The shortage of bus drivers in public transport in The Netherlands in 2030

Analysing the shortage of bus drivers and ways to mediate it

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Abstract

In the Netherlands, there is a shortage of bus drivers which results in high work pressure, bus cancellations, and strikes. The future shortage of bus drivers was unclear except for its projected exacerbation due to the ageing population of bus drivers. To gain a comprehensive understanding of the issue and explore potential solutions, this research sets the following objective: to give insights to governments and public transportation companies about the shortage of bus drivers in 2030 in The Netherlands by engaging the System Dynamics (SD) methodology to analyse what the shortage will be, which factors influence the in- and outflow of bus drivers, and which policies can be undertaken to decrease the shortage. The scope of this study is aimed primarily on bus drivers who are covered by the collective bargaining agreement of regional transport in The Netherlands. However, the calculation of the future shortage applies to the total number of bus drivers in the Netherlands. The research strategy was a mixed strategy of quantitative and qualitative aspects. The input consists of, partly public, quantitative data, and interviews. To reach the objective of the research the following question must be answered:

- How can policy makers address the shortage of bus drivers in public transportation in The Netherlands in 2030 by targeting influential factors?

The findings of this study indicate that the deficit of bus drivers is expected to rise to 20,000-22,000 drivers by 2030. This translates to a scarcity of 55.1% to 57.5% when compared to the average number of bus drivers over the past eleven years. This is mainly because of an increase in travelled kilometres with bus and the ageing population of bus drivers. More than 32% of the bus drivers today are above 60 years old and will go with retirement no later than 2030. Regardless of what is often thought, insufficient salary is not the key problem anymore. According to the findings of this research, bus companies should focus on improving the employee benefits, especially reducing irregularity and enabling customized schedules. Improving employee benefits in combination with more targeted recruitment campaigns, in which the emphasis is on flexible work hours and the good salary, is the according to this research the most feasible and impactful approach of reducing the shortage of bus drivers.

Inhoudsopgave

1. Introduction

This chapter contains the introduction of the thesis including practical and theoretical relevance. The research objective and the research questions are also stated in this chapter.

1.1 Introduction thesis

Public transportation, including bus drivers, has witnessed numerous strikes in 2023, extending to as many as 15 days within a span of six weeks (NOS, 2023-a). These strikes pose significant disruptions to the daily lives of numerous individuals, impacting both the economy and public trust in transportation services. The prevalence of strikes by bus drivers can be attributed to the excessive workload experienced by bus drivers in the public transport sector, primarily stemming from the shortage of bus drivers. According to several news websites (NOS, 2022) (Algemeen dagblad, 2023), bus drivers' express dissatisfaction with their pay, a sentiment partly fuelled by the significant inflation rates (DNB, 2022).

The shortage of bus drivers is a longer-standing problem that is occurring not only in the Netherlands but also in other EU countries (Transport Online, 2022). Significant factors driving the lack of bus drivers is the attractiveness of the profession and the relatively high age of bus drivers, a big proportion of them is over 50 years old (Verkeerskunde, 2023) (SPOV, 2020). This leads to a high retirement rate while there is little inflow due to the low attractiveness of the profession. In addition, the Netherlands is ageing more and more, making it increasingly difficult to rejuvenate the workforce (CPB & PBL, 2015). Because of the before mentioned reasons, the shortage is expected to keep increasing according to the International Road Transport Union (IRU) (Transport Online, 2022). This could have significant consequences for everyone who depends (partly) on public bus transportation in the Netherlands.

Not all bus drivers and passengers in The Netherlands are experiencing the same issues, which is caused by the different collective agreements for bus drivers in The Netherlands. Amsterdam, Rotterdam, Eindhoven, and The Hague are allowed to grant concessions to a transport company without public tendering (Rijksoverheid, n.d.-a), allowing them to create their own collective agreement. In this research, only bus drivers and transport companies attached to the general collective agreement (CAO OV) are being taken into account, except in the calculation of the future bus driver shortage. The CAO OV includes the following companies and their subsidiaries and brands: Arriva, Transdev, EBS, Keolis, Qbuzz, and RET (VWOV, n.d.).

1.2 Practical relevance

In 2021 4,2% of Dutch citizens travelled by public transportation daily, while before COVID-19 it was even higher with 8,6% (CBS, 2022-b). This means that more than 700,000 people use public transportation every day, before COVID-19 it was double this number (CBS, 2023-d) (CBS, 2022-b). A large amount of this group of people uses the bus. This makes it an important mode of transport in The Netherlands.

As described above, there is a shortage of bus drivers that is not expected to solve itself any time soon due to different factors. Therefore, this research is very relevant to passengers and society, aiming to ensure the continuity of bus transport and facilitating people's travel to work or home. The availability of sufficient public transport can also help reduce air pollution, traffic injuries, noise, congestion, and physical inactivity (Kwan & Hashim, 2016).

1.3 Theoretical relevance

The Dutch knowledge institute for mobility policy, also known as KiM, researched the expected growth of bus traffic. This research expects between 3 and 7 per cent more use of public bus services in 2026 compared to 2019 (KiM, 2022). As for travellers' expectations for 2030, nothing has been published yet by KiM. The Dutch Ministry of Infrastructure and Water Management did publish a report with expectations for 2030. The expectations, for 2030, are that the number of trips will increase between 11 and 18 per cent compared to 2018 (ProRail, 2021). These percentages are a combination of buses, trams, and metro; however, bus transport is most represented here with 65 per cent. This growth trips increases the occupancy rate, leading to a shortage of transport capacity that will continue to grow until 2050. The growing shortage of transport capacity will overload bus transport even further (ProRail, 2021)

Public bus transportation is a complex matter, this is a result of the many stakeholders connected to it. Key stakeholders are governments, bus drivers, and public transport companies (Supervisor, personal communication, March 23, 2023), but of course, also the passengers themselves are important stakeholders. All these different stakeholders with different stakes are making it a very complex but also essential problem and system to be mapped and studied. This is, to the best of knowledge, not been done yet with System Dynamics (SD). SD is ideally suited to analyse and understand dynamic complex problems and situations with underlying feedback structures with many stakeholders (Vennix, 1996) (University of Bergen, 2022).

The literature thus shows that passenger numbers will grow, transport capacity will come under pressure and overloading will become an increasing problem. However, the literature does not discuss or indicate the number of bus drivers that will be needed to accommodate this growth in

passengers. So, it is unclear how large the shortage of bus drivers in the Netherlands will become. Therefore, this research looked at what the shortage of bus drivers in public transport will be in 2030, what underlies this and what actions can be taken by governments and public transportation companies to counter these shortages.

1.4 Research objective & questions

Research objective: To give insights to governments and public transportation companies about the shortage of bus drivers in 2030 in The Netherlands by engaging the System Dynamics (SD) methodology to analyse what the shortage will be, which factors influence the in- and outflow of bus drivers, and which policies can be undertaken to decrease the shortage.

Based on the research objective the following research question has been formulated:

- How can policy makers address the shortage of bus drivers in public transportation in The Netherlands in 2030 by targeting influential factors?

The research questions will be answered through the following sub questions:

Problem analysis

SQ1: Which quantitative developments have taken place in the number of bus drivers in recent years and how will this develop in the coming years if expected developments in the in- and outflow continue to occur?

SQ2: What will the developments in the number of bus drivers mean for the provision of bus services and others affected?

Explanatory factors

SQ3: Which factors explain the behaviour of the system?

Measures

SQ4: What are possible measures that can positively affect the system?

SQ5: What are the possible effects of the measures?

2. Theoretical background

To facilitate a deeper comprehension of the studied system, a theoretical background study was undertaken. The theoretical foundation begins with a comprehensive literature review, which outlines the various pertinent aspects and theories relevant to this research. Subsequently, the conceptual model and its key concepts, which have been derived from the literature review, are presented and explained.

2.1 Literature review

The literature review focused on factors associated with three primary stakeholders in the context of bus driver shortages:

1) bus drivers/employees
2) employers in public bus services
3) the government.

The identification of key stakeholders and the factors associated with them was guided by insights from mobility experts at MuConsult, as well as by comprehensive literature research. The relevant factors for each stakeholder are detailed in this section and subsequently integrated into the conceptual model outlined in section 2.2. To ensure a comprehensive literature review, an additional section labelled 'other' is appended at the conclusion of this paragraph.

2.1.1 Bus drivers and employees

In this sub-paragraph, we outline the relevant literature regarding bus drivers and their work. This provides insights into how and why certain factors impact bus drivers and what holds significance for them according to the literature. This orientation enables the research to concentrate on relevant aspects.

2.1.1.1 Work pressure & Sick leave

Work pressure can mean different things to people, but in general, it is the mental or physical pressure to get something done at a certain time. The main things that influence work pressure are (Gallie, 2005):

- skill
- job control
- new technologies
- job (in)security

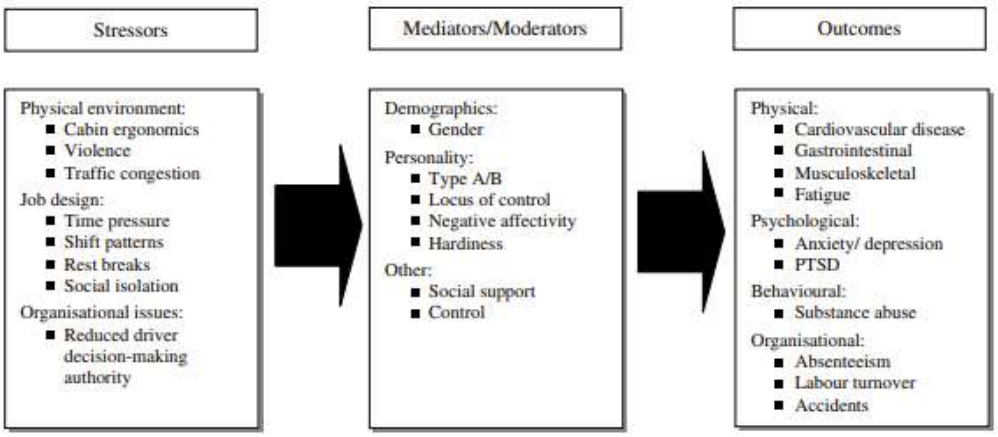
Lack of staff can cause the same tasks to be performed by fewer people, leading to more workload for the remaining employees. High work pressure is a key stressor for bus drivers and it leads to higher sick leave (Tse, Flin, & Mearns, 2006).

Being a bus driver is an unhealthy profession with a high risk of occupational ill health (Winkleby, Ragland, Fisher, & Syme, 1988). There is pressure on the bus drivers to be customer oriented, in the light of the wish for a good quality of services, however, at the same time there is a tight schedule that must be met which leads to task conflicts. Important decisions regarding the work of a bus driver are often made by management teams without the input of the drivers, affecting their job control. Ergonomic problems due to the interior of the bus and irregular work schedules also negatively affect the mental and physical conditions of the bus drivers (Kompier, Aust, van den Berg, & Siegrist, 2000).

Tse, Flin and Mearns (2006) made an overview of the stressors, mediators/moderators and outcomes of occupational stress for bus drivers, which is shown in Figure 1.

Figure 1

Key job stressors, mediating/moderating variables, and outcomes of occupational stress for bus drivers.



Reprinted from "Bus driver well-being review: 50 years of research" by Tse, J.L.M., Flin, R., & Mearns, K., 2006, *Transportation Research Part F 9, 89-114.*

2.1.1.2 Salary

The level of salary affects several things, in the first place it influences current employees to stay or not, and in the second place, it influences potential new employees to apply or not. The interest in the job itself is more influential on the decision to apply or not than the salary (Hsingkuang, Hueryren, & Tingwei, 2018). However, research on finding staff for vacancies by the Mexican government shows that higher wages can indeed make it easier to fill vacancies (Dal Bó, Finan, & Rossi, 2012).

