Project Group 5

Student name	Student number
Wouter van der Hoorn	5370566
Jelle Derks	5339564
Hugo von der Thüsen	4862600
Martijn Damman	5412633
Patrick Kruidenberg	4726642

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from IPython.display import Image
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Research Objective

Requires data modeling and quantitative research in Transport, Infrastructure & Logistics

Introduction

The last twenty years the wealth of many people in the Netherlands has increased. This means more and more people do have access to high speed modes of travel, such as car and train. It is known that the amount of time spend travelling does not change over time a lot and is stable at a little more than one hour. However, due to increase of car use and train use, the speed in traffic and the travel distance can change over time. Also travel motives can have significant impact on the travelling speed that is reached. It could be possible that people do have higher travelling speeds when going to work than when travelling during free time or holidays.

This study seeks to explore the evolution of travel speed over the last 20 years, investigating the impact of travel motives and modes of transport on the speed at which people travel. By examining these factors, we aim to uncover trends and insights that can help to understand the way travel behaviour changes over time.

Research Objective

The research objective for this project is the following:

- How have travel speeds evolved over the past 20 years, and what are the impacts of travel motives and modes of transportation on the speed of travel?

To answer this question first some sub questions are defined:

1. How do different travel motives impact the travelling speed of travellers?
2. How do different modes of travel impact the travelling speed of travellers?

3. What are the changes to travel speed of cyclists? What has affected these changes in travel speed?

Contribution Statement

Be specific. Some of the tasks can be coding (expect everyone to do this), background research, conceptualisation, visualisation, data analysis, data modelling

Patrick Kruidenberg: Worked on Research objective, data pipeline, visualisation and code for subquestion 1.

Jelle Derks: Worked on code to filter the right data from the raw data source. Wrote text for subquestion 2 and 3. As well as visualsing results for subquestion 2.

Martijn Damman: Worked on code for subquestion 1 and wrote the text for subquestion 1 and conclusion.

Hugo von der Thüsen: Worked on code, visualisation, and text for subquestion 3.

Wouter van der Hoorn: Worked on cleaning the data, wrote the code and visualisation for subquestion 2.

Data Used

The data is obtained from the open data website of CBS. Link: https://opendata.cbs.nl/statline/#/CBS/nl/dataset/84755NED/table?ts=1728290082121
The dataset includes information on travel motives, trip length and duration, amount of trips in total and per vehicle type (for example train, bus and car), recorded on a yearly basis from 1999 up to and including 2021. It also includes age and the difference between men and women, but those are not included in this research.The data for these e-bike sales were gathered from a CBS database on total e-bikes and other bicycles in the country.

Data Pipeline

The data pipeline for this project was designed to handle and preprocess the data for both general travel patterns and cycling-specific information. Here is an overview of the main stages:

1. **Data Collection**: The primary data was collected from CBS's open data portal. Additional data specific to cycling was included to allow for a more detailed analysis of trends in cycling behavior. The corona year were excluded from the data since it caused discrepancies in the data.

2. **Data Cleaning**: Data in the CBS file was checked and no NaN values were

discovered.

3. **Categorization**: Travelers were categorized based on travel motives and modes, including specific categories for cycling, to capture more detailed behavioral insights.

4. **Data Aggregation and Transformation**: Data was aggregated across time and different travel modes to enable trend analysis over the years, including changes in cycling speeds and usage rates.

Subquestion 1. How do different travel motives impact the travelling speed of travellers? And over time what changes can be observed?

It is expected that not all travel motives correspond to the same travel speeds. In the CBS data, five primary travel motives have been identified: free time, shopping/groceries, education, commuting (to and from work), and other. It is expected that travel speeds differ among these motives due to varying priorities, distances, and travel behaviors associated with each type.

