates through the combination of advanced technologies such as magnetic levitation, low-resistance tubes, and air propulsion, which shows the modern technical basis of the concept.

It offers a faster and safer mode of transportation, improving on existing travel comfort and security.

Hyperloop uses electric energy, making it environmentally friendly with a low environmental impact.

Arguments against Hyperloop:

The Hyperloop concept initially failed under the leadership of Elon Musk and Tesla.

There have been hurdles in accomplishing the project, with Elon Musk's SpaceX prototype ending destroyed, indicating possible risks and practical challenges in developing the technology."

While **the model of Hyperloop UPV** outputs the following arguments:

Arguments in favour:

"Ahora en China crearon este sistema de transporte de alta velocidad que ya completó sus primeros test de viabilidad en el país asiatico, cuyo objetivo es cubrir grandes distancias a nada menos que 1.000 km/h."

"Además, reportaron que durante las pruebas los componentes más importantes operaron de manera correcta y según lo previsto tales como el imán del superconductor, los sistemas eléctricos, controles de seguridad de inteligencia artificial, sensores y dispositivos de comunicación inalámbrica."

"Pues bien, es un medio de transporte mucho más rápido y seguro."

"Otro factor importante es que utiliza energía eléctrica para funcionar por lo que tiene un bajo impacto ambiental."

Arguments against:

"Sin dudas, es un proyecto prometedor, que por diversos motivos no se ha logrado llevar a cabo y ejemplo de ello es el Space X de Elon Musk, cuya prueba terminó destruída."

In the case of YouTube, the text was first punctuated as the YouTube transcription consists of flat text. Regarding the YouTube example of Appendix B, **GPT 3.5 Turbo** found the following arguments:

"*Arguments in favour of Hyperloop:*

- "the hyperloop is the world's most epic transportation system"

- "revolutionize Transit"

- "a whole plethora of companies were competing to change Transportation forever"

- "proof of concept model"

- "fast and convenient Transit link"

- "building a hyperloop"

- "Construction start for commercial system"

Arguments against Hyperloop:

- "hyperloop companies have basically nothing to show for"

- "incredibly stupid and impractical idea"

- "technical issues which make this whole project impossible"

- "all the technical impossibilities any practicalities aside"

- "the whole hyperloop project was pure from the start a cynical scheme"

- "this scam has managed to Kickstart a decade-long effort"

- "the hyperloop concept has lost whatever little viability it had left"

- "this project dead""

GPT 4, in contrast, detected the following arguments:

"*Arguments in favour of Hyperloop:*

1. It could be the world's fastest transportation system, with a maximum speed of 1200 kilometers per hour.

2. It attracted attention and work from numerous talented individuals and companies, indicating potential promise.

3. The project provides educational and practical experience for students involved in development.

4. Hyperloop can potentially reduce road traffic congestion.

5. The Hyperloop project has attracted financial investment and professional expertise.

Arguments against Hyperloop:

1. The complexity of maintaining an enormous vacuum chamber, along with dealing with heat expansion, tectonic activity, and extreme weather.

2. The project requires a straight line of land between cities, which is difficult due to geographical and infrastructural obstacles (villages, cities, lakes, rivers, national parks, etc.).

3. Many Hyperloop companies have failed or produced little to show for their efforts after several years.

4. Potential risks like terrorist attacks, which could result in a vacuum failure and catastrophic consequences.

5. The original idea for Hyperloop was posited as a way to undermine a proposed high-speed rail system, not necessarily as a viable project on its own.

6. The Hyperloop project may not be able to meet the projected cost, speed, and passenger loads.

7. The Hyperloop has been heavily criticized as a hastily thought up, impractical concept. The initial excitement and anticipation have resulted in an array of problems, ultimately making it unrealistic and unfeasible."

Finally, **the model of Hyperloop UPV** found the following arguments:

Arguments in favour of hyperloop:

"Plus, the whole "worked on the Hyperloop" bullet point will look good on their CVs to the recruiters who havent watched my videos."

"While other companies were just a loose collection of consultants and idea guys barreling towards bankruptcy, Hyperloop 1 means business"

Arguments against hyperloop:

"And so, these magnetic courselets were dreamed up, which were supposed to fix congestion because, as we all know, adding more capacity to roads definitely won't motivate more people to get in their cars, thereby making congestion worse."

"Sir, blink once if you're being held against your will."

"Left them out on the streets and then tried to house them in a detention facility."

"Because after a container spends four weeks on a cargo ship, it cannot sit on a train for three more days."

"Meanwhile, these morons couldn't accomplish more than a carbon fiber sewer pipe after a decade."

"Following that, Virgin perhaps realized that this is an extremely dangerous, impractical, and stupid idea."

By analysing the outputs of the models for a series of randomly selected texts, the judges drew the following conclusions:

- GPT 3.5 Turbo acts repetitive and finds excessive arguments that are not real arguments.
- GPT 4 is more concise with the found argumentations but finds even more examples, also including sentences or statements that are not real arguments.
- The model from Hyperloop UPV is the only model maintaining the literality of the text, which is a critical aspects to detect textual structures and vocabulary commonly use on the arguments.

All things considered, the model from Hyperloop UPV was selected as the best option to extract arguments from the texts for their posterior analysis.

4.3.6 Final Database Description

The selected model was used to extract the arguments from the document collection. Each text was parsed with a sentence tokenizer to analyse each sentence with the classifier, storing the arguments with their stance and discarding the non-arguments.

After processing the collection, a complete database of arguments in favour and against hyperloop was formed. The database contains 5335 arguments in total. From them, 3591 arguments pertain to pieces of news, being 2584 in favour of hyperloop and 1007 against it, while 1744 arguments appeared in YouTube, being 1106 in favour and 638 against it.

While every argument from YouTube is in English, the arguments extracted from the news include 1660 arguments in English and 1928 in Spanish.

4.4 Argument Analysis

4.4.1 Emotions Analysis

Emotions are what give colour to the blank canvas that is the human experience; adding depth and texture to our interactions, choices and beliefs. Therefore, for a message to better reach an audience, it is essential to understand their feelings since they will shape the way in which the information is perceived.

Thus, an analysis was conducted to discern the predominant emotions in the arguments in favour of or against hyperloop, differentiating between arguments extracted from news outlets and those extracted from YouTube.

From the division between "against" and "in favour" we can obtain the average proportion of each type of emotion expressed, to know whether they have a similar frequency of appearance in the news in general. As an overall analysis, the first aspect that stands out is that neutrality is the clearly predominant emotion in both cases and with a similar proportion. This can be explained by the fact that arguments from news outlets are being analysed, a written genre characterised by this neutrality.

The averaged proportion of the expression of the most appeared emotions is shown in Table 0.4.1, divided by the stance of the arguments. Generally speaking, positive emotions such as approval or optimism are found on a higher frequency in news classified as "in favour" whereas negative emotions such as disapproval, disappointment or sadness are more common in news that are against the technology.

Stance	Neutral	Approval	Realization	Disapproval	Optimism	Disappointment	Other
Against	0.499	0.077	0.082	0.15	0.009	0.046	0.137
Infavour	0.488	0.294	0.044	0.017	0.032	0.001	0.124

Table 0.4.1: Main emotions' frequency in news

Nevertheless, as can be seen in the magnitude of each emotion, absolute differences are not enough to draw conclusions. Therefore, the existence of a significant difference between the average values of each emotion depending on the stance of the argument must be proven through more sophisticated statistical methods. ANOVA (ANalysis Of VAriance) –a statistical procedure used to measure the significance of the differences between continuous and qualitative variables– was the first contemplated option to continue the study.

A quantile plot of the values of the emotion "fear" has been plotted in Figure 0.4.1 as an example of the general results of the pre-analysis carried out through all the emotions individually.

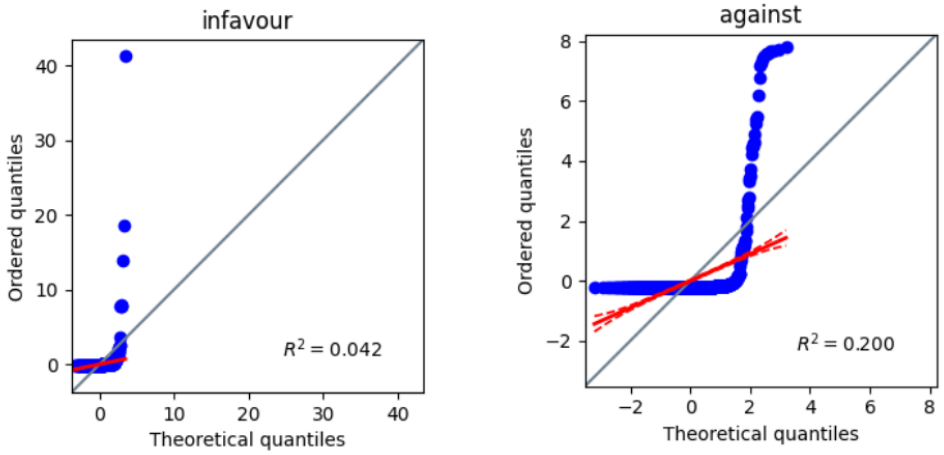


Figure 0.4.1: Normality test for the emotion "fear"

In the previous graph, the dotted blue line represents the values that the variable takes over the "theoretical quantiles" which are that of a Normal distribution. The values need to be forming an oblique line in the main diagonal of the graph for it to be considered Normally distributed. Therefore, the samples do not follow a Normal distribution so an ANOVA procedure would not fulfil its purpose as previously stated.