The gross wages of bus drivers as stipulated in the collective labour agreement for regional transport are between EUR 1805.48 and EUR 3183.56. In reality, wages are often higher as a result of surcharges such as irregular pay and overtime. In Table 1 the salary of bus drivers is compared to other comparable professions and bus drivers with other collective agreements.

Table 1.

Wages of comparable professions without surcharges

Profession	**Wage (gross)**
Bus driver GVB (Amsterdam)	€1811 - €3170 (GVB, 2022)
Bus driver HTM (The Hague)	€1814.82 - €3693.59 (HTM, 2021) (CNV, 2022)
Train driver	€2184 - €3790 (NS, n.d.) (NS, 2022)
Truck driver	€1934.40 - €4379.48 (FNV, 2023)
Police officer (without promotion)	€2217 - €3160 (Politie, n.d.)

2.1.1.3 Attractiveness of the job

Vann, Wessel and Spisak (2000) made an overview of criteria for job attractiveness and ability-to-perform criteria, shown in Table 2. However, this overview is made a lot of years ago, reasonably it can be assumed that (most) of the factors are timeless.

Table 2.

Sample Criteria for Job Attractiveness and Ability to Perform

Job Attractiveness Criteria[a]	*Ability-to-Perform Criteria*[b]
Significance of work	Ability to assume responsibility[c]
Autonomy and responsibility	Initiative/drive/resourcefulness
Chance to use skills	Motivation
Challenge of work	Ability to handle stress
Physical work environment	Self-discipline
Compensation and benefits	Desire to succeed
Job security	Confidence/self-reliance
Career advancement opportunities	Interpersonal skills
Co-workers	Flexibility
Boss/Management	Oral communication
Geographic location	Personality
Size of town, city, community	Interest in job
Commute time	Organizational/planning skills
Company policies/practices/reputation	Leadership
Company's financial position	Creativity
Lifestyle possible outside of work	Written communication

[a]Adapted from Fink, Bauer, and Campion (1994, p. 34).
[b]Adapted from Pritchard and Fidler (1993, p. 48).
[c]Listed in declining order of importance as rated by employers.

Reprinted from "Job Opportunity Evaluation Matrix: Ability to Perform and Job Attractiveness" by J.W. Vann, R.D. Wessel, & S.A. Spisak, 2000, *Journal of Career Development, 26-3, 191-204*

There are first signs that the younger generation, generation Z (people born after 1996, Pew Research Centre, 2021), do not have the same sequence of importance in factors that influence their attraction to a job. Therefore, its unwise to, when trying to attract younger personnel, assume that the traditional factors apply to this younger group of potential employees (Kirchmayer, & Fratričová, 2020).

2.1.2 Employers in public transportation

In this sub-paragraph, we emphasize the crucial elements for bus transportation companies. This will offer insights into specific guidelines, opportunities, and limitations of future measures.

2.1.2.1 Quality of services

To reach the quality of service, earlier mentioned, it is important to provide conditions where the drivers can meet this quality. Brunoro, Sznelwar, Bolis, and Abrahao (2015, p.334) say the following about the quality of service in public transportation:

> Moreover, it is important to provide conditions in order to obtain professional development, such as constant training and recognition of drivers' role in order to assure citizenship. These aspects compose an excellence framework. Continuously monitoring and improving these aspects is fundamental to achieve and to maintain excellence.

The quality standard that is need to be met by the public transportation companies can be determined by the public transport authorities (CROW, 2018). More about this can be found in paragraph 2.1.3.1.

2.1.2.2 Profitability

Most public transportation companies are profit-oriented companies. However, running bus transport is not always profitable by itself. This is why the Dutch government provides subsidies to ensure there is sufficient public transport. It is estimated that the government subsidises 45 per cent of the costs of transport operators, the revenue for bus operators is estimated at 55 per cent of their costs (CROW, 2013). The subsidy and revenue combined could in theory at least cover all costs, anything extra is profit for the transport companies. For more about the organizations that grant the subsidies and how to get them, see paragraph 2.1.3.1.

Providing public transport in these low-density areas is often cost-inefficient, while public transport companies are profit-oriented companies (de Jong, Vogels, van Wijk, & Cazemier, 2011). De Jong et al. (2011) distinguished seven key factors for successful public transport in low-density areas, of which the first three are crucial for success:

1. the presence of financial means
2. the division of responsibilities and cooperation between stakeholders
3. on-demand transport
4. sharing the financial burden
5. bundling of passenger groups
6. access and safety
7. customer service

2.1.3 Governments

This sub-paragraph provides information about government regulations that are important regarding the bus drivers shortage and transport obligations. This establishes a framework within which measures should be identified.

2.1.3.2 Government regulations

The Dutch public transportation authority's often see public transportation as a basic need for all citizens. Therefore, they include public transport for low-density areas in their laws or policies (de Jong et al. 2011). The European Union even ensured public transportation as a public right for everyone. This law called PSO[2] Regulation (1370/2007), ensures that public transportation is provided, even if it is not profitable (Stichting Maatschappij en Veiligheid, 2016).

Critique on Dutch public transportation law

For a bus to be acknowledged as public transportation it needs to have a timetable. This is regulated in the Passenger Transport Act, wp2000 (Wet personenvervoer 2000, 2021). Wijnand Veeneman, associate professor at TU Delft, criticised this law because smaller buses or other vehicles are not being acknowledged as public transport (NOS, 2023-b). Smaller buses and other vehicles can help to retain public transport in low-density areas. The wp2000 law also hinders the development of demand-driven public transportation, according to Fleur Gräper-Van Koolwijk, deputy mobility in the province of Groningen (NOS, 2023-b).

2.1.4 Other

Within this sub-paragraph, we showcase developments and critical subjects that are beyond stakeholders' control. The inclusion of these topics ensures the literature study attains the necessary level of thoroughness.

2.1.4.1 Innovations

Self-driving vehicles

The book Innovations in transport: success, failure, and societal impacts (Van Wee, Annema, & Köhler, 2022), describes what levels of self-driving vehicles you have, and which companies are working on this. There are six levels for driving automation, level 0 is no automation and level 5 is full automation. Waymo (n.d.), for example, is a company working on self-driving vehicles, including

trucks. Since trucks and buses are relatively similar, this innovation could have a big effect on public bus transport and their drivers. However, it is not expected that self-driving trucks or buses are going to take over any time soon.

There are already a couple of self-driving shuttle buses driving in The Netherlands. Transdev is driving since 1999 with autonomous, however small, buses on a fixed route. Important to notice is that they are not driving on a road between other traffic (Transdev, n.d.) (KiM, 2016).

Mobility-as-a-service (MaaS)

In the book edited by van Wee, Annema and Köhler (2022, p. 269), Wijnand Veeneman said the following:

> "Mobility-as-a-service is an innovation in which several new technologies are applied to integrate mobility options for the traveler, with the promise of seamless supply of mobility through a wide variety of modes (see for example Finger et al., 2015 and Smith, 2020). For the user, those mobility options are brought together in a single interface (Durand et al., 2018), mostly through an app"

MaaS can be used for mobility-on-demand, which means that a bus only comes when a traveller needs one. An example of this is the HaltetaxiRRReis in The Netherlands. This is a shared taxi, but part of public transport. It drives directly from bus stop to bus stop, without regard to bus routes. This initiative is part of making buses ride less at times when it is not busy but continues to offer the possibility of public transport (9292, 2022). Letting fewer buses drive in low-demand periods decreases the demand for bus drivers.

Social Return on Investment (SROI)

Social Return on Investment is about helping people with a labour market disadvantage to get back to work. SROI is addressing the moral standards of companies to invest a little extra to help these people, and eventually help themselves with new personnel (SROI, n.d.). Sometimes helping people with a labour market disadvantage can be hard due to legislation, Vluggen, Kuijpers, Semeijn and, Gelderman (2020, p.258) said the following about the problems with legislation: "Legal boundaries and government regulation play an important role in the implementation process of social sustainability". The Dutch government do raise awareness about SROI but provides very few guidelines for companies (Vluggen, Kuijpers, Semeijn, & Gelderman, 2020).

2.1.4.2 Average age & Retirement age

The Dutch population is ageing, which is expected to continue until 2040, in which 25 per cent of the people being older than 65 years. The areas outside the big cities (Randstad) are ageing even harder (CBS, 2022-a). This makes it harder for companies to rejuvenate their workforce.

Attracting younger staff is very important for public transport companies, this is because, as already mentioned in the introduction, a large proportion of bus drivers are over 50 years old (Verkeerskunde, 2023). This is confirmed by the annual report of the Dutch retirement fund for public transportation employees, which stated that between 2015 and 2019 the average age of the working members of the fund was 51.5 years old (SPOV, 2020). This combined with a retirement age in The Netherlands of 67 in 2024 will cause an increase in the outflow of bus drivers in the coming years.

2.1.4.3 Passenger growth

As mentioned in the theoretical relevance, there are forecasts of passenger growth. The predictions are between 11 and 18 per cent growth of passengers using BTM compared to 2018 (ProRail, 2021). BTM is short for bus, tram, and metro. Bus transportation is most represented in this prediction with 65%.

The forecasts are based on 'WLO-scenarios', these scenarios are based on that there will be no major political policy changes. Major transitions in sustainability, energy, digitalisation, and self-driving cars have also not been taken into account (ProRail, 2021). More clarifications on what is and is not included in these forecasts can be found in Rijkswaterstaat (2021). WLO-scenarios are the basis for many policy decisions, including mobility, in the Netherlands. The high scenario is based on 2% economic growth and relatively high population growth. While the low scenario is based on 1% economic growth and moderate population growth (CPB & PBL, 2015).

Factors that seem to affect the growth of passengers in The Netherlands the most are population growth, income growth, and growth of Schiphol passengers. Congestion and the number of students are also important factors affecting the growth of passengers (KiM, 2022).

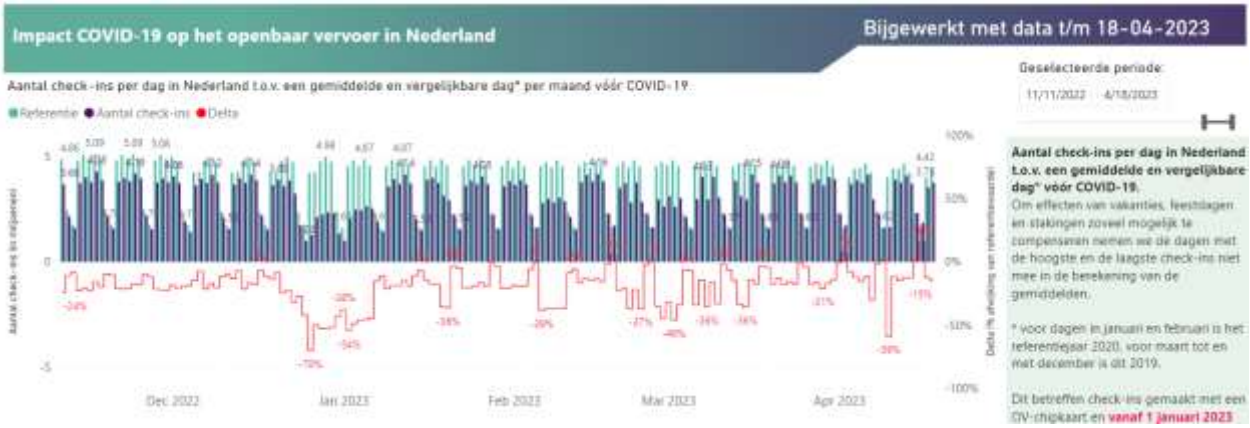
2.1.4.4 Impact COVID-19

In 2020, COVID-19 made its appearance in the Netherlands. The virus had a huge impact on the mobility of Dutch travellers, resulting in huge declines in bus passenger numbers. This change in travel behaviour, caused by more working from home, among other things, is also expected to have longer-term effects. KiM (2022) expects the previously estimated passenger growth rate to be revised downwards by 9.1% as a result of changed travel behaviour caused by COVID-19. The numbers in paragraph 2.1.4.3 are already adapted to this revised number.

