Group project - Proposal

Correlation between transport modes and weather conditions

Group 15

Name	Github username
Brodbelt Lopez, Nicolas David	NBrodbelt
Hemalatha Thirumal, Manasa	Manasaht31
van Herwijnen, Anna	AnnavanHerwijnen
Nikolova, Greta	greta.sch4-commits
Zeng, Zitong	Zitong22

Author contribution statement:

- Anna – Finding relevant datasets, gaining access to protected datasets, writing research questions.
- Evelyn – introduction writing and explanation of the transport modes
- Greta – Understanding the structure of the databases and describion of the practical information correlated to them
- Manasa – Making a Data Pipeline for the data visualization after going through the dataset and various other data pipeline architecture.
- Nicolas – Research question formulation, exploring possible datasets, finding prior research on the topic for hypothesis formulation, hypothesis formulation.

Introduction

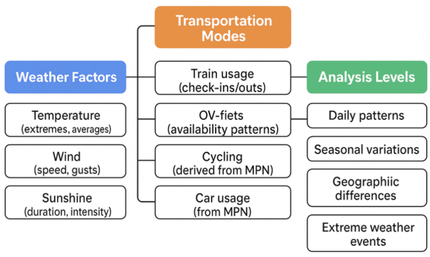
The Netherlands has a temperate maritime climate, with mild winters, cool summers, and frequent precipitation (annual rainfall around 700–800 mm). Cloudy and rainy conditions can influence travel behaviour. The country's flat terrain and well-developed infrastructure allow residents to flexibly choose between cycling, public transport (trains, buses), and private cars.

Cycling accounts for about a quarter of all trips, while public transport plays a key role in intercity and daily travel. Studies have shown that weather significantly affects mode choice: dry, calm, and moderately warm conditions encourage cycling, whereas adverse weather reduces cycling and increases public transport use (Böcker et al., 2016). Research on e-bike travel indicates that rain, wind, and snow reduce usage, while moderate temperatures have a positive effect, very high temperatures may decrease trips. For public transport, adverse weather can increase travel time and affect user willingness (Sabir et al., 2010).

Most research, however, focuses on a single mode or local areas, with limited studies examining nationwide weather variations across multimodal transport. It remains unclear how weather drives mode shifts in the Netherlands' interconnected transport system.

Understanding these dynamics is crucial for climate adaptation. Operators can optimize scheduling and resources, and policymakers can design more resilient sustainable transport networks.

This study aims to examine the relationship between daily weather patterns and travel mode choice in the Netherlands from 2020 to 2024. Using KNMI meteorological data, Translink train usage, and OV-Fiets bike-share availability, we analyse how people adjust between cycling, trains, and other modes under normal, rainy, and hot conditions.



Research Questions

From the topic found, the following research question was designed:

What is the correlation between daily weather patterns and the modes of transport that people use in the Netherlands between 2020 and 2024?

From this research question, several sub-questions are necessary to research:

- What transport mode do people use when the temperature is very high or very low?
- What transport mode do people use when there is a lot of rainfall?
- What is the correlation between daily number of train passengers per station and the weather?
- What is the correlation between number of car users and the weather conditions?

Research Gap and Hypothesis Formulation

Based on the research question posed, it is now important to briefly explore the prior art. This serves a dual purpose, on the one hand, to find what the current project can contribute to. On the other hand, this process helps identify what relations could be expected between the different variables. This will be done by exploring outcomes reached by prior research and subsequently complemented by a newly formulated hypothesis.

It was found that prior research had already been conducted in the desired geographical context. Namely, investigations by Böcker et al. (2019) and Wilkesmann et al. (2023) were conducted within the desired geographical context and focused on the effect of weather on mobility patterns – with Böcker et al. (2019) analysing the effect of weather on mode choice and Wilkesmann et al. (2023) evaluates possible "temporal and weather-related determinants" associated to the use of OV Fiets. Beyond this, research by Galich and Nieland (2023) was also found to be insightful, covering the effect of weather conditions on the transportation mode used in Germany.

From the research identified, the key research gap found is related to the analyses conducted with seasonal data and more detailed analyses with different weather phenomena such as wind, precipitation or fog. Therefore, efforts will be made to assess the feasibility of conducting such research with the data available.