Hypothesis on travel motives: Travelers who commute for work purposes will tend to travel at higher average speeds than those traveling for leisure or personal reasons. This is because work-related travel often involves stricter time constraints, leading travelers to choose faster modes of transportation and more direct routes. In contrast, leisure travel allows for greater flexibility in speed and mode choice, as these travelers are less likely to be constrained by time. It is also expected that travel motives associated with greater travel distances will, on average, correspond to higher travel speeds. For example, motives like commuting to work, which often involve longer distances, may result in the use of faster modes such as trains or cars. Shorter-distance motives, like traveling to educational institutions, may occur more often in urban or suburban areas, where slower speeds are typical due to shorter distances and possibly slower modes.

Hypothesis on changes over time: Over the last 20 years, the hypothesis is that average travel speed has generally increased across all travel motives due to overall higher speeds in each mode of travel. As people tend to take the same mode of travel for their travel motive over the last 20 years, though the primary travel mode for each motive may have remained relatively consistent, the technological advancements within these modes are likely to have led to a gradual increase in travel speeds over time.

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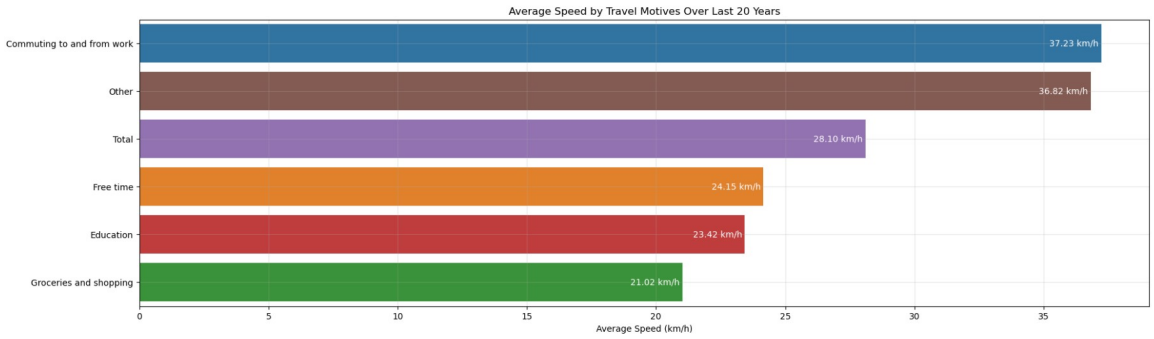

In the barplot above, we can see the average speeds for different travel reasons. Overall, the average speed for all trips is 28.10 km/h. When looking at specific reasons, commuting to and from work comes in at 37.23 km/h, which is the fastest. Not far behind is the 'Other' category, with an average speed of 36.82 km/h.

After these two, the speeds drop quite a bit. For 'Free Time' trips, the average speed is 24.15 km/h, and for 'Education', it's 23.42 km/h. The slowest of all is 'Groceries and Shopping', at just 21.02 km/h.

These results line up with what was expected. It makes sense that people travel faster for work and other important trips since those are usually time-sensitive. In contrast, trips for shopping or leisure tend to be slower because there's less pressure to hurry. Overall, this data really highlights how the reason for traveling can impact how fast people go.

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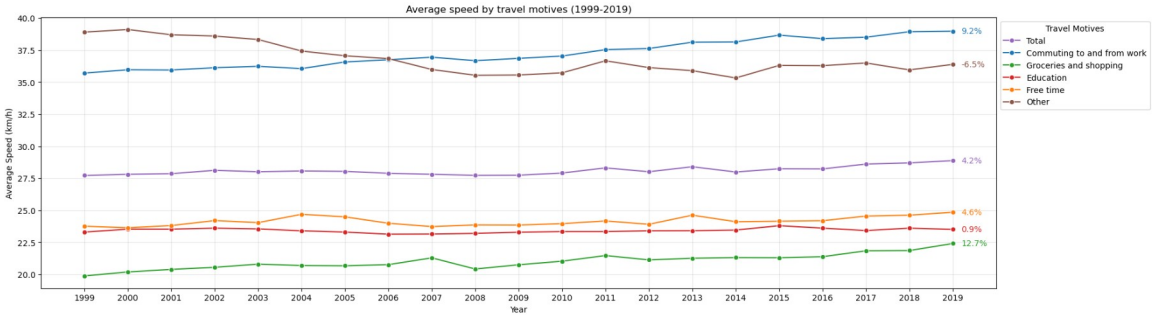

The graph above illustrates changes in travel speeds across different travel motives from 1999 to 2019. Notably, average speed has increased by 4.2% overall during this period. This upward trend reflects advancements in transportation infrastructure and vehicle efficiency. Among the various travel motives, "Groceries and Shopping" and "Commuting to and from Work" saw the most substantial increases, with speed gains of 12.7% and 9.2%, respectively. These improvements may be attributed to urban development and better public transport options. Travel for "Free Time" activities also rose noticeably, with a 4.6% increase.