In Figure 2 (Translink, 2023) there is a visual overview of the decline of passengers. The light blue bars are dates before COVID-19, and the dark blue bars are for the period 11/11/2022 until 4/18/2023. De red line shows the percentage difference.

Figure 2

Impact COVID-19 op het openbaar vervoer in Nederland



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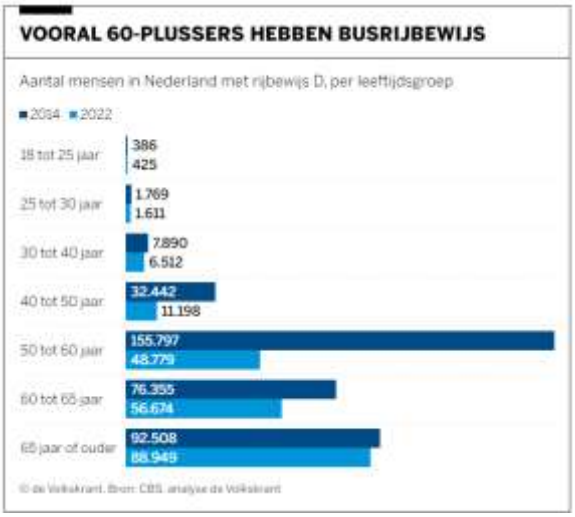
2.1.4.5 Pressure on the labour market

In The Netherlands, there is high labour market pressure. In the last quarter of 2022, there were 122 vacancies per 100 unemployed people, meaning that there are more jobs than people unemployed (CBS, n.d.-a). Although you do not have to be highly educated to become a bus driver, not many people can immediately start driving buses for public transportation. In Figure 3 the age distribution of people with the right driver's license (license D) is shown (Volkskrant, 2022). The age distribution, in combination with the driver's license a new employee needs, does not make it easier to find new employees.

The exact lack of bus drivers is unknown, the experienced shortage is explained in paragraph 1.1. The growing shortage of bus drivers fits in the trend of the transport and storage sector (CBS) with growing numbers of vacancies over the last few years. In 2012 there were 7 vacancies per 1,000 jobs, 10 years later it is 47 vacancies per 1000 jobs (CBS, n.d.-b).

Figure 3

Vooral 60-plussers hebben busrijbewijs



Reprinted from *Sterke daling in aantal mensen met busrijbewijs, terwijl vraag naar OV tot corona gelijk bleef,* by S. Hofstede, Volkskrant, 2022, retrieved from https://www.volkskrant.nl/nieuws-achtergrond/sterke-daling-in-aantal-mensen-met-busrijbewijs-terwijl-vraag-naar-ov-tot-corona-gelijk-bleef~b3961882/#:~:text=In%202014%20telde%20Nederland%20nog,aantal%20gedaald%20tot%20214%20duizend

The Dutch institute which takes care of allowances when people are unemployed, UWV, also sees that there are big labour shortages. To tackle this problem, they made a report which 34 recommendations about how to attract new employees. These 34 recommendations can be categorized under three major subjects, namely:

1) find talents in new places
2) organising work differently
3) binding and engaging

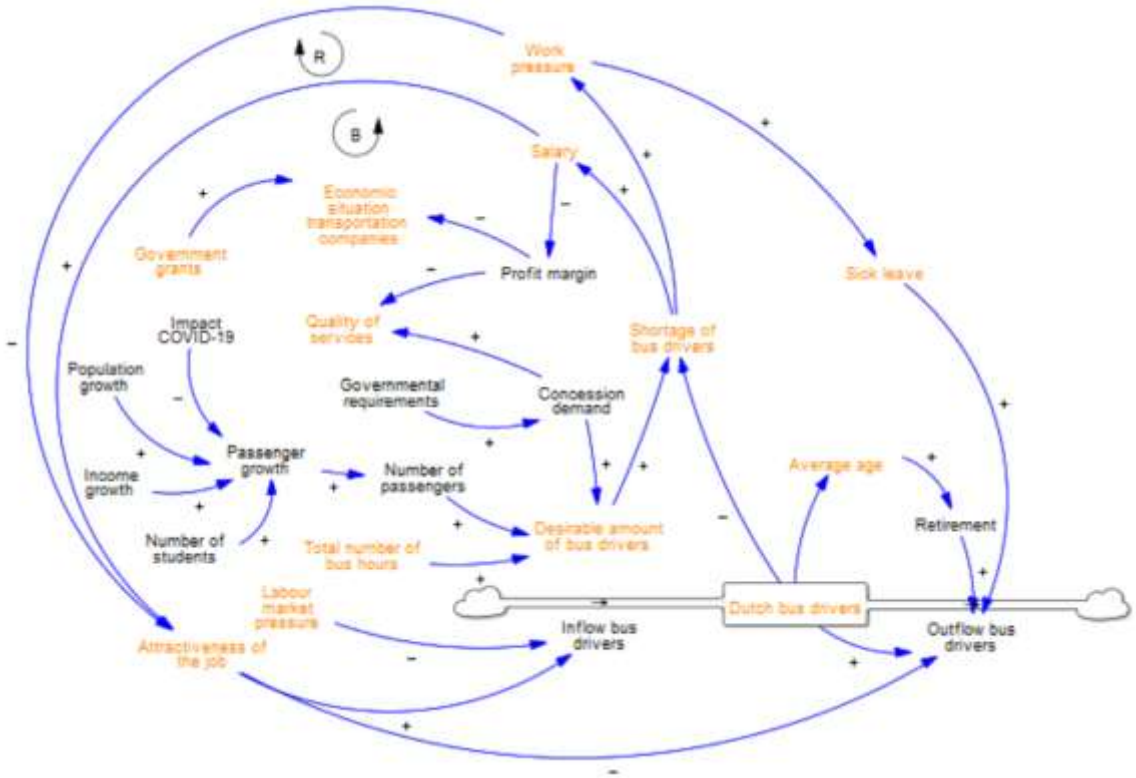
Examples of UWV's recommendations are hiring refugees, students, and people with labour market disadvantages. Other recommended topics that recur frequently are taking care of the employees in the sense of health, satisfaction, and terms of employment (Molleman, Eskes, Ahn, 2023).

2.2 Conceptual model & Key concepts

The findings of the literature are brought together in the conceptual model shown in Figure 4. The conceptual model is constructed in a System Dynamics format. The conceptual model provides a comprehensive understanding of the interconnections of the problem being studied. Further explanation is provided below Figure 4.

Figure 4

Conceptual model of the shortage of bus drivers



The factors marked in orange are key elements in the system, which means that they are very important or influential to the system. These elements are further explained in Table 3. The factor innovations cannot be found directly in the conceptual model. However, innovations can directly or indirectly affect the model. For example, SROI could influence the inflow, self-driving vehicles can reduce the need for bus drivers and MaaS can reduce the amount of bus hours driven. The aforementioned examples can make the innovations useful in overcoming the shortage and are therefore discussed.

There are 2 feedback loops in this model. Feedback loops show a chain of cause and effects in the model. This gives insights into the dynamics of the system and is essential for understanderstanding the systems behaviour (Monat & Gannon, 2015). The first, indicated by a R, is a reinforcing feedback loop, The other, indicated by a B, is a balancing feedback loop. The loop goes as follows:

Feedback loop R1: There is a shortage of bus drivers, which leads to higher work pressure, which leads to a lower attractiveness of the job, a lower attractiveness of the job leads to less inflow of bus drivers, less inflow of bus drivers leads to fewer bus drivers. When the stock of bus drivers is lower, the effect of the stock on the shortage becomes weakened, which leads to less decrease of the shortage, which makes the shortage even bigger. This makes the loop reinforcing, also known as self-strengthening.

Feedback loop B1: The second loop is a balancing feedback loop, indicated by a B. The loop goes as follows: There is a shortage of bus drivers, which leads to more salary, and more salary leads to more attractiveness of the job. A high attractiveness of the job leads to more inflow of bus drivers, more inflow of bus drivers means a higher bus driver stock, a high bus drivers stock leads to less shortage of bus drivers.

The interplay of a reinforcing and balancing feedback loop complicates the prediction of the model and system's future behavior. Their respective magnitudes and capacity to outperform each other dictate the system's behaviour. Moreover, other factors in the system can influence these loops, making the formulation of a realistic hypothesis quite challenging. Nevertheless, it can be inferred that a stronger balancing loop would lead to a decrease of the shortage, whereas a stronger reinforcing loop would result in an increase of the shortage.

Table 3.

Key concepts & definitions

Key concepts	**Definition**
Dutch bus drivers	Bus drivers in The Netherlands who work in public transportation of people. The bus drivers work for one of the following companies or subsidiaries: Arriva, Transdev, EBS, Keolis, Qbuzz, and RET
Average age	The average age of Dutch bus drivers and the age distribution of the workforce. This provides insight into future retirement numbers. The average age of employees in public transport between 2015 and 2019 was 51.5 years old.
Attractiveness of the job	Attractiveness of the job indicates the level of attractiveness of the profession bus driver. This assumes that the more attractive the profession is, the more people will become it. However, when the profession becomes less attractive, the amount of bus drivers will decrease.

Desirable amount of bus drivers	The amount of bus drivers who are needed to meet the number of bus hours, which in itself meets the amount of passengers and concessions demands. It gives input for the shortage of bus drivers variable.
Economic situation transport companies	The financial situation of bus transport companies as an independent factor is important. It is considered an independent factor because it does not directly influence the model. However, the relevance of this factor must be taken into account to maintain a sustainable system. For example, a high salary increase can lead to bankruptcy.
Government grants	The subsidies given by the Dutch government and public transport authorities to bus transport companies to enable bus transport in predefined areas and/or routes.
Labour market pressure	The ratio between vacancies and unemployed people. The more vacancies per unemployed people will lead to a higher labour market pressure. High labour market pressure leads to fiercer competition between companies to attract new employees. A lot of competition makes it harder to attract new bus drivers to reduce the shortage.
Quality of services	The quality of services refers to a certain, mostly prearranged with the authorities, level of quality or quantity in the bus services. For example, the bus frequency and passenger comfort. The quality of services is also an independent factor because it is not directly affecting the model. However, a certain level of quality is needed to keep bus transport attractive enough for passengers to travel with it.
Salary	The financial payment bus drivers receive for their labour. The standard salary is between €1805.48 and €3183.56 while it is often supplemented by surcharges. The literature states that a salary increase can have an impact on decreasing the shortage of bus drivers, but very large impacts are not expected.
Shortage of bus drivers	The discrepancy between the actual amount of bus drivers (the bus driver stock) and the desirable amount of bus drivers.

Sick leave	The number of days bus drivers do not come to work due to any sort of sickness.
Total number of bus hours	The accumulated number of hours that buses have driven or will drive. It provides a useful indication of the number of bus drivers needed because a bus cannot run without a bus driver.
Work pressure	The work pressure experienced by Dutch bus drivers that is negatively affecting the attractiveness of the job and the amount of sick leave.

In conclusion, Figure 4 illustrates various factors influencing the system, each with its unique magnitude of impact. Among these factors, the combinations within the feedback loops are particularly influential. Notably, the job's attractiveness remains a key consideration, alongside factors like the average age of bus drivers, labour market pressure, and government grants, all contributing significantly to the system's dynamics.

3. Methods

3.1 Research strategy

In this section, the research strategy of this paper will be explained. The research uses a mixed-method approach (Denscombe, 2019). To achieve the best results, both quantitative and qualitative data are used (Sterman, 2000).

The research strategy consists of four main parts. Firstly, a problem analysis (SQ1 & 2) is done, outlining the historical, current, and future state of the system. This analysis is supported by both quantitative data and qualitative data, with the latter being derived from interviews.