As a result, a Kolmorov-Smirnov analysis was the substitute method to determine if the distributions, while not Normally distributed, are at least the same between themselves. Kolmogorov-Smirnov is a non-parametric analysis to detect significant differences between the distribution of the values of each emotion depending on the stance.

This image 0.4.2 shows the distribution of the variable "neutral_normalized" by stance "in favour" and "against" using two types of plots: a Violin Plot (top) and a Density Plot (bottom).

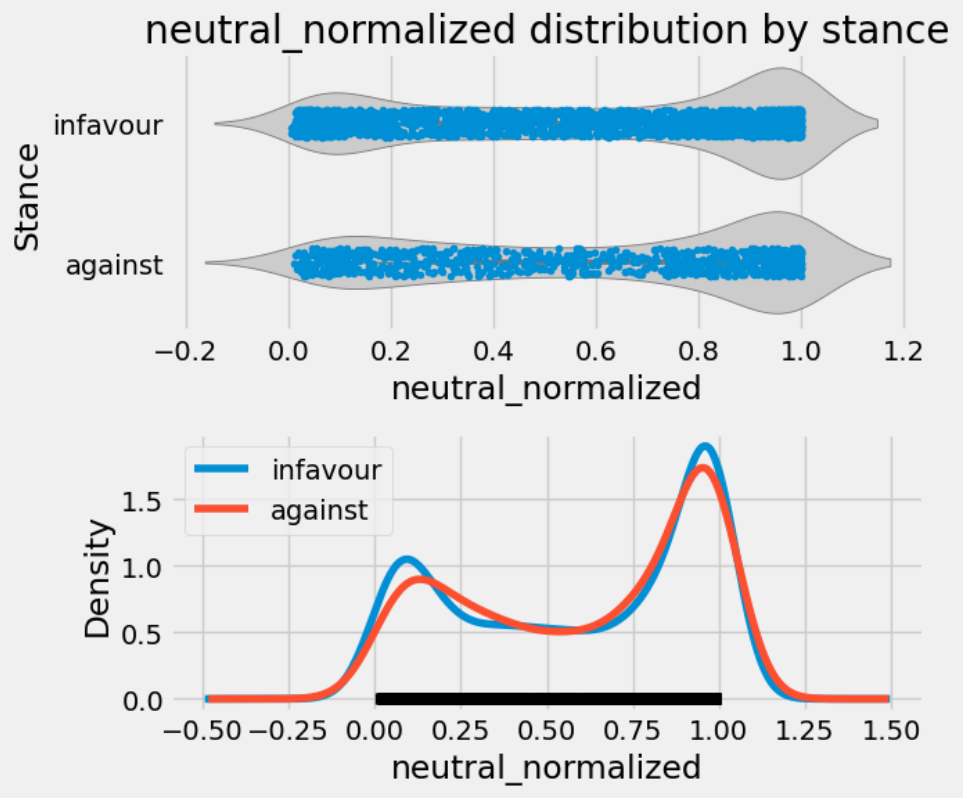


Figure 0.4.2: Violin and Density Plot of the emotion "neutral"

The width of each violin at different points along the axis represents the density of arguments containing that value of the emotion. The wider the graph, the higher the frequency of data points in that value and vice-versa. Both positions –in favour and against– have similar shapes, indicating that their distributions are somewhat similar.

Regarding the Density Plot, it represents the distribution of the "neutral_normalized" variable for both instances "in favour" (in blue) and "against" (in red). Both stances show a Bimodal distribution with two distinct peaks in value 0 and value 1. The value of 0 represents the absence of the

emotion while the value of 1 means the total predominance of it in the argument. The Y-axis shows the proportion of arguments with the value shown in the X-axis.

The fact that the peak in the values around 0 shows a higher density for the "in favour" stance indicates that the value is more commonly seen for such individuals with that specific stance. In other words, it is more common to find "in favour" arguments with null expression of the emotion. Similarly, the graph also shows a peak around value 1 where both densities are similar but the "in favour" stance is slightly higher too, meaning that there is more proportion of of "in favour" arguments with the maximum expression of the emotion. In other words, in the case of neutral, "against" arguments are more centred, with more similar values of neutrality, whereas "in favour" arguments are more polarized..

Aiming to extract visual information, a Principal Components Analysis (PCA) was developed, which is a statistical technique used to reduce the dimensionality of the data while preserving as much variability or information as possible. PCA reduces the number of variables in a dataset by transforming them into a smaller set of uncorrelated variables called principal components. This enables the visualisation of high-dimensional data in 2D or 3D plots, making it easier to identify patterns, clusters, and outliers.

The plot visualises data points in the space defined by the second principal component (PC2) on the X-axis and the third principal component (PC3) on the Y-axis. The vectors labelled with different emotions indicate the direction and magnitude of the contribution of these emotions to the principal components. The length of each vector represents the strength of the correlation between the principal component and the corresponding emotion.

The angles between vectors also provide useful information. Small angles suggest a positive correlation between the variables, whereas bigger ones suggest the opposite. Angles close to 90 degrees suggest uncorrelation.

Figure 0.4.3 shows the biplot of the six emotions present in arguments extracted from news outlets which presented a lower p-value in the Kolmogorov-Smirnov test –the ones with the most significant difference in the distribution between "in favour" and "against" arguments–:

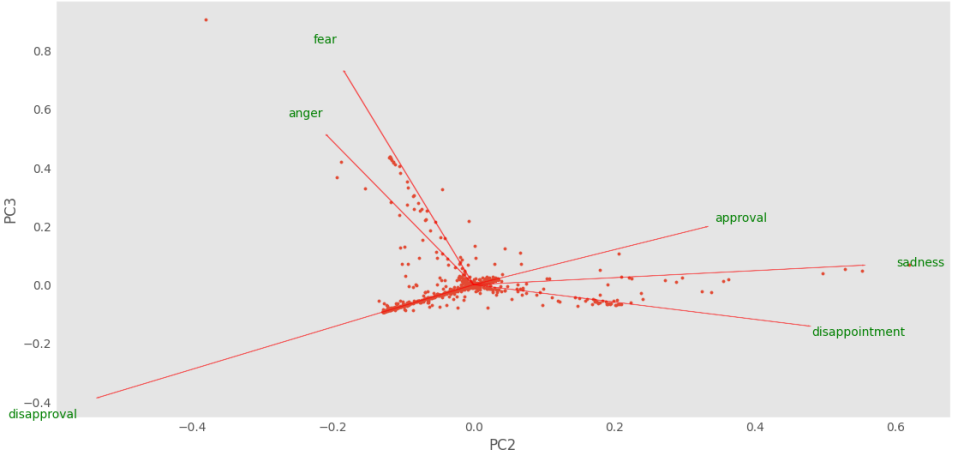


Figure 0.4.3: PCA analysis of emotions in news' arguments

Some conclusions can be drawn from the graph:

All vectors are considerably long. Therefore, valuable information is provided by all the represented variables. The angle between approval and disapproval is close to 180 degrees, indicating a strong negative correlation between them. Fear and anger are close together, suggesting a positive correlation between them. Disappointment and sadness also seem to be positively correlated, but, interestingly, approval seems to be correlated with them as well. This could be an indicator of arguments with nuanced or conditional support.

As was done with arguments extracted from news outlets, a Kolmogorov-Smirnov analysis was conducted for YouTube arguments. The results showed that the six emotions with the lower p-values are disappointment, sadness, approval, disapproval, anger and annoyance. Whereas approval is more present in arguments in favour of hyperloop, the rest of the emotions are characteristic of arguments against it.

In addition to the emotions mentioned above, others such as desire, optimism, remorse, fear and embarrassment showed a low p-value score as well. A PCA of said emotions was conducted. Its results can be seen in Figure 0.4.4:

Figure 0.4.4: PCA analysis of emotions in YouTube's arguments

The following information can be drawn from the analysis:

- Fear, embarrassment and disapproval are positively correlated, and therefore they often go together. The same applies to anger and annoyance, as well as to remorse, sadness and disappointment.
- Approval is negatively correlated to all the other emotions except for desire, optimism and confusion, with which it has little to no correlation. However, it is worth mentioning that the negative correlation between approval and disapproval is not as strong as in arguments extracted from news outlets.
- Optimism and desire are also positively correlated, but given that their vectors are so short, not much information can be drawn from them. The same can be said about confusion

4.4.2 Group Detection

To simplify the analysis, understand key themes and facilitate the comparison of perspectives, arguments in favour and against hyperloop were clustered into six different groups each. The clustering was performed separately for arguments from news outlets and from YouTube, thus resulting in the creation of 24 different groups.