In contrast, travel speed for "Education" has remained quite stable over the past two decades, showing only a modest rise of 0.9%. The one significant decline occurred in the "Other" category, where speed dropped by 6.5%. This decrease is somewhat difficult to interpret, as the category broadly includes business travel and other activities.

Changes in Travel Modes for Educational and Commuting Purposes

To gain a deeper understanding of how various travel modes have influenced the speed changes in educational travel and commuting to and from work, we focus on these two specific travel motives. The key questions we aim to address are: Do all travel modes evolve similarly to these travel motives? Do they remain constant for educational purposes? Or do certain travel modes experience significant increases while others show little to no change?

To answer these questions, we have developed two additional graphs illustrating the

changes in speed for each mode of transportation. These visual representations will help clarify the dynamics between travel modes and their respective impact on the identified travel motives.

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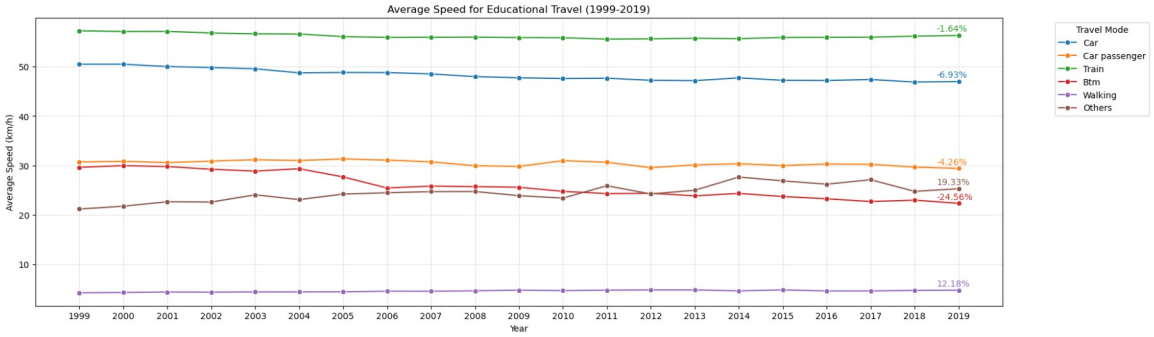

For educational travel, the speeds of most travel modes have remained relatively constant. However, three modes have experienced notable changes of more or less than 10%: walking, “other” modes, and BTM (bus, tram, and metro). Notably, walking speed has increased by 12.18%, while the “other” category has seen an increase of 19%. In contrast, the speed of bus, tram, and metro services has decreased by nearly 25%.

While these changes are interesting, providing a clear explanation for them is challenging due to the influence of various factors. Additionally, different measurement methods employed by the CBS (Statistics Netherlands) may also contribute to these observed fluctuations.

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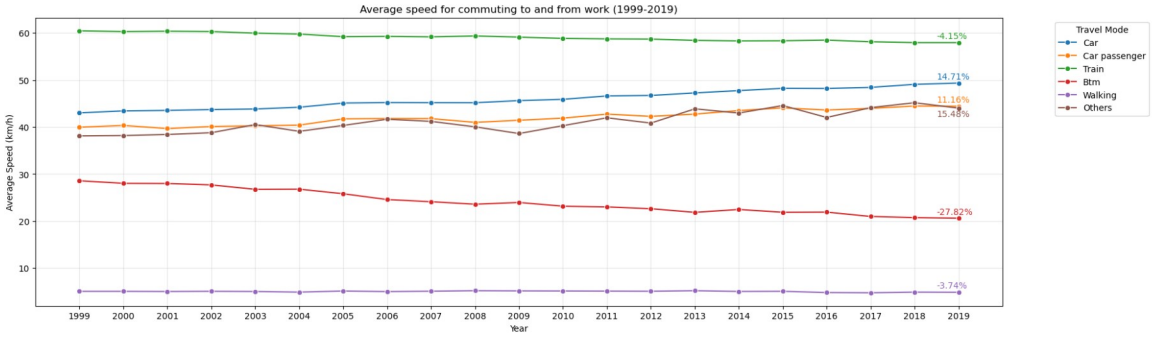