Secondly, the factors explaining the behaviour of the system and its problems are being distinguished and shown in a single System Dynamics (SD) model (SQ3). These factors, which help us understand the system's behaviour, can be linked, as discussed before, to three main stakeholders: 1) Bus drivers/employees, 2) employers in public bus services, and 3) the government. The data gathered is primarily qualitative and is analysed through content analysis methods (Luna-Reyes & Andersen, 2003).

Afterward, a qualitative exploration is carried out to find possible ways to influence the system and handle the problems identified in the first section (SQ5).

Finally, the effectiveness and feasibility of the methods mentioned in the previous section will be described to figure out which has the highest potential to solve the problem (SQ5). The effectiveness of the measures depends on how much effect they have on the explanatory factors and how feasible they are.

3.2 Data collection methods

Below the data collection and method of each research question will be further explained. This sub-chapter is divided into 3 sections, namely problem analysis, explanatory factors, and measures, including their corresponding sub questions.

3.2.1 Problem analysis

Sub-question 1

SQ1: Which quantitative developments have taken place in the number of bus drivers in recent years and how will this develop in the coming years if expected developments in the in- and outflow continue to occur?

Quantitative data

The purpose of sub question 1 was to collect quantitative data regarding the number of bus drivers and its development. The collected data includes numerical historical and current data related to:

- the number of bus drivers,
- kilometres travelled by bus
- shortage of bus drivers
- age distribution of bus drivers

Only data from 2001 and onwards are utilized, in consideration of the introduction of the wp2000 law (Wet personenvervoer 2000, 2021), which introduced the Dutch tendering system in 2001.

The data for this sub-question has been collected from various sources. For the number of bus drivers and kilometres travelled by bus, data from CBS (the Dutch organization responsible for tracking national statistics) was utilized. Age distribution data was acquired through a request to Expert C, who collaborates with transport authorities on a demand basis. Numerical expectations for growth, derived from the Dutch mobility knowledge institute KiM (2022) and ProRail (2021), were used as growth indication, as discussed in more detail in paragraph 2.1.4.3.

To calculate the future needed amount of bus drivers the following equations was used:

1) Kilometres travelled by bus per certain year / amount of bus drivers per certain year
2) Som of outcome equation 1 / 1 / number of years = average bus driver km ratio
3) Expected km's travelled by bus per scenario / Bus driver km ratio

The calculation provides the required number of bus drivers necessary to maintain the current average bus driver kilometre ratio in a future scenario with increased passenger numbers. The years 2020 and 2021 are excluded from these calculations due to the significant impact of COVID-19 on kilometres travelled (Translink, 2023), as this could corrupt the data.

The original data includes both bus drivers and tram drivers. This data could not be separated exclusively for bus drivers, so it also involves tram drivers. However, bus drivers are more prominent in these figures than tram drivers, as described in paragraph 2.1.4.3. From now on, the term 'bus drivers' will be used to refer to the combination of bus drivers and streetcar/tram drivers unless mentioned otherwise.

The original growth percentages for bus transport included data of bus, tram, and metro drivers. For 2030, there was sufficient data to calculate the growth percentage specifically for buses. However, due to insufficient data for 2026, the same calculations couldn't be carried out, leading to the utilization of the combined growth percentage instead. Details regarding the calculations of the adjusted growth percentage and more can be found in Appendix B.

Sub-question 2

SQ2: What will the developments in the number of bus drivers mean for the provision of bus services and others affected?

Interviews

To gather more information about who is affected by the outcome of sub question 1, interviews are held. The interviewees are experts from public transportation companies, mobility experts, bus drivers, and passengers who often travel with buses. The goal of the interviews was to discover on whom or what the shortage has an effect and what the effect is.

The interviews are conducted using a semi-structured format, either in face-to-face meetings or online. Four interviews were conducted with experts, eight interviews with bus drivers, and one interview with a location manager of a bus facility. After these thirteen interviews, saturation was reached, and additional interviews did not yield significant new insights (Kvale, 2007) (Hennink, Kaiser, & Marconi, 2017). Additionally, seven passengers were interviewed to incorporate their perspectives. The interviews are transcribed and coded using Atlas.ti. The interview guides for the expert, bus driver, and passenger interviews are provided in Appendix A.

The experts who were formally interviewed are:

- Expert A: senior consultant specialized in sustainable mobility at a big consultancy firm in The Netherlands.
- Expert B: concession marketer for a big bus company active in The Netherlands.

There are two other experts who contributed to this study, although there are no recordings or transcriptions available of their input. These experts are:

- Expert C: works on behalf of the Dutch public transport authorities, mainly checking concession applications.
- Expert D: manager for a Dutch consultancy company specialized in mobility.

Quantitative data

Quantitative data was gathered with the goal to quantify the effects mentioned in the interviews and derived from the literature. The following data was gathered:

- experienced work pressure of bus drivers
- sick leave of bus drivers
- average sick leave in The Netherlands
- average days of sick leave per age category in the Netherlands

The data was obtained from the Dutch Central Bureau of Statistics (CBS), the official organization responsible for tracking statistics in the Netherlands. This data was utilized to visualize the behaviour of the factors mentioned above over time.

3.2.2 Explanatory factors

Sub-question 3

SQ3: Which factors explain the behaviour of the system?

This sub-question focuses on identifying factors that are interconnected with, have an impact, or are vital for the system. Within this sub-question, a distinction has been made between exogenous and endogenous factors. Exogenous factors are those that are very difficult or impossible to change, affect, or influence by the public transportation sector and its stakeholders. Endogenous factors are those that can be altered or influenced by one or more stakeholders within public bus transportation.

Literature study

The first method employed to address this question is a literature study, which enabled the identification of established factors related to inflow and outflow.

Information and insights were gathered using academic literature as well as literature from (semi) governmental research institutions. The literature was sourced from the Radboud University's database called RuQuest and from Google Scholar. Various combinations of terms such as 'Dutch bus drivers,' 'urban bus drivers,' 'factors,' 'applicants,' 'public sector,' 'public transport,' 'labour market,' 'COVID-19,' 'innovations,' 'age,' 'job attractiveness,' 'inflow,' 'outflow,' 'retirement,' and more were employed to search for relevant literature.

In this literature study, articles were not strictly limited by publication date. This approach was chosen since factors related to personnel inflow and outflow are not inherently time-dependent. However, it is acknowledged that some factors might be more relevant in recent times. Hence, whenever feasible, the study prioritized more recent articles. Additionally, the frequency of article citations was considered, a feature only available through Google Scholar.

Interviews

To gather insights from experts, a total of four interviews were conducted. These expert interviews involved an employee from a public transport company, two mobility experts from consulting firms, and an expert representing transport authorities. Additionally, interviews were conducted with bus drivers and a location manager of a bus facility. These interviews were held concurrently with those from sub question 2 and followed a semi-structured format. By conducting these interviews, the knowledge and perspectives of experts, public transport companies, and bus drivers were used to create the most complete model possible (Andersen et al., 2012).

The objective was to identify new factors influencing the inflow and outflow of Dutch bus drivers in public transportation, as well as to validate, and if feasible, quantify the already identified factors, and verify the overall System Dynamics (SD) model. The same saturation criteria as those used for sub-question 2 were applied here. The interview guides for the expert, bus driver, and passenger interviews are provided in Appendix A.

Quantitative data

Quantitative data is collected and employed to validate and illustrate factors identified through interviews and the literature study. Additionally, it aids in highlighting the extent of the impact of various factors. The data is sourced from CBS and Expert C. Information regarding the number of vacancies in the transport sector and labour market pressure has been obtained from CBS.

The data obtained from Expert C included: the age distribution of bus drivers, years of service, sick leave percentage, and the number of bus drivers employed as agency workers. This dataset covered 41 concessions operating from 2002 to 2023, located throughout the Netherlands. The analysis is based on the average per year while working with this dataset. It's important to note that there are 28 concessions (excluding special regions, as discussed in paragraph 2.1.3.2) in the Netherlands (CROW, 2018). Since all of these concessions remain consistent over multiple years, the data from the 41 concessions provides a reasonably reliable representation.

Disconfirmatory interviews

To validate the overall model, its factors, and their relationships, a series of disconfirmatory interviews were conducted, following the approach proposed by Lune-Reyes and Anderson (2003). These interviews involved the same experts mentioned previously. The purpose of these disconfirmatory interviews was to foster confidence in the model, enhance its quality, and validate its structure (Andersen et al., 2012). These interviews were conducted in an unstructured format and were carried out concurrently with the interviews from the preceding sub-questions.

After the semi-structured questions from the previous sub-questions, the model was presented to the experts. The experts reviewed the model and provided their assessments (Lune-Reyes & Anderson, 2003). Any changes resulting from the disconfirmatory interviews are outlined in this sub-question.

3.2.3 Measures

Sub-question 4

SQ4: What are possible measures that can affect the system in a positive way?

Literature study

The first thing that was done to answer sub question 5 is a literature study. There is looked at what the literature says about preventing and remedying labour shortages.

For this phase of data collection, academic literature was gathered and studied. The literature was sourced from the Radboud University database known as RuQuest and from Google Scholar. The literature search involved utilizing various combinations of terms, such as 'Dutch bus drivers,' 'urban bus drivers,' 'labour shortage,' 'personnel shortage,' 'policies,' 'improving,' 'enhance,' 'public sector,' 'public transport,' and more. Similar to the limitations on publication date and citation conditions described for the literature study in sub-questions 1 & 2, the same constraints were applied to this literature study.

Interviews

The second method employed for data collection in this sub-question involved conducting interviews. These interviews followed a semi-structured format and were conducted either through face-to-face meetings or online interactions. The interviewees were the same individuals as those involved in the previous sub-questions. The saturation criteria applied in sub-question 2 were also applicable here. All interviews adhered to the same terms outlined in the preceding sub-questions.

The objective of these interviews was to gather new insights, facts, and perspectives on how to alleviate the shortage of bus drivers in the public transport sector in the Netherlands. The interview guides for the expert, bus driver, and passenger interviews are provided in Appendix A.

Sub-question 5

SQ5: What are the possible effects of the measures?

Trade-off

Because of a lack of data, policy testing through simulations in the SD model (Barlas, 2009) was not possible. Therefore, the interviews were used to indicated the impact and feasibility of the proposed measures. This is called the places to intervene script or technique (Meadows, 1999). The experts were asked about their perception of the impact and feasibility, the other sources are analysed with coding of the interviews through Atlas.ti.

The aim of the trade-off was to determine which measures have the most favourable and feasible impact on the shortage of bus drivers. These insights and recommendations are intended for the public transportation sector and government.

3.3 Uncertainties

Forecasting the future involves uncertainties, which are addressed through the adoption of WLO scenarios. The growth rates utilized to calculate the projected shortage in paragraph 4.1 are rooted in the WLO scenarios, as elaborated in *'Nederland in 2030 en 2050: Twee referentiescenario's'* (CPB & PBL, 2015) and further detailed in paragraph 2.1.4.3. By employing growth rates derived from the WLO scenarios, the research tackles part of the uncertainty because it is already considered in the WLO calculations and scenarios. By utilizing high and low scenarios, some uncertainties about the future are already partially considered.

These scenarios assume a low-policy future (CPB, & PBL, 2015), whether this is realistic is questionable. The challenge arises from predicting future policies in a democratic setting like the Netherlands, where government composition and perspectives can shift. Nonetheless, this study will utilize the WLO scenarios, recognizing that abrupt policy changes could influence the applicability of the research outcomes.

3.4 Research ethics

To ensure research ethics, this study adhered to the guidelines of the Economic and Social Research Council (2022). While collecting primary data from participants, every individual had the right and opportunity to cease participation at any moment during data collection. The interpretations and conclusions drawn from the interviews were, if desired, reviewed with the interviewees for validation and approval. However, this validation process did not extend to bus drivers or passengers due to their anonymity and the inability to contact them afterward.

Before conducting the interviews, participants were provided with advance written notice detailing the study's nature, objectives, data processing methods, and intended use of the interviews. The interviews were recorded for later transcription. Any audio or video recordings will be promptly deleted in accordance with Radboud University's guidelines.