Essentially, the clustering process categorises arguments into a certain number of groups based on certain criteria, such that those within the same cluster are more similar to each other than to those in other clusters. Having too many groups would result in overfitting and difficulty interpreting the information, whereas having too few would lead to the opposite.

After trying different options, it was concluded that six groups brought the best results. Figure 0.4.5 shows a Silhouette plot of the various clusters:

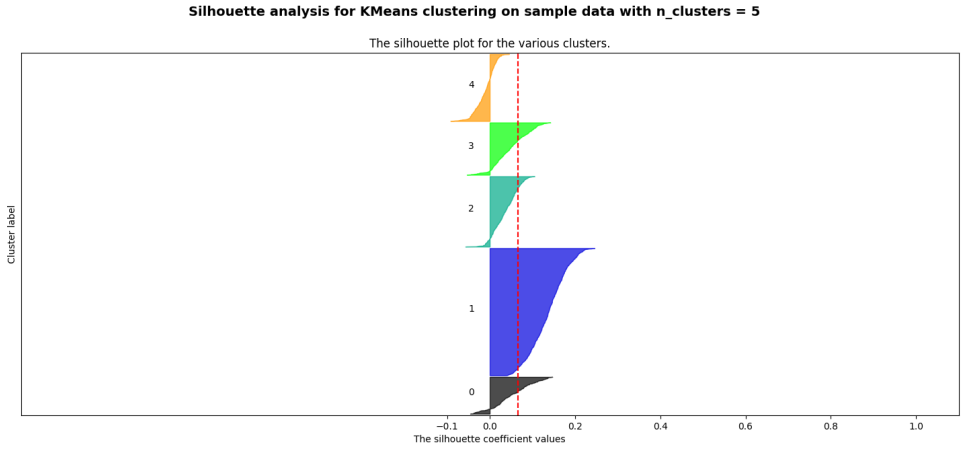


Figure 0.4.5: Clustering plot

The red dashed line indicates the mean, and the coloured regions –the silhouettes– represent each cluster. What lies left of the value of 0 shares more of a similarity with arguments from a different cluster than its own, while what is right shows affinity.

Therefore, it can be observed that out of the six groups, five exhibit cohesion within their own cluster. Conversely, there is one cluster almost entirely on the left side, thus indicating a lack of internal coherence (Cluster number 5).

4.4.3 Word Frequency Analysis

Although the clustering process classifies arguments into groups based on similarity, the criterion used to make the division is unknown. Therefore, in order to identify the common link between arguments in each cluster, a word frequency analysis was carried out.

The analysis was performed on each cluster, as well as on the entirety of arguments in favour or against hyperloop, differentiating between the source of extraction –news outlets or YouTube–. The results were displayed in a word cloud format, an image that shows the words used in a text or series of texts, their size determining the frequency with which they appear.

To enhance clarity and improve the accuracy of the analysis, stop words – term which refers to words without importance for the meaning of the sentence or that do not provide useful information to differentiate between to groups, such as “or”, “my”, or “the”, and including “hyperloop” in this case– were filtered.

To begin, the word clouds of the analysis of arguments in favour and against hyperloop from news outlets are shown in Figure 0.4.6:

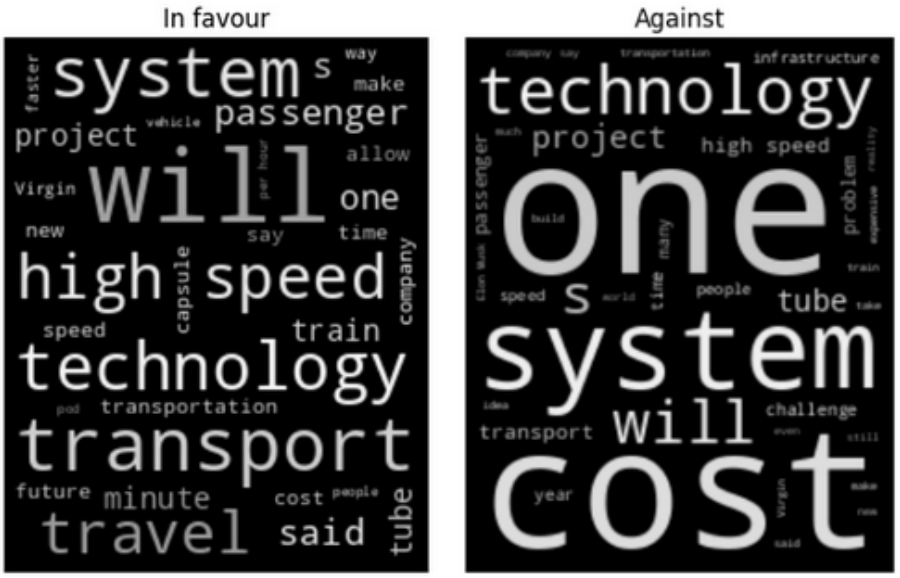


Figure 0.4.6: Word clouds of news’ arguments in favour and against hyperloop

- **In favour**: the most characteristic words are “high”, “speed”, “technology”, “transport” and “travel”, amongst many others. This seems to indicate that arguments in favour tend to focus on general, easier-to-understand aspects of the hyperloop technology, instead of using technical terms. The presence of the word “said” is interesting, since it could indicate that these arguments use other people’s testimonies as proof.
- **Against**: in this word cloud, “cost” stands out. This indicates that financial concerns are one of the primary areas of criticism. The frequency of “one”, which could be a reference to Hyperloop One, is worth mentioning as well.

Figure 0.4.7 shows the word clouds of the different clusters of arguments from news outlets in favour of hyperloop:

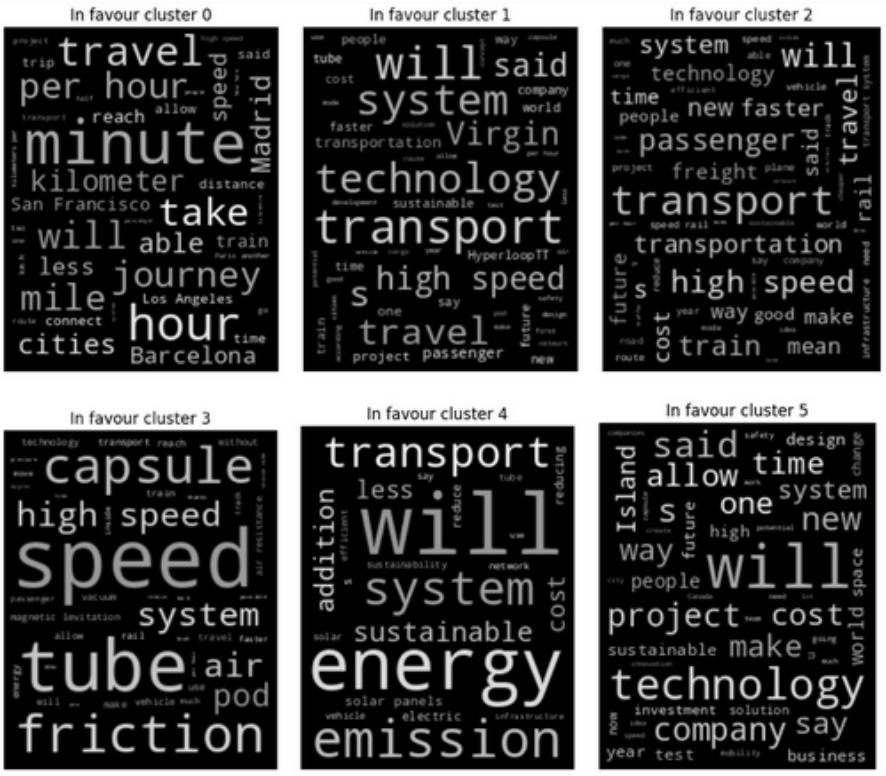


Figure 0.4.7: Word clouds of news clusters in favour of hyperloop

- **Cluster 0**: many different cities can be seen, together with words like "travel", "minute", "will", "able"... This cluster could therefore contain specific, real examples of the time it would take to travel between two cities.
- **Cluster 1**: this group seems to contain general aspects of the hyperloop technology. It is interesting to find some company names, which could indicate they have a good communication strategy that attracts the public's attention.
- **Cluster 2**: the presence of "cost" along with "transport", "train", "road" or "rail" seems to indicate that this cluster contains arguments that deem the cost of hyperloop as an advantage comparing it to other means of transport.
- **Cluster 3**: the theme of this group appears to be "speed", but in this case it seems like more technical concepts are used since words like "tube", "friction" or "air" are also present.
- **Cluster 4**: in this case, the focus seems to be hyperloop's sustainability. The presence of "addition" is also interesting, since it could indicate that these arguments focus on what hyperloop could add to our lives and our world, not only what it could change.
- **Cluster 5**: this group contains many different words that have already been mentioned and none particularly stand out, so not much information can be drawn from it.