In terms of commuting travel, most modes have experienced a slight increase in speeds. Notably, private car travel has increased by 14.71%, while car passengers and the "other" category have seen increases of 11.16% and 15.48%, respectively, since 1999. Conversely, public transport modes, including trains, buses, trams, and metros (BTM), along with walking, have witnessed decreases in travel speeds. Specifically, train speeds have decreased by 4.15%, walking by 3.74%, and BTM by nearly 28%.

These changes are difficult to explain due to the multitude of factors involved. It is also important to recognize that while BTM has experienced a significant decline, this does not necessarily have a large impact on the overall average travel speed, as BTM accounts for only a small percentage of total travel.

Subquestion 2. How do different modes of travel impact the travelling speed of travellers? And over time what changes can be observed?

Travel modes play a significant role in determining the average traveling speed of individuals. Various modes of transport offer differing speeds due to their inherent characteristics, as well as infrastructure and environmental factors. In general, faster modes like private cars and trains enable higher average speeds than slower modes such as walking or cycling.

Hypothesis on Travel Modes and Speed Changes Over Time:

It is anticipated that, in general, the average speeds across all travel modes will increase over time due to advancements in technology, infrastructure, and the growing availability of efficient alternatives such as e-bikes and improved cycling lanes. However, for private car travel, we hypothesize a potential decline in average speed due to increasing traffic congestion and urbanization. As cities become more densely populated, the likelihood of traffic jams rises, which could counteract improvements in vehicle technology and infrastructure. This congestion is expected to slow down car travel, while other modes of transport, particularly non-motorized and public transit options see an increase in speed.

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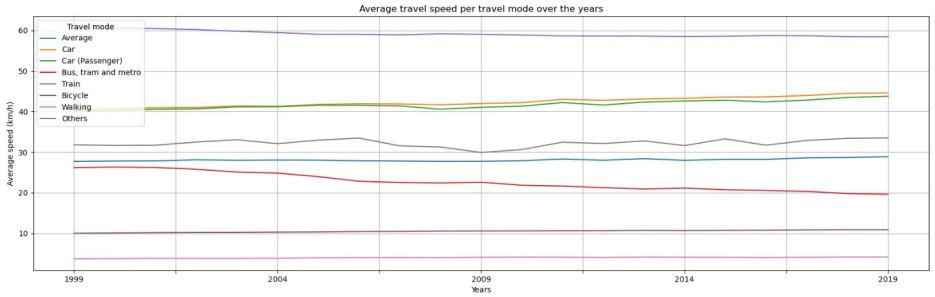

Overall changes in speed

Between 1999 and 2019, the general trend has been an increase in average speed across most travel modes. Private car travel has seen a rise in speed. Other modes such as cycling and walking have also seen an increase in overal speed.

In contrast, public transport, such as the bus, tram and metro, have generally seen a decline. Bus, tram, and metro (BTM) speeds, in particular, have decreased. Train speeds have also dropped slightly. These declines will be discussed in upcomming sections in detail.