The non-public data was anonymized prior to its acquisition. As this data is anonymized, it cannot be traced back to specific individuals. The data is stored within the researchers' SharePoint account, facilitated by Radboud University.

Given labour market pressures, the process of attracting new individuals could potentially have negative impacts on other companies and organizations. This study does not specifically focus on drawing new personnel from certain sectors, as this approach would not align with ethical considerations.

4. Results

In this chapter, the outcomes of each sub question are displayed. These results were generated using the methods described in the preceding chapter

4.1 Quantitative developments

This section discusses the historical, current, and future numbers of bus drivers, with an attempt to calculate the projected shortage of bus drivers in 2026 and 2030, aiming to provide insights into the progression of the problem. For this paragraph quantitative data from public and non-public sources have been gathered.

Historic number of bus drivers

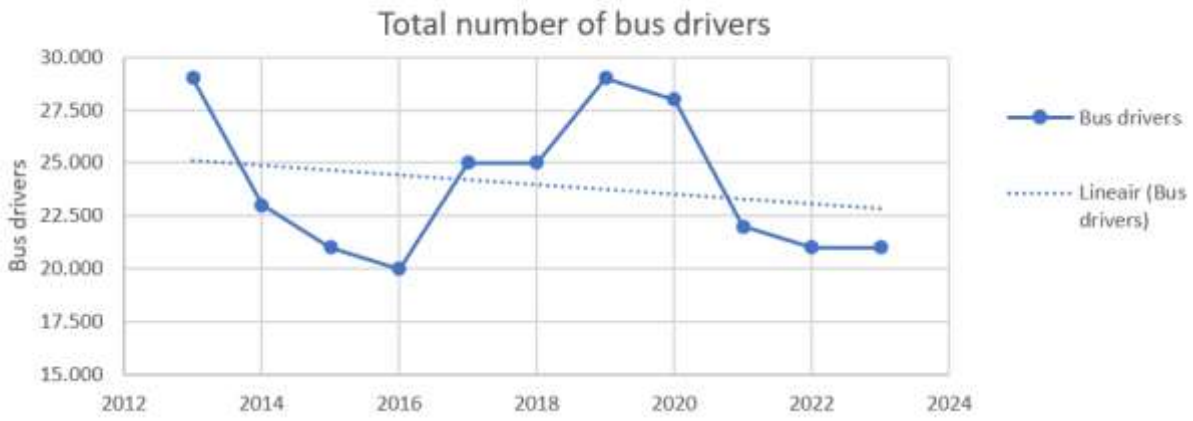
The initial step involves assessing the current and recent past count of bus drivers. Figure 5 displays the total number of bus drivers in the Netherlands for the period 2013-2023. Over the span of eleven years, the count of bus drivers has decreased by 27.59%. Notably, there was a peak in the number of bus drivers just before the outbreak of COVID-19.

According to Expert C, a considerable number of bus drivers, particularly agency workers, were laid off due to budget reductions necessitated by the impact of COVID-19 and the subsequent substantial decrease in ticket revenue. Expert B highlights that during the pandemic, there was a period when marketing and recruitment efforts for the bus driver profession ceased entirely, leading to a decline in the number of bus drivers. Public transport companies have a hard time to bring those or new people back into business.

The decline of the amount of bus drivers means the outflow is larger than the inflow. Death as an outflow reason was not included in this research because there is no reason to assume this has a significant factor on the amount of bus drivers.

Figure 5

Total number of bus and tram drivers



Adapted from *Werkzame beroepsbevolking; Beroep.* By CBS, 2023, retrieved from https://opendata.cbs.nl/#/CBS/nl/dataset/85276NED/table?dl=90586

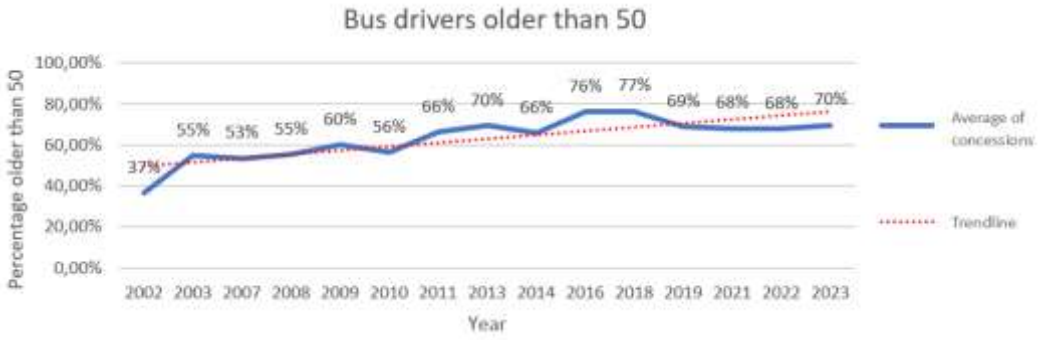
Outflow bus drivers

Over the past decade, an increasing percentage of bus drivers are aged 50 years or older. As a result, larger and larger groups of drivers are nearing retirement age. This trend has been widely reported in the news (Verkeerskunde, 2023) (Transport Online, 2022), and the data collected for this research confirms its significance, as shown in Figure 6. Additionally, the average age of members in the public transport retirement fund, which covers various professions within bus companies, consistently exceeds 50 years (SPOV, 2020).

The aging demographic of bus drivers will lead to a heightened outflow in the coming years. This challenge is worsened by the broader trend of aging across the entire Netherlands, which makes rejuvenating the workforce increasingly difficult (CPB & PBL, 2015). Currently, over 32% of current bus drivers are aged above 60 years and 70% of bus drivers is 50 years or older.

Figure 6

Percentage bus drivers older than 50 years old



***Based on 41 concessions located across the whole country*. Obtained via Expert C (personal communication, June 5, 2023)**

Current shortage

According to CBS (2023-f), there are 8,800 unfilled vacancies in the transportation across land sector. Bus drivers constitute 10.24% of the total workforce in this sector (CBS, 2023-e). Assuming that the vacancies are distributed proportionally, it implies that there are 901 unfilled vacancies for bus drivers (10.24% of 8,800). Therefore, the current shortage of bus drivers, based on vacancies, stands at 901.

However, some news articles suggest that the shortage of bus drivers is as high as 20% (NHNieuws, 2022), which contrasts with the 4.3% reflected by the 901 vacancies. An interview with Expert B indicates a 6% deficit, reasonably aligning with the 4.3% shortage. Considering this and the aforementioned data, this study assumes a current shortage of 901 bus drivers. It's important to note that the percentage of shortage could vary for specific regions.

It's a common practice for bus companies to initially employ agency workers rather than directly hiring new bus drivers. This approach is often chosen to avoid immediate commitment to permanent employment. Additionally, hiring agency workers can serve as a strategy to address the shortage of bus drivers. Based on calculations involving 17 concessions listed from 2018 to 2023, an average of 12.7% of bus drivers are agency workers. However, as not all agency workers are new employees, it is reasonable to assume that a portion of this 12.7% is utilized to mitigate shortages. Consequently, this can also be perceived as part of the current deficit.

Despite this, agency workers will not be taken into account in the calculation of the current shortage due to substantial uncertainty regarding the exact proportion used to fill up the shortage.

Future shortage of bus drivers

If the same ratio of bus drivers per kilometres travelled were maintained, the shortage of bus drivers would experience a substantial increase in the upcoming years. The deficit is projected to escalate from 37.8% in 2026 to 57.5% in 2030. In practical terms, this translates to an anticipated shortage of 20,000 to 22,000 bus drivers by 2030. Comprehensive details can be found in Table 4.

This calculation can be classified as conservative, as it does not yet incorporate the potential contribution of agency workers to alleviate shortages. Therefore, the current and future shortage of bus drivers might be even more significant. Furthermore, this calculation does not account for potential future policy changes. Also, the effects of the new collective labour agreement remain unknown (Expert A & B) and, therefore, are not included into this calculation.

Table 4

Forecast of bus driver shortage in 2026-2030, weighted against an average of 24.000 bus drivers

Calculation year	Needed bus drivers	Discrepancy between average bus drivers last 11 years and needed bus drivers 2026/2030	Bus driver shortage including outflow retirement	Total bus driver shortage including current shortage	Percentual shortage
2026 L	35,449	11,449	12,482	13,383	37.8%
2026 H	36,826	12,826	13,859	14,760	40.1%
2030 L	36,371	12,371	19,135	20,036	55.1%
2030 H	38,398	14,398	21,162	22,063	57.5%

*L= low growth scenario (2026 is 3% growth compared to 2019 (Kim, 2022)) (2030 is 5.68% growth compared to 2018 (ProRail 2021)) H= high growth scenario (2026 is 7% growth compared to 2019 (Kim, 2022)) (2030 is 11.57% growth compared to 2018 (ProRail 2021)). Average amount of bus drivers between 2013 and 2023 is 24,000. The current shortage of bus drivers is not included. The growth percentage of ProRail (2021) is corrected, which is shown in Appendix B.

This research was unable to collect sufficient data to calculate future inflow. Following discussions with Expert D, who conducted similar calculations in the past, it was determined that the most suitable approach is to use the average number of bus drivers over the past eleven years (24,000). Therefore, the assumption is that inflow and outflow (excluding retirements) will remain balanced. This assumption stems from the absence of indications suggesting a significant change in inflow. Thus, the outcomes above compare the projected required number of bus drivers in the future with the average number of bus drivers in the Netherlands over the past eleven years.

Conclusion

Over the past eleven years, the count of bus drivers has fluctuated, but the average is 24,000 drivers. The bus driver population is undergoing significant aging, with 70% of them being 50 years or older in 2023, and 32% being 60 years or older. This trend will notably impact the number of drivers exiting the profession due to retirement in the upcoming years.

Currently, the shortage of bus drivers stands at 901, and this deficit is set to increase due to growing passenger numbers and retiring bus drivers, projected to reach a range of 13,000-15,000 by 2026. This results in a deficit of 37.8%-40.1%. Looking ahead to 2030, the shortage is projected to expand further to a range of 20,000-22,000, corresponding to a deficit of 55.1%-57.5%

4.2 Effects of the shortage of bus drivers

In the previous section, we discussed the current and future shortage of bus drivers. This part focuses on the effects of this shortage and who is affected by it. The information in this section will help to understand why the shortage needs to be reduced in order to maintain or improve public bus transportation. The information was obtained by conducting interviews, reviewing literature, and collecting and analysing data from CBS.

The lack of bus drivers has effect on different things. In this sub-question it is divided in direct effects, effect on bus drivers and societal effects.

Direct effects

Bus cancellation

The shortage of bus drivers directly impacts bus schedules. Expert B mentioned receiving a memo every morning detailing the increasing number of cancelled rides. According to bus drivers interviewed and Expert B, the cancellations predominantly occur due to the lack of reserve drivers available to step in. Companies already struggle to complete schedules. To mitigate this, bus drivers are sometimes asked to work on their days off, helping to contain bus cancellations. However, this negatively affects the work-life balance of the drivers, which is one of the main factors contributing to bus drivers considering leaving their job (Lannoo & Verhofstadt, 2016). Bus cancellations can also result in an inability to fulfil the concession agreements. Unfortunately, this study lacks numerical insights into this matter.

As a result of the cancellation of buses, people are unable to get to work, school or doctors, or are delayed in getting there. This can have a great effect on the lives of these people, as well as the economy. News sites often report on individual cases of people who cannot do certain things because their buses are cancelled. An example (translated): “Angry passengers and crying bus drivers: many Qbuzz buses fail due to staff shortage” (Frenay, 2022). five out of eight interviewees said that people get upset by the fact that buses are cancelled or delayed. According to Expert A and several bus drivers who were interviewed this also has an effect on the work pleasure of the bus drivers, because they have to deal with the angry passengers. On the opposing side, passengers who were interviewed, but also bus drivers themselves, complain about the mood of bus drivers.