Figure 0.4.8 shows the word clouds of the different clusters of arguments from news outlets against hyperloop:

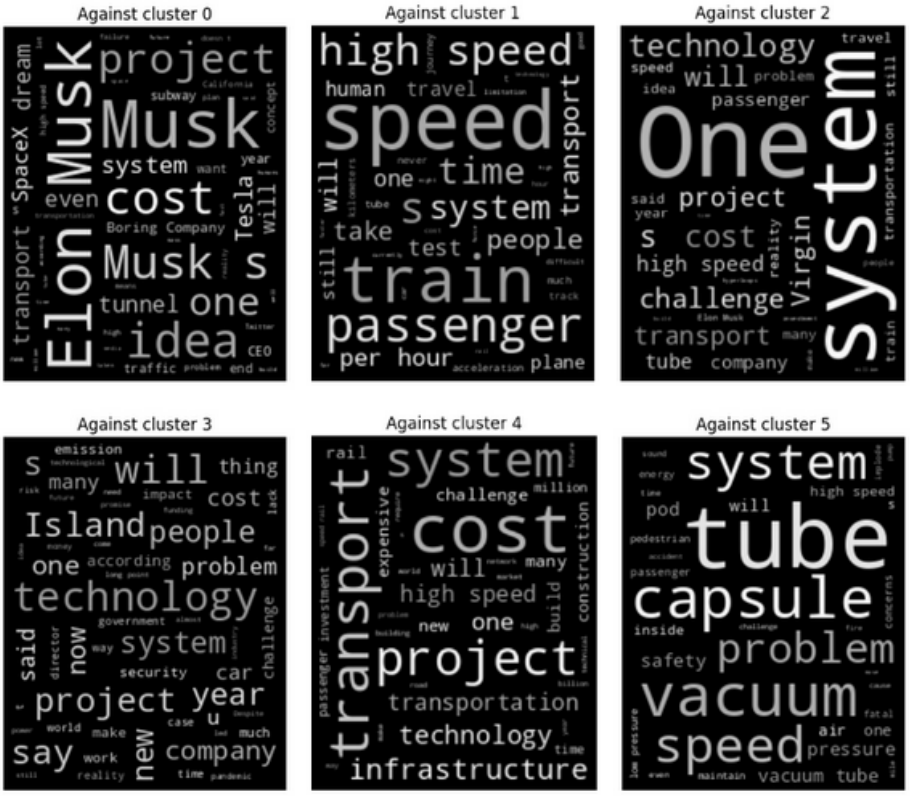


Figure 0.4.8: Word clouds of news clusters against hyperloop

- **Cluster 0**: it seems clear that the main theme in this cluster is the disapproval of Elon Musk and his ideas. Musk is a person who draws a lot of attention –in this case, negative attention–, and despite him no longer being involved in the development of the hyperloop, people still associate him with the technology.
- **Cluster 1**: this group seems to be about speed and the effects it could have on passengers' health.
- **Cluster 2**: this cluster is similar to cluster number 0, since "One" –most likely a reference to "Hyperloop One"– is one of the most frequently mentioned words. The criticism, instead of being directed to hyperloop as a technology, is directed to a company that the public associates with it.
- **Cluster 3**: many different words can be found, but none stand out particularly. Therefore, not much information can be drawn from this cluster.
- **Cluster 4**: in this group, the main concern appears to be the cost of hyperloop and its implementation, particularly focused on the construction of its infrastructure.
- **Cluster 5**: like cluster 1, this group appears to contain arguments concerned about people's health, but in this case, the preoccupation comes from the problems that could derive from the vacuum and travelling inside a tube.

The word clouds of the analysis of arguments in favour and against hyperloop extracted from YouTube are shown in Figure 0.4.9:

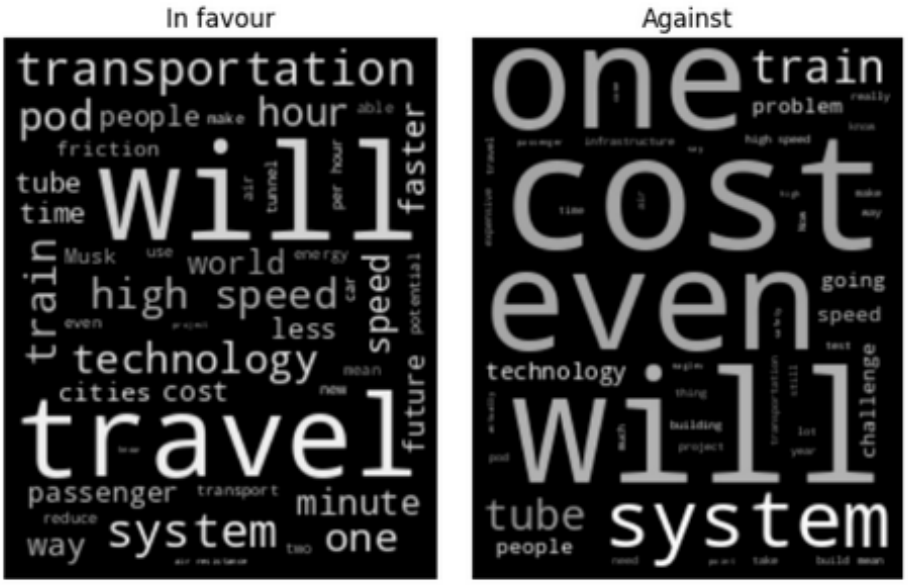


Figure 0.4.9: Word clouds of YouTube arguments in favour and against hyperloop

- **In favour**: many different words can be found, but "will", "travel" and "transportation" stand out. This could mean that arguments in favour tend to emphasize how hyperloop will impact travel/transportation by giving a broad set of reasons instead of focusing on one aspect in particular.
- **Against**: it is interesting to find "even" as one of the most frequently used words in arguments of this kind. It could indicate that critics are highlighting specific challenges or concerns since it is a word often used to introduce points that emphasize or strengthen an argument.

Figure 0.4.10 shows the word clouds of the different clusters of arguments from YouTube videos in favour of hyperloop:

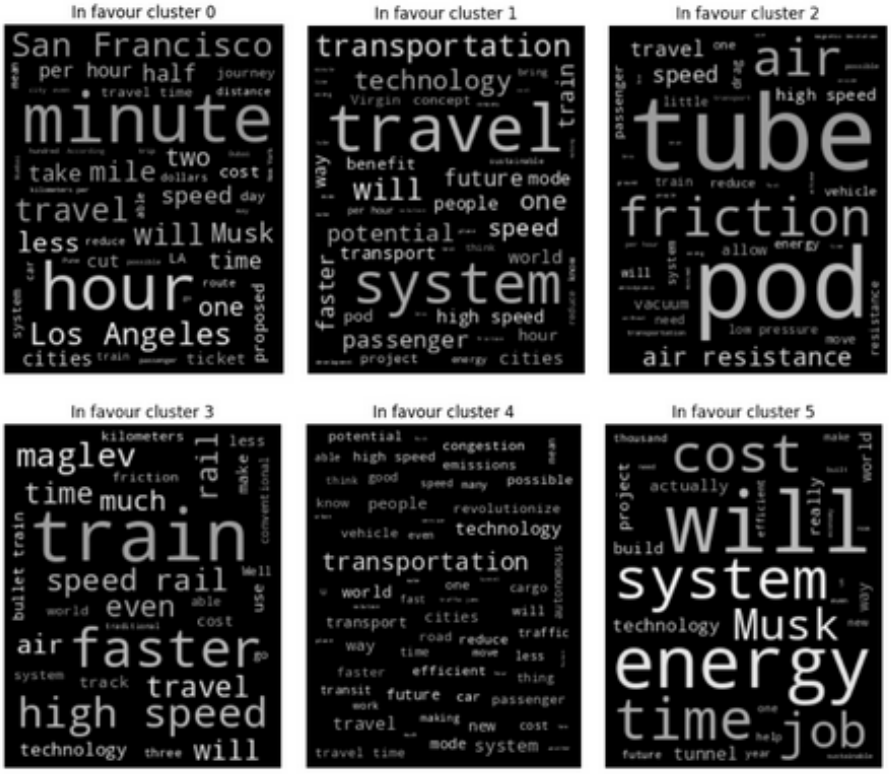


Figure 0.4.10: Word clouds of YouTube arguments in favour of hyperloop

- **Cluster 0**: this group seems to include specific examples of the time it would take to travel between two cities, given that "San Francisco", "Los Angeles", "hour· and "minute" are some of the most frequently used words. The word "Musk" also appears, which could mean that these arguments are talking about Elon Musk's initial idea of connecting those two aforementioned cities.
- **Cluster 1**: "travel" stands out the most, together with "transportation", "technology", "potential", "faster"... The common link within this group seems to be the potential that hyperloop has to revolutionize travel and transportation, but describing it in a more general way rather than using concrete examples, such as in cluster 0.
- **Cluster 2**: given the frequency of the words "friction", "tube", "air resistance" and "pod", this cluster appears to be about the technology behind hyperloop and how it allows the speed of the vehicle to be so fast.
- **Cluster 3**: the frequency of "train" and "maglev"; together with words like "even", "much" or "faster", could indicate that the arguments in this cluster are comparisons between hyperloop and other means of transport.
- **Cluster 4**: this cluster contains many different words, but none of them particularly stands out, so not much information can be drawn from it.
- **Cluster 5**: this group is quite interesting for various reasons. The word "cost", often found in negative arguments, is one of the most frequent ones in this cluster. This shows that, contrary

to what some people might think, the cost of hyperloop can actually be seen as an advantage. The presence of "energy" could indicate that this group also focuses on hyperloop's sustainability, a topic not considered in any of the previous groups. The frequency of "Musk" is also of interest, given that it is usually one of the most frequent ones in arguments against hyperloop.