Private cars and active modes

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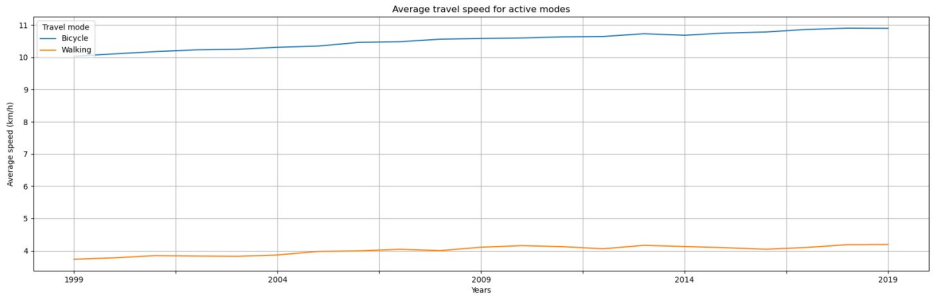

Walking, as a mode of travel, has experienced a slight increase in average speed, rising by 12.25%. This could be attributed to factors like improvements in pedestrian infrastructure and the adoption of fitness trends that emphasize faster walking paces. Whilst the graph increases like other travel modes, it does not increase linearly, a reason for this could be the data acquiry. Similarly, cycling speeds have gradually increased with 8.61%, benefiting from dedicated lanes and e-bikes, which support higher average speeds than traditional bicycles.

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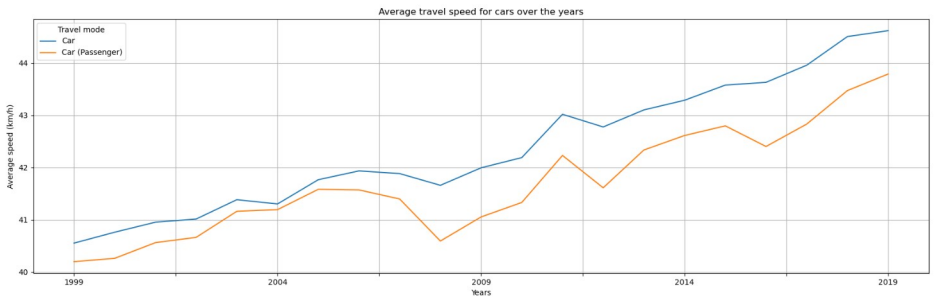

Car speeds have increased by 10% for drivers and 8.93% for passengers. Contrary to the hypothesis, car speeds have not decreased in recent years, even though the total amount of traffic congestion has increased. This could be explained by the fact that not all trips people make occur during peak hours. Therefore, it's possible that speeds outside of rush hours have increased enough to offset the decrease caused by traffic jams. A possible explanation for the lower speed for car passengers compared to drivers could be the need to make stops at locations like carpool points or to detour to drop off passengers at destinations different from the driver's final stop.

Public transport

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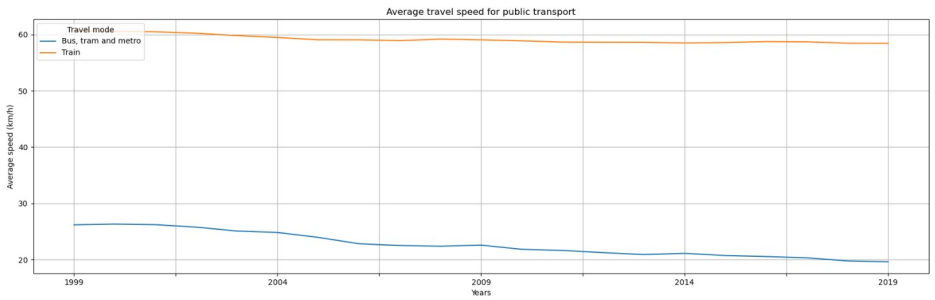

The image above shows a decrease of 3.67% in train speed and a striking 25% drop in the average speed of BTM (bus, tram, and metro) transport modes. The reduction in train speed may be related to a preference for deploying more local trains instead of intercity trains within urban areas. However, the decrease in BTM speed is particularly notable. One possible explanation is that BTM lines now make more frequent stops than in previous years, which would ultimately lower the overall travel speed.

In conlcusion, between 1999 and 2019, average travel speeds increased for most modes, largely due to advancements in infrastructure and technology. Walking speeds rose by 12.25%, likely from better pedestrian facilities and health trends, while cycling speeds increased by 8.61%, aided by e-bikes and improved bike paths. Car speeds also rose (10% for drivers, 8.93% for passengers), despite congestion, possibly due to faster speeds outside rush hours.