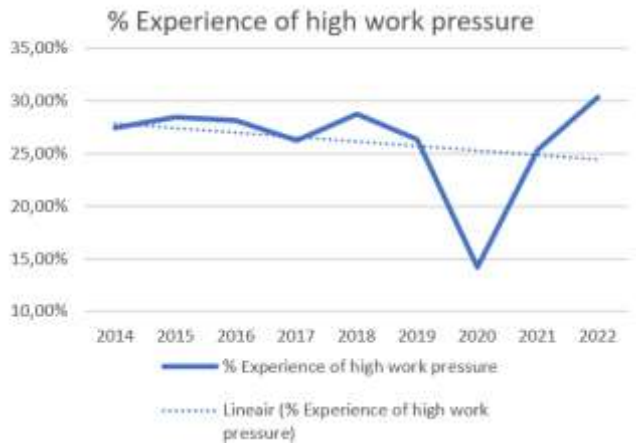
Effect on bus drivers

Work pressure & sick leave

The experienced work pressure by the bus drivers is doubled in two years since 2020, see Figure 7, after a trend of slow decrease. High work pressure is a key stressor for bus drivers, affecting the attractiveness of the job, and it leads to higher sick leave (Tse, Flin, & Mearns, 2006), which matches the growing trendline of Figure 8. The increase in experienced work pressure began simultaneously with the large drop of bus drivers in 2020, see Figure 5.

Figure 7

Percentage of bus drivers experiencing high work pressure

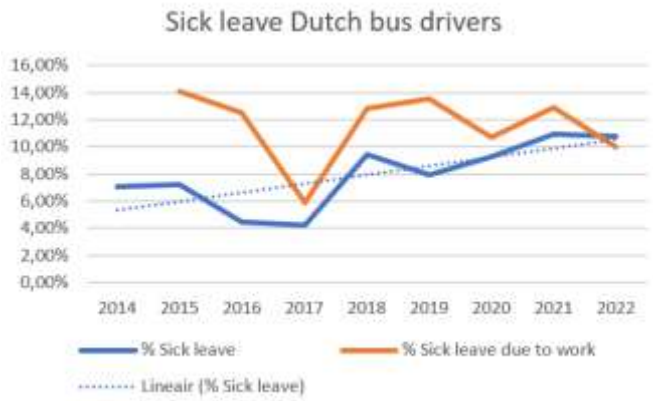


Adapted from *Psycho-sociale arbeidsbelasting werknemers; beroep* [Data file]. By CBS, 2023-a, retrieved from https://opendata.cbs.nl/#/CBS/nl/dataset/84436NED/table?dl=90583

The average sick leave of bus drivers in 2022 was more than double than the average of The Netherlands. Bus drivers have a sick leave of 10.8% in 2022 (CBS, 2023-b), while the average sick leave in the Netherlands was 5.2% (CBS, 2023-c).

Figure 8

Sick leave Dutch bus drivers

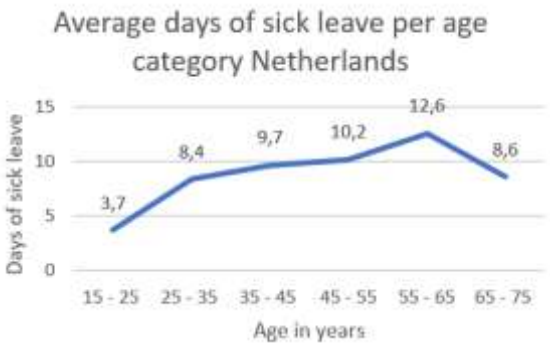


Adapted from *Ziekteverzuim volgens werknemers; beroep* [Data file]. By CBS, 2023-b, retrieved from https://opendata.cbs.nl/#/CBS/nl/dataset/84437NED/table?dl=90585

However, on average, work pressure has decreased over the last nine years, while sick leave has shown an increasing trend in recent years. This suggests that there might be an underlying reason for the rising sick leave. One plausible explanation for the growing sick leave rates could be attributed to the aging average age of bus drivers, as depicted in Figure 6. This trend aligns with the overall aging population in the Netherlands (CBS, 2022-a). Notably, older workers tend to experience more frequent sickness and subsequently take more frequent and extended sick leaves compared to their younger counterparts (CBS, 2023-c), as visually represented in Figure 9. During interviews, bus drivers commonly reported experiencing high work pressure, while emphasizing that its impact varies depending on how individuals manage work and time pressures.

Figure 9

Average days of sick leave per age category in The Netherlands



Adapted from *Ziekteverzuim volgens werknemers; geslacht en leeftijd* [Data file]. By CBS, 2023-c, retrieved from https://opendata.cbs.nl/#/CBS/nl/dataset/83056NED/table

Societal effects

The shortage of bus drivers, as previously discussed, has a direct impact on schedules, leading to a reduction in the frequency of buses operating. The Dutch government strives to enhance specific aspects within the country by providing funding for public transportation (KiM & CPB, 2009), namely:

- liveability, environment, and safety
- Accessibility and congestion
- Social participation
- Economic and competitive position

Reduced bus services have a negative impact on these goals (KiM & CPB, 2009). According to Expert A, bus cancellations could lead to people choosing not to use public transportation and selecting other options like cars, which would have negative effects on the environment (Milieu Centraal, n.d.) and traffic congestion (Expert A). The passengers interviewed share this sentiment, as they tend to go for different transportation methods due to bus cancellations and the unpredictability of schedules.

Conclusion

As mentioned earlier, the shortage of bus drivers leads to various effects, with bus cancellations being one of the most significant. This can greatly affect passengers who rely on buses for their jobs, healthcare, or social activities. Bus cancellations also undermine the government's objectives for public transportation, which include improving quality of life, economic competitiveness, and environmental well-being. Furthermore, the shortage has negative effects on the work pressure and consequential sick leave of bus drivers.

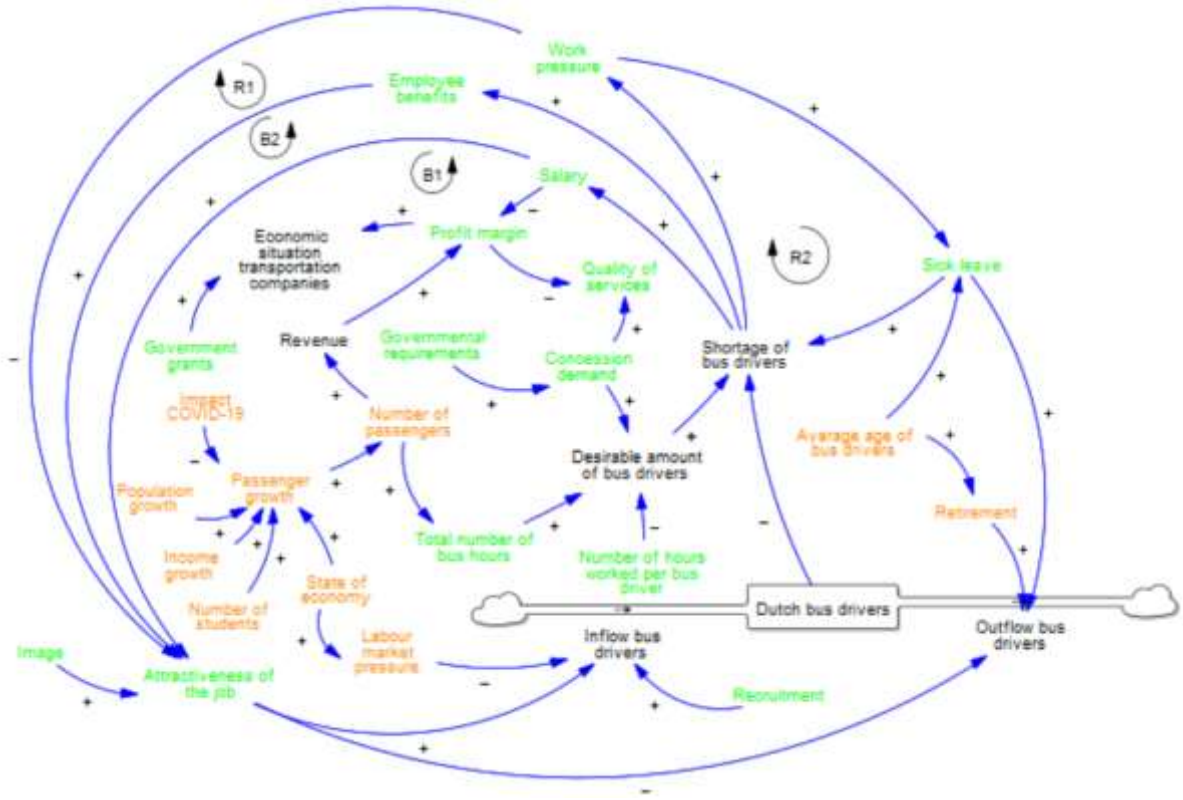
4.3 Exogenous & endogenous factors

This section distinguishes the exogenous factors and endogenous factors of the model. Exogenous factors are factors of which it is very hard or impossible to be influenced by the stakeholders connected to the bus shortage problem, while endogenous factors can be influenced by the stakeholders. This distinction provides clarity regarding the variables that can be influenced to affect the shortage of bus drivers, thereby offering guidance for future measures, which will be discussed in the following paragraphs. The factors were mainly distinguished through interviews with several stakeholders.

Firstly, the new model of the bus driver shortage system is shown in Figure 10. After that, the key exogenous factors are explained, and additions to the model, derived from expert interviews, are elaborated upon. After the exogenous section, the endogenous factors are being discussed in the same way. However, the endogenous part makes a difference between inflow and outflow factors, which will be explained furthermore.

Figure 10

Dutch bus driver system, exogenous and endogenous factors



Note. Green factors are endogenous and orange factors are exogenous. The justification of each link in Figure 10 can be found in Appendix C.

Exogenous factors

Figure 10 displays pertinent exogenous factors in orange, while the feedback loops labelled as R1 and B1 are explained in paragraph 2.2. Feedback loops R2 and B2 will be elaborated later in this paragraph.

Exogenous factors influencing the behaviour of the system:

- impact COVID-19
- population growth
- income growth
- number of students
- passenger growth
- state of economy
- labour market pressure
- number of passengers
- average age of bus drivers
- retirement

Key exogenous factors

1) **Passenger growth:** as can be seen in Figure 10, several exogenous factors are linked to passenger growth, which in itself is linked to the number of passengers. As a result, the number of passengers is a factor heavily influenced by factors that cannot or are very difficult to change. The number of passengers is an important indicator of the number of bus drivers needed, making it a key factor for the system.
2) **The state of the economy**: is also affecting the system state by influencing the labour market pressure, which makes it harder or easier to attract new bus drivers. It also affects the passenger growth, if the economy is flourishing, more people are likely to travel with buses.
3) **Average age of bus drivers:** cited by all respondents as the most important factor affecting the system is the aging of bus drivers. Because it has such a big influence on the outflow and therefore the amount of bus drivers, the average age of bus drivers' factor is a key factor in the system.
4) **Labour market pressure**: is currently under significant pressure, marked by a surplus of job vacancies in comparison to the available unemployed workforce (CBS, n.d.-a). This circumstance presents a challenge in attracting new bus drivers, as unemployed individuals have a variety of job options to consider.

Conceptual model vs new model

Several adjustments have been made to the model based on the data collection and analysis. These modifications are outlined below. They represent alterations in comparison to the initial conceptual model presented in Figure 4. The objective of these changes is to enhance the model's comprehensiveness.

Revenue is added to the model and is positively influenced by the number of passengers. The revenue is also positively linked to the economic situation of the transport companies (Expert A & C).

State of economy is added as a variable affecting the labour market pressure and passenger growth. The number of passengers and the labour market are conjuncture sensitive and therefore they are influenced by the state of the economy (Expert A).

The number of passengers is no longer directly linked to desirable amount of bus drivers. The number of passengers is now linked to total number of bus hours. The amount of bus hours driven decides how many bus drivers there need to be. The number of passengers affects the amount of bus hours driven you need, therefore this link has been changed (Expert D).