Figure 0.4.11 shows the word clouds of the different clusters of arguments from YouTube videos against hyperloop:

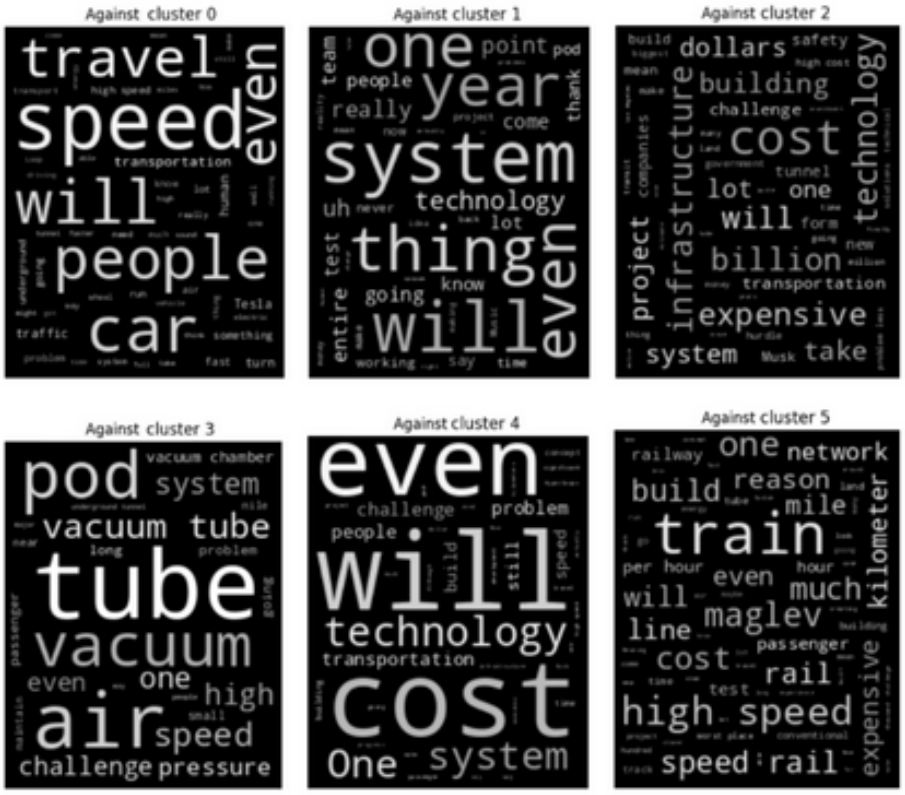


Figure 0.4.11: Word clouds of YouTube arguments against hyperloop

- **Cluster 0**: it seems like this group contains arguments concerned about the effects of speed on passengers' health. It is interesting to see the word "car" since it is not a means of transport that is usually compared to hyperloop.
- **Cluster 1**: in this cluster, the frequency of "thing" is interesting. It could mean that this group contains arguments that are phrased in less precise terms, reflecting uncertainty, scepticism or simply criticism of hyperloop as a whole.
- **Cluster 2**: this cluster appears to contain arguments about the cost of implementing the hyperloop technology, given the frequency of words like "infrastructure", "cost", "expensive", "dollar"...
- **Cluster 3**: the frequency of words such as "tube", "vacuum", "air" or "pressure", amongst others, seems to indicate that arguments in this cluster are concerned about the technological challenges that hyperloop presents.

- **Cluster 4**: the strong presence of "will" and "even" could be an indicator of arguments highlighting negative points or with a comparative emphasis.
- **Cluster 5**: this group contains many different words, but the presence of words like "maglev", "train", "rail", "kilometre" or "cost" could be an indicator of arguments comparing hyperloop to other transportation modes in a negative way.

4.4.4 Combined Analysis

Additionally, an analysis of the predominant emotions in each of the clusters was performed. The results were normalised and represented on four different graphs: news in favour, news against, YouTube in favour and YouTube against.

Figure 0.4.12 shows the emotions present in arguments in favour extracted from news outlets.

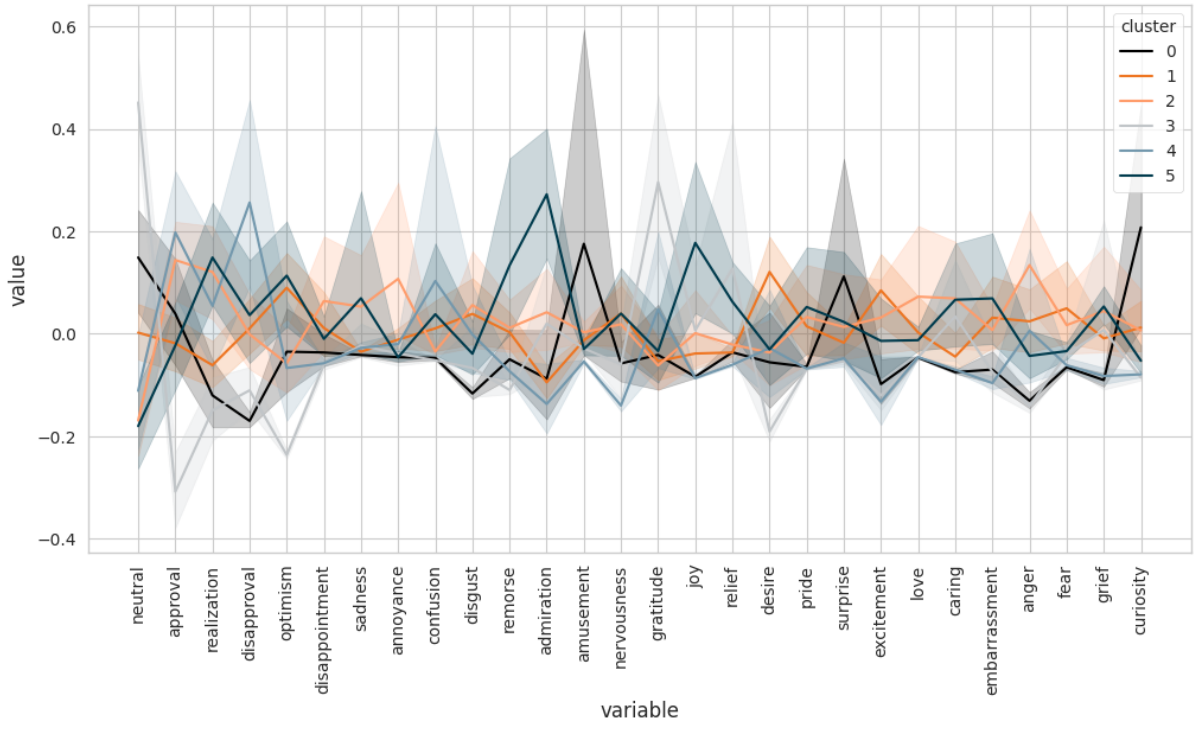


Figure 0.4.12: Predominant emotion in clusters "in favour", news outlets

The following conclusions can be drawn:

- **Cluster 1** shows high values of optimism, desire and excitement. The theme of this group is general aspects of the hyperloop technology, suggesting that hyperloop as a whole evokes interest and enthusiasm among the public and that its potential benefits are awaited.
- **Cluster 3** shows a high level of gratitude. This group focuses mainly on speed and the hyperloop technology but uses more technical terms. The presence of gratitude could be linked to speed, but it could also be a sign of technical appreciation and informed enthusiasm from an audience with a deeper understanding of the hyperloop technology.

- **Cluster 0**, which mainly contains examples of the time it would take to travel between two cities, shows curiosity and surprise. This indicates that analogies and real examples are a good way to engage the audience's imagination and get their attention.

Figure 0.4.13 shows the emotions present in arguments against hyperloop extracted from news outlets.