Then, regarding the hypothesis formulation concerning the effect of weather on transport mode selection, the research by the papers mentioned attribute a varying degree of significance to the effect weather has on transportation mode selection. For instance, Galich and Nieland (2023) characterise this effect as marginal – most notably concluding that these impacts tend to be smaller in densely-populated urban metropolis – while Böcker et al. (2019) find considerable regional differences in this effect. Lastly, Wilkesmann et al. (2023) state that no clear set of variables were found that were able to explain variance across the entire set of stations. Due to the differences in findings amongst the papers mentioned, it was not possible to create a hypothesis linked to the general trend of research.

As such, a new hypothesis has been formulated:

> It is expected that, accounting for the time and scope constraints of the project, a tenuous effect will be observed with respect to weather altering transportation patterns of users of the Dutch mobility system. Specifically, it is expected that as weather conditions get more extreme – that is, with respect to wind, rain, fog and temperature – the percentage of bicycles used decreases.

List of datasets

KNMI
KNMI is the Koninklijk Nederlands Meteorologisch Instituut (Royal Netherlands Meteorological Institute). They measure several parameters in stations all throughout the Netherlands and document the measurements in the KNMI weather database that is publicly available. Some of the parameters included in the database are wind speed, wind gust, minimum temperature, maximum temperature, sunshine duration, and precipitation duration. Every station has coordinates which will be used to connect public transport stations to the closest weather station. The continuity of the data varies per station, however, the oldest one dates from 1991, running up until 2025. Moreover, some of the data from the current 10-minute database could be unvalidated but for the project only the daily measurements would be necessary which would be the average of the values for that day.

Translink
TransLink dataset is a public data source for public transportation data in the Netherlands. The information included in this dataset is the total number of check-ins. This data is available for both daily check-ins and hourly check-ins, however, only daily check-ins will be used. Before 2023, only the check-ins from the OV-chipkaart are registered, while after 2023, OVpay is also included. The available data from this database runs from 2020 until 2024.

OV-fiets
The OV-fiets database is an open database containing historical data, obtained through the NS API. The available data includes the time of making the log, number of rental bikes available in the locations, and the location itself. The available logs run from 2015 up to early 2025.

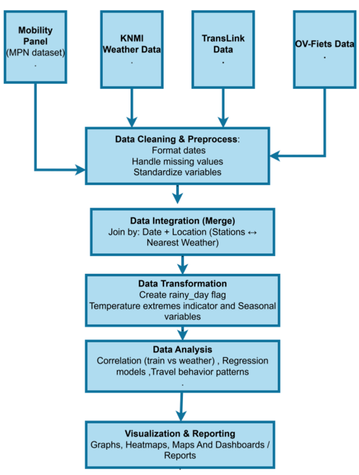
MPN
MPN is The Netherlands Mobility Panel, a study that aims to identify travel behaviour trends in a preset group of people. The continuous data obtained from the surveys over several years can be used to measure the effects of changes in social-economic factors such as use of public transport, increase in public transport rates, and more. The level of measurement is both individual and household since some data is concerned with the household as a whole. Additionally, every person has an individual number as well as identifier number that can connect them to a household which allows for analysis on different measurement levels. The survey includes a 3-day travel diary that aims to document the daily journey as well as provide reasoning for changes in the schedule routine if necessary. Since the data cleaning requires time, the new wave of results are published 2 years after data collection. Collection of the data starts from 2013 with the newest addition being from 2022. Since the data is provided to third parties for academic, policy and socially relevant non-commercial research purposes only, a formal request is necessary in order to be granted access to the database. However, after receiving the data, it is discovered that there are no time measurements and thus no connection could be made with the rest of the databases.

Geographical and temporal scale
All of the aforementioned databases have the geographical scale of the Netherlands. As for the temporal scale, the common timeframe of available data throughout all of the databases simultaneously is 2020-2024. It is expected that in the final project this time period will be used for the analyses.

Links to databases:

- Mobility panel (MPN) dataset: https://mpndata.nl/
- KNMI weather dataset: KNMI - https://www.knmi.nl/nederland-nu/klimatologie/daggegevens
- TransLink dataset: https://translink.nl/open-data/
- OV-fiets availability dataset: https://trein.fwrite.org/idx/dedup_OVFiets.html

Data Pipeline



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