Endogenous factors

In Figure 10, the endogenous factors are depicted in green. While most of these factors were part of the conceptual model illustrated in Figure 4, new factors introduced in this paragraph are also explained.

Endogenous factors influencing the behaviour of the system:

- government grants
- salary (B1)
- attractiveness of the job
- work pressure (R1)
- sick leave (R2)
- governmental requirements
- quality of services
- concession demands
- total number of bus hours
- recruitment
- profit margin
- employee benefits (B2)
- image
- number of hours worked per bus driver

Inflow

The inflow of bus drivers is directly influenced by the exogenous factor of labour market pressure. Additionally, there are two endogenous factors that directly affect the inflow:

1) **Attractiveness of the job:** is a very important pillar for the inflow of bus drivers because if it is unattractive, people will not want to do the job, especially with the high labour market pressure. The attractiveness is in general determined by salary, employee benefits, work pressure, and image.
2) **Recruitment:** campaigns can persuade individuals to consider becoming bus drivers. Expert B, along with several bus drivers, mentioned a successful approach involving an open day event, where potential bus drivers are given the opportunity to experience driving a bus.

These two factors are influenced by the other variables in the system. The inflow is also under the influence of two feedback loops, one of which is reinforcing and the other balancing, denoted with R and B. Two loops which were not identified in the literature have come to surface during this research, both are explained below.

Loop R1: See paragraph 2.2

Loop B1: See paragraph 2.2

Loop B2: The loop operates as follows: A shortage of bus drivers results in improved benefits due to a stronger bargaining position, leading to increased job attractiveness. Higher job attractiveness leads to a greater inflow of bus drivers, which subsequently raises the overall bus driver count. A higher bus driver count leads to a smaller shortage of bus drivers.

The interviews with bus drivers indicate that they currently prioritize enhanced employee benefits over higher salaries. This preference stems from their satisfaction with their current salary pay scale. This leads to a more significant role for B2 than B1.

Outflow

The outflow is influenced by three variables/factors stated below.

1) **Attractiveness of the job:** if the job is not attractive people are more likely to go work somewhere else. (Lee & Mowday as cited in Dass & Baruah, 2013) (Tett & Meyer, 1993).
2) **Sick leave:** could lead to outflow of bus drivers, however a location manager of bus drivers said that this was not a big influence. It is possible that this is different for other geographical locations in The Netherlands. The sick leave is influenced by work pressure, see paragraph 2.1.1.1 and average age of bus drivers, see paragraph 4.2.
3) **Retirement:** the experts and retrieved data agree on the fact that retirement is the major reasons for outflow of bus drivers. This is mainly driven by the old age of most bus drivers, see paragraph 4.1 for more details about this.

Shortage of bus drivers

All the variables/factors mentioned above have varying degrees of direct or indirect impact on the shortage of bus drivers. The economic situation of transport companies and the quality of services, while not directly affecting the system, are still crucial considerations. These two variables are essential because enhancing employee benefits or salaries might not be feasible if the economic situation of the companies doesn't permit it. Similarly, the quality of services needs to meet a certain

standard to ensure the availability of governmental grants (Supervisor, personal communication, April 12).

Conceptual model vs new model

Several things about the model are changed as a result of the data collection and analysis, these changes are stated below.

Employee benefits is added because it plays an important role for the attractiveness of the job. Employee benefits are something else than salary, it refers to schedules, breaks, vacation leave, days off, retirement plan, labour conditions but also permanent contracts. This new variable was added based on the interviews with the bus drivers and experts.

New feedback loop R2. An arrow with a positive polarity is added from the variable sick leave aiming to the variable shortage of bus drivers' (Expert A) (Location manager & bus drivers' interview). For loop explanation see above. This loop may seem logical, however during this research the old age of bus drivers was confirmed in combination with data gathered about age-related durations of sick leave. Those two in combination with the interviewees saying it made the loop sufficiently substantiated.

Recruitment is added to the model because not only the state of the labour market and the attractiveness of the job influence the inflow, but also the recruitment efforts. Especially in this market where companies have to compete for new employees, recruitment and recruitment campaigns play an important role.

Sick leave being influenced by the average age. The average age has a positive polarity with sick leave, because older people are more often sick and they are sick for a longer period of time (CBS, 2023-b) (CBS, 2023-c).

Image is added as a variable influencing the attractiveness of the job. In four out of eight interviews with bus drivers, they mentioned that the image of bus drivers is not very positive. Five out of 7 passengers interviewed say the same thing about the image of bus drivers. The relatively bad image of bus drivers and the profession is negatively affecting the attractiveness of becoming a bus driver (Expert A). They believe this image has emerged because bus drivers are in the news negatively because they do not earn enough, especially during the strikes. In addition, through experiences people themselves have had on the bus. However, there is no complete consensus about this topic, Expert B does not think that the image of bus drivers is bad or negatively affecting the attractiveness of the job.

Number of hours worked per bus driver is according to the location manager also an important topic. He mentions that that young people do not want to work 40 hours a week anymore, or they want to be free at the weekend, also mentioned by the bus drivers. The managers explanation for this is that people receive surcharges from the government, which is an incentive to work less. This is because they will have the same amount or more money for less hours of work. This variable influences the desirable amount of bus drivers because if bus drivers work less hours, more bus drivers are needed for the same amount of bus hours driven.

Conclusion

There are several key factors in the system of bus driver shortage. The key exogenous factors are:

- passenger growth
- economic conditions
- the average age of bus drivers.

When identifying essential endogenous factors, it becomes evident that a division between inflow and outflow factors can be established. Key endogenous inflow factors encompass:

- labour market pressures
- job attractiveness
- recruitment

On the other hand, key endogenous outflow factors include:

- job attractiveness
- sick leave
- retirement

The latter is the most influential among them. The key factors are the ones that should be influenced in order to alleviate the bus driver shortage. Also, two new feedback loops were identified, one reinforcing and one balancing loop.

4.4 Measures

This section describes which measures could be taken to affect the system in a positive way, in other words, reducing the deficit. The measures are based on the literature and interviews with stakeholders.

To change the bus drivers' stock, the system has to be affected by certain actions. One or more of the factors/variables have to be changed and/or adapted to achieve this. Many different possible solutions emerged during this research. Those that emerged through multiple sources will be highlighted further below.

Government

The government can take several measures to decrease the shortage of bus drivers. The ones that are most mentioned in the interviews and literature are being set out below.

1) Increase grants

As mentioned in 2.1.2.2 the public transport companies heavily rely on subsidies of the Dutch government. Raising the governmental grants can have a big impact on the system and the bus driver deficit (Expert A & B). More money for the public transport companies enables them to provide better salary and benefits for the bus drivers. It is not very likely that this will happen because they are already speaking of budget cuts in public transport (Het Parool, 2022). However, a few months after the publication of this research, new elections will be held which could lead to a shift of plans. The extra money can be used to increase the attractiveness of the job and intensify recruitment efforts in an attempt to decrease the shortage.

2) Less requirements

Another way to decrease the deficit of bus drivers is to set less requirements for bus companies. An example of this was provided by the interviewed location manager. He mentioned that another less desirable approach involves reducing the number of buses by 20%, resulting in a corresponding 20% reduction in the required number of bus drivers. Also, the (informal) requirements imposed on bus drivers can be lowered, e.g., non-Dutch-speaking drivers. However, decreasing the requirements of bus transportation will negatively affect the goals, mentioned earlier, set by the government (KiM & CPB, 2009).

3) Innovations

Self-driving vehicles

An interesting innovation that can help reduce the need for bus drivers are self-driving buses. An example of this is already driving in Rotterdam. Here, self-driving buses act as shuttles between a subway station and an industrial site. The buses are quite small and are riding a fixed route on a track where no other traffic is riding (Transdev, n.d.) (KiM, 2016). The technology for self-driving buses on public roads is not far enough. Nevertheless, bus companies, the Dutch government, and universities should conduct further research to identify routes suitable for self-driving buses, thereby reducing the demand for bus drivers. Each self-driving bus that is riding, saves a bus driver. Therefore, this can have a high impact, but the applicability is difficult and should be well researched. There is as a matter of facts another example from The Netherlands where it failed thanks to technical reasons (De Kreij, 2021).

Mobility-as-a-Service (MaaS)

MaaS can help public transportation run more efficiently. By applying mobility on-demand more widely, bus drivers will not have to drive through low-density areas during low-demand periods with barely any passengers on the bus (9292, 2022). Letting fewer buses drive in low-demand periods decreases the demand for bus drivers (Jong et al., 2011). This could serve as an alternative to the reduction of routes driven, as mentioned in the aforementioned measure to decrease requirements

Public transport companies

Considering that there are no quick solutions expected from the government, it is up to the public transport companies to reduce the problem in the short run. The various measures that OV companies can take will be presented below.

1) More salary

News reports frequently highlight the issue of inadequate earnings among bus drivers (Verkeerskunde, 2023). Expert A further emphasizes that addressing this concern is crucial for attracting a larger number of bus drivers. However, there is a new collective agreement which raises the salary of bus drivers, the effects of this new agreement are not yet known. However, six out of eight bus drivers who were interviewed said that there is nothing wrong with the salary or retirement plan. As mentioned in the literature review, the interest in the job itself is more influential to apply than the salary. But there are studies who indicate that higher wages can make it easier to fill vacancies (Dal Bó, Finan, & Rossi, 2012).

According to Expert C getting paid during your education can positively influence the inflow of the system. For one of the interviewees who just became a bus driver, this was a key factor for starting with the education program.

2) Better benefits

The interviewees, literature, and experts are all in consensus about improving the benefits of bus drivers. Things mentioned by interviewees that can be improve the benefits of bus drivers:

1. continue to pay downtime
2. continue to pay for broken shifts
3. free travel by bus
4. customized schedules
5. less irregularity in working time
6. paid breaks
7. more breaks
8. retirement plan

Especially the customized schedules and less irregularity in working time are considered important. The buses are driving 365 days a year almost the whole day, this gives room for very irregular schedules which are not appreciated by most bus drivers and scares of potential new bus drivers. They suggest that you should customize schedules so potential new bus drivers can indicate when they want to work. By making these customized schedules, people are more likely to join and remain in the workforce because they know when they will have to work (Expert B). Fixed working hours enable them to have a balanced work-life balance and have their preferred lifestyle outside of work (Vann, Wessel & Spisak, 2000).

3) Permanent contracts

According to three bus drivers interviewed the type of contract is very important for bus drivers to join the profession and stay in it, it enhances job security (Dass & Baruah, 2013). It is common within the bus industry to first join the company as a temporary worker through an agency. This creates uncertainty for bus drivers. They have no secure employment and do not know how long they can work there (Vann, Wessel & Spisak, 2000). It can also cause problems when buying a house, making it more attractive to work somewhere else where you can get a permanent contract after maximum 2 years. Providing bus drivers with permanent contracts earlier and avoiding hiring through agencies would alleviate these uncertainties, making the profession of bus driver more attractive.

4) Recruitment

Recruitment is directly affecting the inflow of bus drivers, therefore an important factor on which measures could be taken. Several suggestions have been made to improve the return on recruitment actions.

1. approachable introductory days
2. customized schedules
3. attracting unused labour capacity: students, housewives etc.
4. attracting Immigrants with a legal status
5. social return on investment (SROI, see paragraph 2.1.4.1)
6. promote awareness of the salary and benefits
7. approaching specific target groups

The latter is very important, according to the site manager of a bus company. He is convinced that approaching specific target groups and offering them customized schedules can have a very big effect. Expert B supports this claim by indicating that the companies should facilitate bus drivers as much as possible to recruit and retain them, as discussed by benefits. However, the process of achieving this type of scheduling demands a significant amount of additional time and effort.

Because of the high average age of bus drivers, there is consensus among the interviewees that attracting younger employees is an important pillar of a new recruitment strategy.