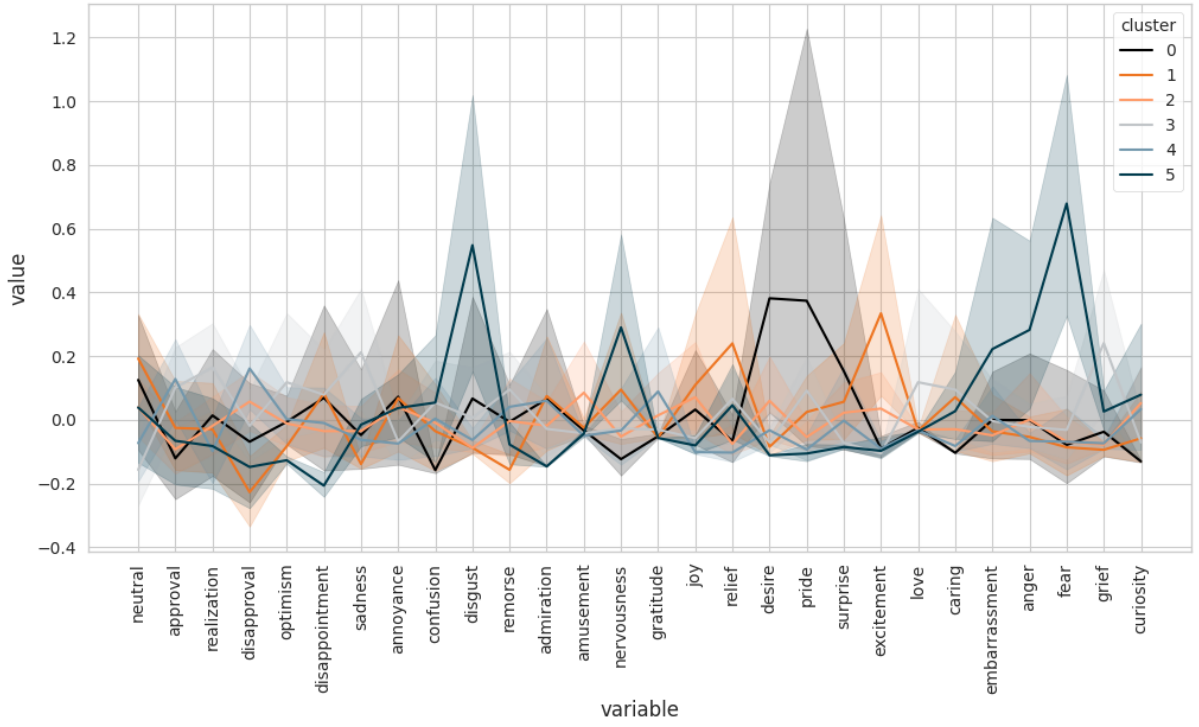


Figure 0.4.13: Predominant emotion in clusters "against", news outlets

The following conclusions can be drawn:

- **Cluster 5** shows the highest level of fear and nervousness. Said cluster contains arguments concerned about the possible implications that travelling inside a tube in a vacuum environment could have on passengers' health, so it is no surprise to find such emotions.
- It is surprising to find that **Cluster 0**, which has Elon Musk as its main theme, shows levels of desire and pride that are higher than average. This could be a reflection of the complex response associated with public figures and their projects; but it could also suggest that even if critics do not agree with Musk, they still admire the visionary approach and desire to push the boundaries of what is possible that hyperloop represents.

Figure 0.4.14 shows the emotions present in arguments in favour of hyperloop extracted from YouTube videos.

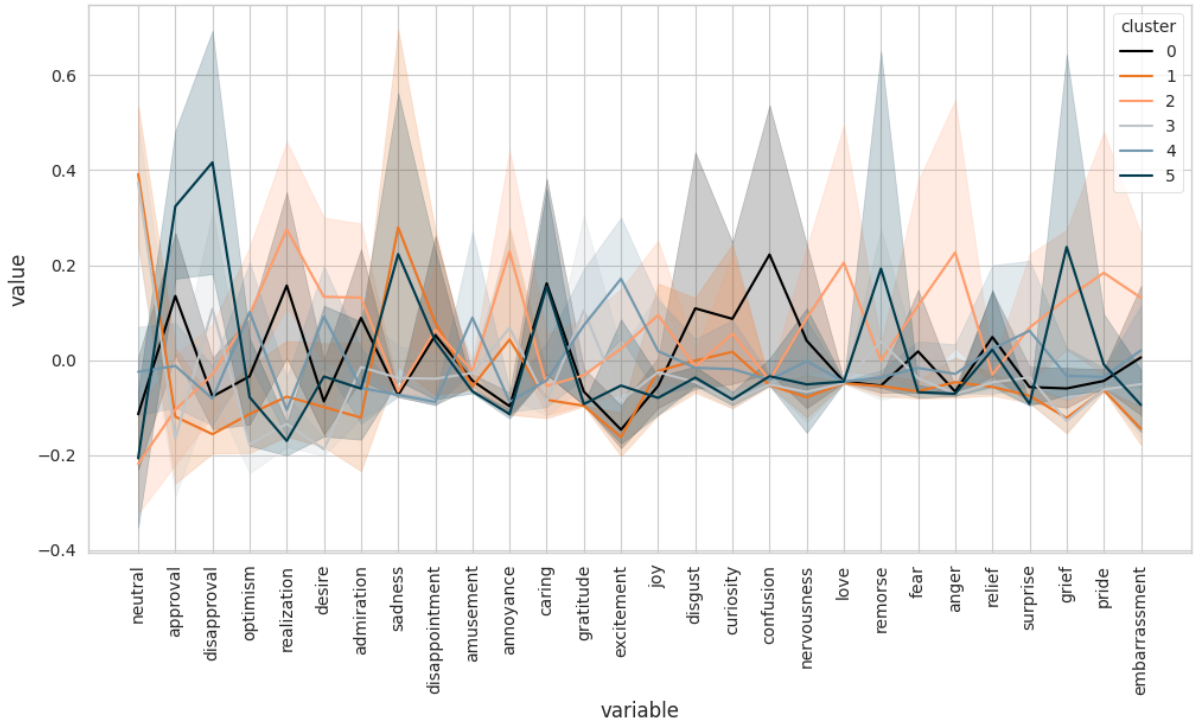


Figure 0.4.14: Predominant emotion in clusters “in favour”, YouTube

The following conclusions can be drawn:

- **Cluster 2** shows the highest value of admiration and realization. This group contains arguments that talk about different technical aspects of hyperloop. Therefore, this could be an indicator of positive perception from experts, but it also suggests respect towards innovation and technical admiration.
- **Cluster 4** shows excitement and optimism. Although this is the cluster that most likely contains all the arguments that cannot be classified into any of the other groups, it suggests that in general people feel drawn to the idea of hyperloop, and highlighting its groundbreaking aspects and potential benefits could help enhance the audience’s positive perspective.

Figure 0.4.15 shows the emotions present in arguments against hyperloop extracted from YouTube videos.

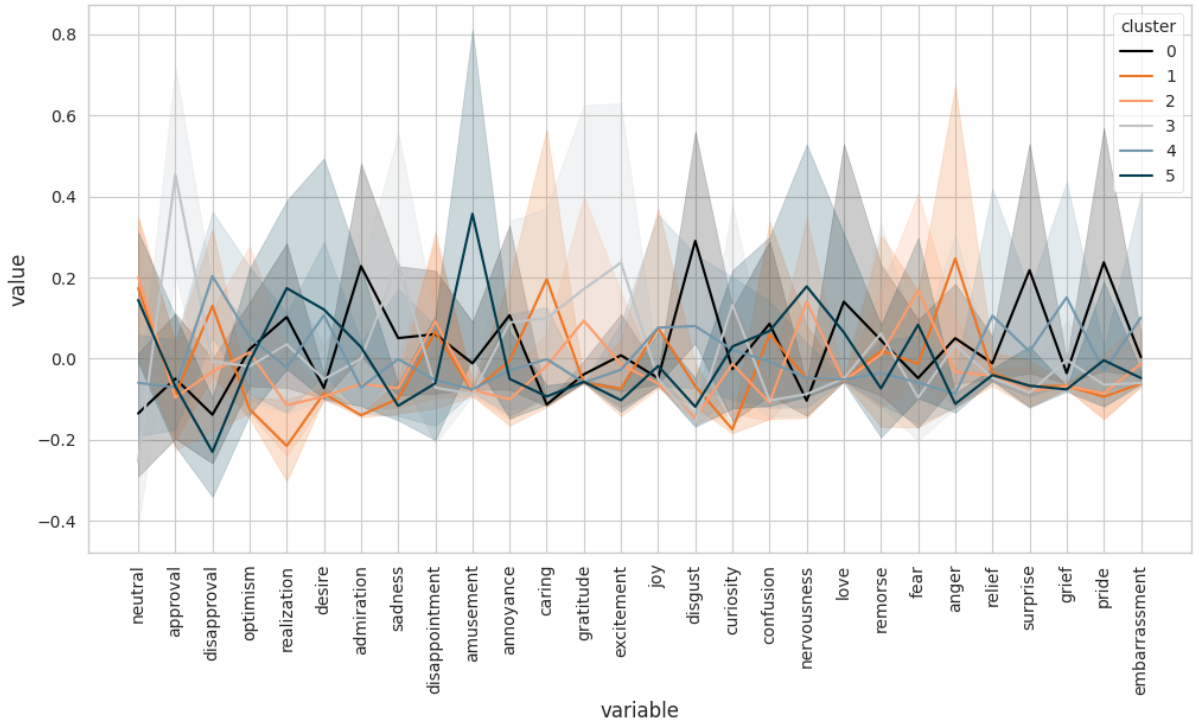


Figure 0.4.15: Predominant emotion in clusters “against”, YouTube

The following conclusions can be drawn:

- **Cluster 2**, which mainly focused on the cost of hyperloop, shows high levels of fear. This could be an indicator that hyperloop is viewed by critics as a financial uncertainty.
- **Cluster 1** shows high levels of anger and disappointment, which is interesting since it is the group where the word “thing” appears often. This suggests that anger and frustration could lead to adopting a dismissive and sceptical attitude towards hyperloop, but it could also be an indicator of unmet expectations.