In contrast, public transit speeds declined; bus, tram, and metro (BTM) speeds dropped 25%, likely due to more frequent stops, and train speeds fell 3.67%, with more local services in urban areas.

Subquestion 3. What are the changes to travel speed of cyclists? What has affected these changes in travel speed?

The hypothesis of this reschearch question, is that certain travel motives impact the speed of cyclists. It is estimated that motives such as biking from and to work operate at relatively higher average speeds than e.g. free time. Next to that, it is expected that the average speed for motives such as from and to work, or shopping and groceries are seeing an increase due to the rise of electric bikes. These, usually, higher aged people have the financial means to buy such an e-bike.

When plotting the e-bike sales in The Netherlands next to the average speed of cyclists in the country an upward trend can be seen for both. One could correlate these two by assuming that the increased amount of cyclists using e-bikes has led to an increase in overal speed because e-bikes make higher speeds less of an arduous task. However, the increase in speeds can already be observed before the large introduction of e-bikes which suggests that there are other factors at play. One of these factors could be the increase in segregated bicycle paths and general improvements made in bicycle infrastructure.

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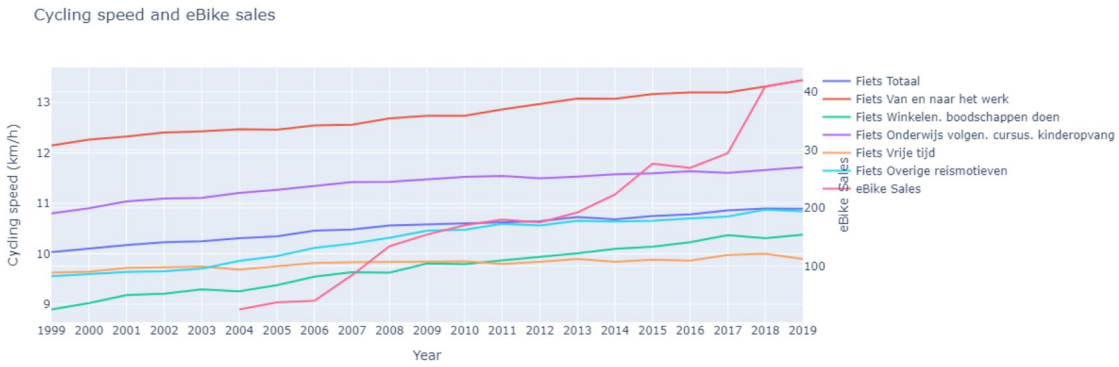

Conclusion

Over the past 20 years, average travel speeds in the Netherlands have increased by 4.2%, driven by various factors influencing travel behavior. This research focused on two main themes: travel motives and travel modes.

For travel motives, commuting and grocery trips experienced the largest speed gains. Work-related travel consistently displayed the highest speeds, while leisure and shopping trips were slower, likely due to differing priorities. Commuting speeds have increased significantly, attributed to the growing use and improved performance of cars, while educational travel speeds have slightly decreased, likely due to the reliance on slower modes like bus, tram, and metro (BTM), which have experienced a decline in speed.

Between 1999 and 2019, most modes of transportation saw speed increases, supported by technological advancements and infrastructure improvements. Walking speeds rose by 12.25%, aided by better pedestrian facilities and health-conscious trends, while cycling speeds grew by 8.61%, partly due to e-bike adoption and enhanced cycling infrastructure. Cars also showed notable speed increases (10% for drivers and 8.93% for passengers), despite congestion. However, public transit speeds declined during the same period, with BTM speeds dropping by 25%, likely due to more frequent stops, and train speeds decreasing by 3.67%, reflecting a shift toward urban-focused local services.

Although this research could not explore all factors influencing travel mode and motive choices, it examined cycling trends in more detail. Findings suggest that increased e-bike sales have contributed to faster cycling speeds, though improvements in bicycle infrastructure, such as segregated bike paths, also played a role.

These findings emphasize the importance of continued investment in transportation infrastructure to sustain and enhance these positive trends.