4.5 Argument Comparison

In this section, a detailed comparison of the different arguments analysed in Section XI will be done, drawing insights and conclusions from the results that were observed.

In all kinds of arguments, the use of comparisons and real examples to highlight a point was frequently observed. However, this was especially common in arguments in favour of hyperloop, mostly in those from news outlets. The complexity of hyperloop and its potential impact can be quite complex to understand. Therefore, by using tangible analogies, arguments become more relatable and understandable, thus making it easier for the message to reach the audience.

In addition to using analogies, arguments in favour of hyperloop rely on the use of testimonies to enhance credibility, as evidenced by the frequency of appearance of the word “said”. This was, how-

ever, only observed in arguments from news outlets but not in arguments extracted from YouTube videos. This evidences the need to use different strategies across different platforms.

News outlets tend to be more formal and they adhere to standards that prioritise accuracy and objectivity. Incorporating testimonies from reputable sources aligns with said principles and meets the audience's expectations, therefore making it a good communication strategy. While YouTube creators may still aim to inform their audience in a trustworthy way, the less formal nature of this platform makes testimonies a less useful strategy. Instead, creators tend to rely on images, visual demonstrations or anecdotes.

The aforementioned difference in communication style was also found in the emotion analysis. In the PCA of emotions present in arguments from news outlets, approval and disapproval are almost at a 180-degree angle, indicating a high degree of polarization which reflects the formal style of news reporting. In arguments from YouTube videos, however, the angle between the two emotions is smaller, suggesting a more ambiguous approach.

Another discrepancy found between news outlets and YouTube videos is the attitude towards Elon Musk. In the case of news outlets, Musk is highly present in arguments against hyperloop, with a whole cluster directed to him. In YouTube videos, however, not only is his name not present in the "against" group, but it appears in some of the word clouds from arguments in favour.

This is yet another reflection of the contrast between platforms. Both the creators and the audience of YouTube videos tend to be younger than those of news outlets. Young people are less critical of Musk's extravagant initiatives, instead finding them funny or interesting, not delving too deep into their consequences. This, therefore, might suggest that in order to reach younger audiences, a less formal approach is preferred.

Despite these differences, there are certain aspects of the hyperloop technology that appear in arguments against hyperloop from both sources, such as cost and possible effects on passengers' health.

On the one hand, it is no secret that hyperloop, as any other transportation technology, has a high cost of implementation. Critics view this as a major obstacle, but the presence of "cost" in arguments in favour of hyperloop shows that there are also supporters who see it as a necessary investment for the future. This highlights the complexity of the debate but also shows that cost is an issue that can be framed from different perspectives.

On the other hand, it is not surprising to find concern about the possible implications of different aspects of the hyperloop technology on passengers' health. This has been a recurrent theme throughout the history of the development of different transportation technologies. In each case, the initial excitement and optimism about technological progress were clouded by concerns about their consequences on human health. Hyperloop is no exception, but as history also shows, time will bring improved safety protocols and further research about the matter, which will help ease the public's fear.

When it comes to arguments in favour of hyperloop, there is also common ground between sources, apart from the use of concrete examples –which was mentioned above–. In both cases, it was observed that instead of delving into technical terms, simpler concepts were mostly used to explain the hyperloop technology. This allows the message to be accessible to a more general public, emphasizing hyperloop's potential benefits in a clear, simple and straightforward manner.

In addition, there were two main themes present in this group of arguments: speed and sustainability. It seems like people are very attracted to the idea of being able to travel from one place to another in a much faster way, which is also why examples that illustrate the time it would take to cover the distance between two specific cities appear to be so impactful.

However, in today's world, sustainability has become an increasingly important consideration in the development of new technologies. People are no longer satisfied with the development of revolutionary technology; they also want it to be sustainable, to meet certain standards. As concerns about climate change and environmental damage continue to grow, the demand for transport solutions that are fast, efficient and sustainable grows as well.

When comparing the most prevalent emotions in the different clusters, similar results are found between sources. However, it is interesting to notice that the same theme can be perceived as positive - and thus related to positive emotions - and as negative. It is, for example, the case for the technicalities of hyperloop, since they are simultaneously a source of excitement and a source of fear. This highlights the importance of adopting an optimal communication strategy tailored to the specific platform and audience that is being targeted.

Innovation always comes with uncertainty, and uncertainty is often something seen as a threat. Therefore, it is important to address concerns transparently, providing clear information that any given audience could easily understand.

Additionally, the combined analysis showed that an important source of disapproval of hyperloop could be unmet expectations and disappointment. Again, this emphasizes the need to communicate things transparently, ensuring that the audience understands the message.

Chapter 5

Conclusions

5.1 Results Discussion

Throughout the previous sections, an analysis of the different arguments used in the discourse surrounding hyperloop was conducted. This set the foundation for a comprehensive understanding of the key themes, emotions and communication strategies that shape the public perception of hyperloop.

In this section, we will present and interpret the findings from the said analysis, providing clear guidelines on the main topics that communicators should address in order to maximize their success and get their message to reach their intended audience.

- **Use of analogies and real examples**: it has been found that using concrete examples, such as the time it would take to travel between two cities, is a good strategy for making arguments more tangible and understandable, thus making it easier for the message to read its intended audience.
- **Use of simple language**: again, it was found that most arguments in favour of hyperloop used a simple, easy-to-understand language to describe the technology, instead of delving into technical terms. Just like the use of analogies and examples, this is done with the purpose of making the message accessible to a broader audience.
- **Focus on speed and sustainability**: the main themes present in arguments in favour of hyperloop were speed and sustainability. Therefore, it appears that emphasizing these aspects is particularly effective in capturing the audience's attention and making the technology more appealing.
- **Use of comparisons**: comparisons help put things into perspective and therefore can be a useful tool to reframe aspects that might generate concern, such as cost or safety. Comparing hyperloop to other existing transportation systems, communicators can contextualize these concerns and provide a clearer point of view. An example could be comparing the initial costs of hyperloop to those of major infrastructure projects.

- **Understanding platform differences**: the findings seemed to indicate a clear difference in the communication strategy needed for news outlets and YouTube videos. Different platforms imply different audiences and different standards that need to be met. Therefore, it is essential to have a clear understanding of the platform that is going to be used to distribute the message, since the most optimal strategy will vary from one to another. For example, when targeting a younger audience on a platform like YouTube, a less formal approach with engaging visuals and anecdotes may be more effective; whereas in news outlets, testimonies from reputable sources seem to work well.
- **Transparent address of concerns**: as seen on the combined analysis, a concept can be interpreted in different ways depending on the way the message is perceived. Hyperloop brings to the table revolutionary concepts that can be difficult to understand, which could lead to misinterpretations and fear. Therefore, it is important to address any potential sources of concern transparently and to communicate in a reassuring way that makes the audience feel that hyperloop is something they can trust and feel safe about.

By understanding and applying these guidelines, communicators can develop more optimal strategies tailored to their audience, guiding the development and implementation of hyperloop in a way that aligns with societal values and mitigates fears.

In conclusion, this analysis hopes to serve as a roadmap for effective communication about hyperloop, enhancing public understanding and helping hyperloop transition from concept to reality; shaping our future.

References

[1] Meaning of the word argument. Cambridge Dictionary.

[2] Thambawita V Hammou M Riegler MA Halvorsen P Parasa S. Hicks SA, Strümke I. On evaluation metrics for medical applications of artificial intelligence. In *Sci Rep.*, October-November 2022.

[3] Kathrin Hilgarter and Peter Granig. Public perception of autonomous vehicles: A qualitative study based on interviews after riding an autonomous shuttle. *Transportation Research Part F: Traffic Psychology and Behaviour*, 72:226–243, 2020.

[4] Yinhan Liu, Myle Ott, Naman Goyal, Jingfei Du, Mandar Joshi, Danqi Chen, Omer Levy, Mike Lewis, Luke Zettlemoyer, and Veselin Stoyanov. Roberta: A robustly optimized bert pretraining approach, 2019.

[5] Jana Sochor and Alexandros Nikitas. Vulnerable users' perceptions of transport technologies. *Urban Design and Planning*, 169:154–162, 01 2016.

[6] Christian Stab, Tristan Miller, Benjamin Schiller, Pranav Rai, and Iryna Gurevych. Cross-topic argument mining from heterogeneous sources. In Ellen Riloff, David Chiang, Julia Hockenmaier, and Jun'ichi Tsujii, editors, *Proceedings of the 2018 Conference on Empirical Methods in Natural Language Processing*, pages 3664–3674, Brussels, Belgium, October-November 2018. Association for Computational Linguistics.

Appendix A

News Outlet Example

La idea nació en un principio por Elon Musk, el dueño de Tesla pero fracasó. Ahora en China crearon este sistema de transporte de alta velocidad que ya completó sus primeros test de viabilidad en el país asíatico, cuyo objetivo es cubrir grandes distancias a nada menos que 1.000 km/h.

Bajo el nombre T-Flight y concebido por la defensa de China Aerospace Science and Industry Corporation (CASIC), inició su proyecto el 2022. Sin dudas, es un proyecto prometedor, que por diversos motivos no se ha logrado llevar a cabo y ejemplo de ello es el Space X de Elon Musk, cuya prueba terminó destruída. No obstante, en el país asíatico buscan la manera de hacerlo viable.

Según detalla South China Morning Post, este Hyperloop ya cuenta en su historial con tres pruebas, y la última fue la que transportó pasajeros donde recorrió solo 210 metros a una velocidad de 50 km/h, levitando sobre imanes. Además, reportaron que durante las pruebas los componentes más importantes operaron de manera correcta y según lo previsto tales como el imán del superconductor, los sistemas eléctricos, controles de seguridad de inteligencia artificial, sensores y dispositivos de comunicación inalámbrica.

¿Cómo funcionan los Hyperloop? Mediante la unión de ciertas tecnologías avanzadas, lo que incluye levitación magnética, tubos de baja resistencia y propulsión aérea.

¿Por qué es importante desarrollar un Hyperloop? Pues bien, es un medio de transporte mucho más rápido y seguro. Otro factor importante es que utiliza energía eléctrica para funcionar por lo que tiene un bajo impacto ambiental.

Appendix B

YouTube Transcription Example

The Hyperloop is the world's most epic transportation system. It's a magnetically levitating train in a vacuum tube with a maximum speed of 1200 kilometers per hour. This idea, from 1888, was first conceived by Elon Musk in 2012. He said, "Thus, the Hyperloop was born," and immediately, the best and the brightest pounced on the concept, aiming to revolutionize transit.

It's been 11 years since Musk's fateful speech. He himself did not get involved in development and couldn't now, even if he wanted to, as his tube is a signal-boosting fort for lunatics on Twitter while at the same time running the site into the ground. Only true geniuses can multitask like that. But thankfully, as I said, Musk wasn't the only one who saw promise in the Hyperloop. People just as smart and talented as Musk also jumped on the bandwagon, and before we knew it, a whole plethora of companies were competing to change transportation forever.

We've been waiting 11 years for a functional Hyperloop system, and we're still waiting. But what are all those Hyperloop companies up to nowadays? Where are they now?

First off, Arrivo. Arrivo is a Hyperloop company founded by Brogan BamBrogan—yeah, that's his real name—who apparently kept an axe in his office, with which he would punch a hole in the wall to let off steam. Now, there is a sign of a successful, well-run company. Though Arrivo started as a Hyperloop company, the vacuum tube idea was quickly abandoned in favor of maglev technology—you know, that thing which doesn't exist yet and definitely needs pioneering. So BamBrogan was like, "What if maglev, but worse?" and thus, these magnetic corslets were dreamed up, which were supposed to fix congestion. Because, as we all know, adding more capacity to roads definitely won't motivate more people to get in their cars, thereby making congestion worse. Gee, I wonder if this is a well-known phenomenon we've been aware of since, like, 1930, because if that was the case, that would make Arrivo and BamBrogan look real silly. Though, thankfully (or unfortunately), Arrivo went bankrupt a year later, ultimately forcing them to depart.

Next up, Hyperloop Delft. Oh, I've been to Delft; it's a beautiful small college town in the Netherlands, and now they're also building a Hyperloop. Founded in 2016, after seven years of feverish development, they have a tiny proof-of-concept model. Ah yes, the Amsterdam-Paris high pillar, which is most definitely needed. If only there was a fast and convenient transit link between these two cities already. Look, I don't want to give them too much flak—they are a non-profit, and this is

clearly just a university project. Students come and go every year, and they get some useful hands-on experience working on their prototype. Nothing will ever come of it, sure, but this is first and foremost an educational tool. Plus, the "worked on the Hyperloop" bullet point will look good on their CVs to recruiters who haven't watched my videos.

Moving on, we have Hyperloop Italia. What is this website? Oh, it's one of those scrolling things. All right, uh, let's watch the video. Oh, that's nice. Okay, so their videos seem to have been deleted. That's cool. Uh, wait, these are just Hyperloop TT promotional images. They must be their Italian subsidiary then. Wait, who is this guy? Is he crying? Sir, blink once if you're being held against your will. Since this is a subsidiary, let's look at the origin point instead: Hyperloop TT, the TT part meaning Transportation Technologies. They have a helpful section on their website exploring their progress so far.

Okay, so in 2013, they were just starting out. 2014, the same. 2015, missing. Oh, 2016 was a busy year. They seem to have invented maglevs, right? They just built a small-scale prototype revealing "vibranium" skin material. Wow. For those of you who don't know, vibranium is just a carbon fiber tube with some sensors in it. It's a name Elon came up with to appeal to sci-fi-oriented young adults who are bad at interpreting social cues. Wow, what's this? Brno, Czech Republic, takes first step to create European Hyperloop connecting to Slovakia. Ah yes, Brno, the city that legalized parking on the sidewalk and that refused to help Ukrainian refugees who were of Roma ethnicity, left them out on the streets, and then tried to house them at a detention facility. Truly a place of progress and innovation.

Back to the list: in 2017, it's more photo ops and PR stuff. 2018, wow, Hyperloop TT announces partners and construction start for commercial system in Abu Dhabi. It's happening, folks! Well, through the power of me reading this in 2023, I can tell you that absolutely nothing came of this project. Oh, I know this one—this is the Hyperport, the cargo Hyperloop from the port of Hamburg into the continent. Because after a container spends four weeks on a cargo ship, it cannot sit on a train for three more days. It has to barrel down a hundred billion euro vacuum tube, because that's how logistics works. Also, European Commission moves ahead in assessing Hyperloop regulatory needs. All right, you might notice a lot of these articles are either just fluff pieces or about some institutions starting a process to organize the meeting where they will discuss what food should be served at the gathering where they schedule the Zoom call to confirm the session where 0.86-9 F of the agenda will be about what should we do with this Hyperloop thing. These mean nothing, yet the Hyperloop TT people put them out on their website nonetheless. If you ever had to pad out an essay at school, this might feel familiar to you.

From 2019 till 2022, it's much the same: feasibility studies, cooperation agreements that lead nowhere. Apparently, they also released a bunch of Hyperloop NFTs, because of course they have. Their most recent news item is from six months ago about the unveiling of the second full-scale capsule at a convention. Curiously, photos are missing from this article aside from the headline image, but I went to Twitter and found four more, thankfully. Now, you might think this is extremely embarrassing. After a decade of work, all they have is a static mock-up of the capsule that people can sit in. Except that's not the capsule's interior—that's a 2D canvas print stretched over the gaping hole of their empty tube. After a decade of work, this is all they have: a hollow tube with some studio lights slapped inside, wires and all, with two monitors that don't even match, playing videos on loop and an open end, next to the miniature mock-ups of their interior furniture. This is what they accom-

plished in a decade. Ukrainian engineers are out there changing modern warfare with hardware they invented and built from scratch in a year during an active war and are mass-producing it out of a shed. Meanwhile, these morons couldn't accomplish more than a carbon fiber sewer pipe after a decade.

Finally, we have Hyperloop One, formerly Virgin Hyperloop, formerly Virgin Hyperloop One, formerly Hyperloop One, formerly Hyperloop Technologies. If one company is going to make the Hyperloop real, then this is it. While other companies were just a loose collection of consultants and idea guys barreling towards bankruptcy, Hyperloop One means business. They have funding, real professionals, and an actual working prototype with humans in it—an actual working pod, which my friend Thunderf00t suspects to be a piece of jet fuselage encased in plastic, and I tend to agree. They even performed a successful test run. Following that, Virgin perhaps realized that this is an extremely dangerous, impractical, and stupid idea, so they pulled out of the project. Hyperloop One then announced they would focus on freight instead and started laying off employees en masse. Their website is now an empty void with a "new site coming soon" message, with a faint render of the cargo Hyperloop capsule almost rotating in the background. And I, for one, can't wait to see the actual renders of this epic project that won't happen in a million years due to being a fundamentally stupid and impractical idea.

So, after a decade of work, all these much-hyped Hyperloop companies have basically nothing to show for it: tiny models, empty mock-ups, scrapped prototypes, and dissolved companies. And this is not because the evil fossil fuel or train lobby is trying to sabotage them, but rather because the Hyperloop for passenger use is just an incredibly stupid and impractical idea. All you need is one crazy person blowing up one section of one tube somewhere, and the resulting vacuum failure, plus the wall of one atmosphere air rushing in, will immediately turn hundreds of people into canned spaghetti.

Thank you. This is assuming they can even maintain such an enormous vacuum chamber, deal with the problem of heat expansion, tectonic activity, extreme weather, and so on, after managing to somehow purchase all the land needed across multiple countries in a straight line to be able to even potentially start construction. Seriously, all technical impossibilities and impracticalities aside, try drawing a straight line between two large cities and see how many villages, cities, lakes, rivers, national parks, and so on are in your way—places where you cannot build but can't go around because your 1200 kilometers per hour pods cannot do sharp turns and would need an almost completely straight line. Once again, this is just the land acquisition. We haven't even talked about all the technical issues which make this whole project impossible.

HYPERLOOP **UPV**

Shaping the future.