Bus drivers

Bus drivers themselves can also do something in order to decrease the shortage. This is outlined below.

1) Improving the image

As discussed before, the image of bus drivers is not great. Some of the interviewees argue that the negative image of bus drivers negatively affects the inflow of bus drivers. They also propose that bus drivers should be more friendly and kind to customers in order to improve their image and attract new people. However, changing the social behaviour of the drivers, especially older ones, is quite hard (interviews) and difficult to maintain (De Witte & Jonker, 2003).

2) More full-time workers

Based on interviews conducted with bus drivers and the location manager, it has been found that a significant number of bus drivers are no longer working full-time. Regarding the interviewed location

manager, it is noteworthy that 10 years ago, 95% of the employees were working full-time, whereas currently, only 65% are. This trend can be attributed to several factors, including: 1) the implementation of the 100/80/60 work arrangement, 2) a decreasing willingness among young individuals to commit to 40-hour workweeks, and 3) the attractiveness of reduced-hour schedules as a result of government allowances.

The 100/80/60 work arrangement allows senior bus drivers to work 60% of their previous hours, receive 80% of their former salary, and continue accruing 100% of their pension (Expert C).

Conclusion

There are various measures that each stakeholder can undertake to alleviate the deficit of bus drivers. As discussed, some of these measures are more feasible than others. For instance, it is unlikely that the government would significantly increase grants or lower their requirements, as this could impact their objectives concerning public transport. Additionally, the measures that bus drivers themselves could potentially adopt are challenging to achieve. Therefore, the decision was made to concentrate the following section on measure that public transport companies could implement, including the innovation measures.

Table 5

Overview possible measure per stakeholder

Possible measures		
Government	**Public transport companies**	**Bus drivers**
Increase grants	More salary	Improving the image
Less requirements	Better Benefits	More full-time workers
Innovations: 1) self-driving vehicles, 2) MaaS	Permanent contracts	
	Recruitment	

4.5 Impact and feasibility of measures

This paragraph focuses on the evaluation and ranking of the potential measures outlined in section 4.4. The assessment is based on both the measures effect/impact and its feasibility. The resulting rankings are presented in Table 6, followed by detailed individual explanations of each measure, elaborating on their effects and feasibility. This approach will offer an overview of the anticipated effects of each measure and its level of feasibility, thus enabling the formulation of actionable steps. The data used to compose this paragraph was gathered through interviews with several stakeholders.

Table 6 presents an assessment of each measure based on its impact and feasibility, with the aim of identifying the most promising option. Individual scores, ranging from -2 to 2, contribute to a total score that spans between -4 and 4. Interviewee responses were evaluated using plus and minus indicators, each capped at a maximum of 2. These indicators were summed and subsequently divided by the total number of participants to yield an average rating. Bus drivers scores represent an average of their opinions.

Table 6

Effect and feasibility of measures on a -2 till +2 scale

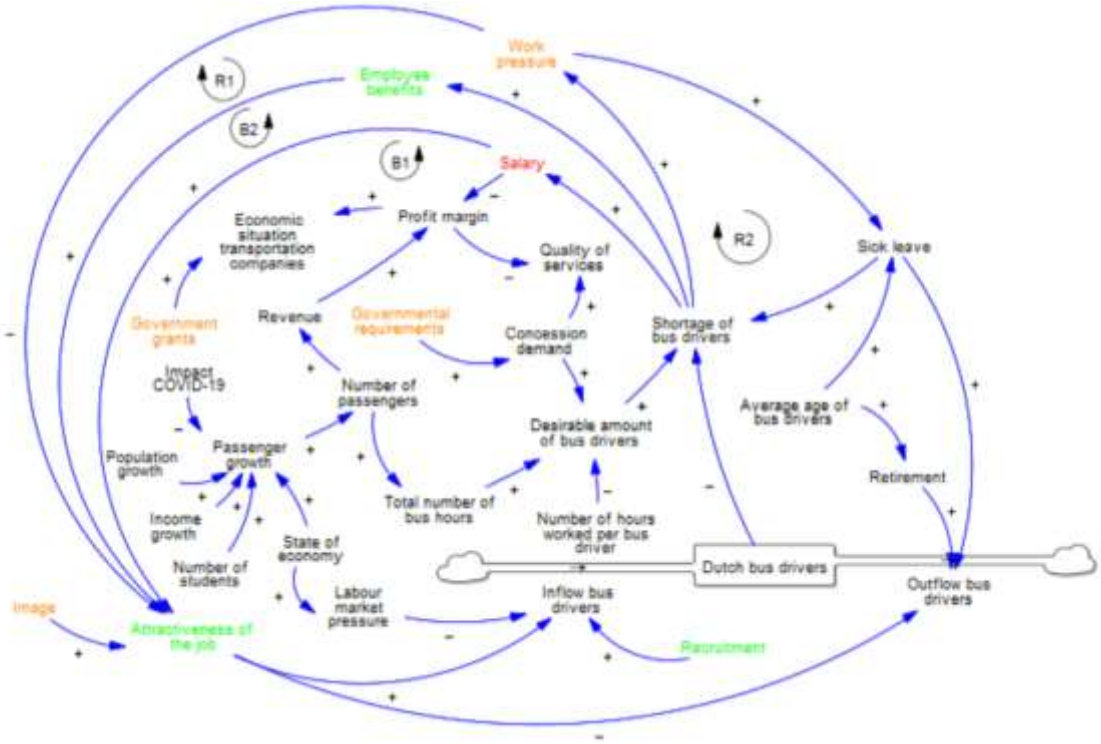
Measure	**Effect of measure**	**Feasibility of measure**	**Score**
More salary	1.33	-0.8	0.53
Permanent contracts	1.14	0.57	1.71
Better benefits	1.33	0.43	1.76
Recruitment	1.66	0.83	2.49
Self-driving vehicles	See explanation below		
MaaS	See explanation below		

As can be seen in Table 6, the expectation of experts, bus drivers and the literature are that the four measures will have a reasonable impact. However, the feasibility of the different measures varies greatly. More salary for bus drivers is expected as not feasible, while other recruitment ways are described as very feasible. In conclusion, alternative recruitment methods emerge as the most favourable option, given their substantial impact and reasonable feasibility. Enhanced benefits packages and the provision of permanent contracts also stand as viable considerations. While the prospect of higher salaries shows a decent effect, its lack of feasibility renders it an unrealistic solution. Due to limited familiarity with self-driving vehicles and Mobility-as-a-Service (MaaS), the study's respondents did not provide a ranking for these two aspects. Nevertheless, further information regarding these innovations is available at the end of this section.

In Figure 11, the measures are displayed in the System Dynamics model. The green factors are aspects where intervention is recommended. The customized schedule is part of the employee benefits and, when paired with recruitment, presents a favorable approach. The orange factors could potentially yield significant impact but might face feasibility challenges considering other aspects such as costs, effort, and time. The red factor, salary, could generate substantial impact if increased significantly. However, bus drivers express satisfaction with their current salary, and a substantial raise would incur substantial costs, making it less realistic. Therefore, it is recommended to focus on the other measures than salary.

Figure 11

Places to intervene



More details on the impact and feasibility of the various measures are given below.

More salary

Effect

Increasing the salary of bus drivers can have significant effect on the inflow of bus drivers, as stated by Expert A and D. This is consistent with the findings of Dal Bó, Finan, and Rossi (2012) in their research on vacancies in the public sector in Mexico. Their study indicates that higher salaries attract more capable applicants (measured by their IQ) and lead to a higher acceptance rate. According to the other interviewees, there is no necessity for a higher salary.

Feasibility

Increasing the salary of bus drivers presents challenges. Transport companies rely significantly on government subsidies to maintain profitability (CROW, 2013). Over the years, the government has been allocating more funds to public transport (KiM, 2022). These increased allocations have helped bus companies cover rising costs, inflation, and accommodate the new collective agreement, which includes higher salaries for bus drivers. Nevertheless, as of now, the desired impact is not yet seen. To effectively raise bus driver salaries, the government would need to allocate a substantial amount of additional funding to public transport. The likelihood of the government taking this step is currently low, as discussions of budget reductions in public transport are already underway (Het Parool, 2022). However, considering the recent improvements in the collective agreement with increased salaries, a salary raise remains feasible (Expert D).

Better benefits

Effect

There is widespread agreement that improved benefits (see paragraph 4.4) will play a role in attracting more bus drivers and consequently reducing the shortage of bus drivers. Expert B and the location manager are both certain that the benefits are already good, and further enhancements would still have an impact. However, they believe the impact might not be as significant as other respondents suggest. Expert D holds the view that there might not be a substantial effect, as the current benefits are already adequate. Therefore, increasing benefits may not necessarily lead to a notable increase in new bus drivers.

Feasibility

The overall conclusion is that increasing the benefits to tackle the shortage of bus drivers is quite feasible. It is important that these improvements are communicated to the outside world in order to boost recruitment. If the latter is not done properly, it will have less impact.

Permanent contracts

Effect

Job security is considered very important for bus drivers. Therefore, the effect of permanent contracts, and especially hiring employees in-house rather than through agencies, which is common for the first few years of a bus driver's career, will have a significant impact on the shortage of bus drivers. The bus drivers and experts interviewed are convinced that this change will attract more young people because it will provide them with a sense of stability.

Feasibility

There is not a high level of confidence in providing permanent contracts more quickly or immediately implementing in-house hiring. This hesitation arises from the fact that bus companies prefer to assess new bus drivers' performance before offering permanent contracts, which is why they often begin with temporary agreements. Additionally, many companies choose to hire through employment agencies to minimize risk, resulting in job uncertainty among employees. However, according to the interviewed location manager, some bus companies are transitioning to in-house employment because they are observing positive outcomes. The feasibility of implementing contract changes is assessed to be moderately positive.

Recruitment

Effect

The impact of recruitment strategy adjustments is regarded as significant. The consensus is that companies should tailor their approach to target specific audiences that could truly appreciate the advantages of becoming a bus driver. The emphasis should be placed on promoting the flexible working hours (as mentioned in sub-Question 4 benefits) and the competitive salary. It is suggested that the bus driver profession should be portrayed in a positive light, rather than being overshadowed by negative news related to strikes. Moreover, placing greater emphasis on reaching out to individuals facing labour market disadvantages (Social Return on Investment), students, and migrants could also yield considerable results.

Feasibility

There are different thoughts on the feasibility of a change in the recruitment process. Most of the respondents who directly work at a bus company, but also one of the experts, think that this is a very feasible measure. However, one of the experts believes that it is not feasible in the light of the competition with other sectors, especially when the labour market pressure is high. There is consensus that it will be hard to identify the right groups to approach. Considering all of the above, the overall feasibility is moderately positive.

Self-driving vehicles

Self-driving vehicles can make a very big impact because it allows buses to drive while there is no bus driver needed. As discussed before there is already a bus route in The Netherlands on which only self-driving buses are driving. However, there are a lot of complications in applying it on a large scale due to technical reasons. An example of this was the pilot in Wageningen (De Kreij, 2021). Because of the costs and technical implications, the feasibility of self-driving vehicles is low (-). However, it is

possible, as shown in the example, to apply this in other places (Transdev, n.d.) (KiM, 2016). For this reason, further research will need to be done on which routes this could be applied. Future technological developments could accelerate the implementation of self-driving vehicles.

MaaS

Mobility-as-a-Service can have an impact on the shortage of bus drivers because it allows buses to drive less when it is not busy but still continues to offer public transportation (9292, 2022). However, KiM (2020) does not expect large changes in transport mode choice until 2030. They do see that people using MaaS are replacing it for regular public transport. Taking both things in mind, the feasibility of MaaS having a significant impact on the shortage of bus drivers is considered low (-).

5. Conclusion & discussion

5.1 Conclusion

The purpose of this study was to map the problematic shortage of Dutch bus drivers in order to get a better idea of how the shortage arose, how it will develop but more importantly what policies can counteract it. The research question of this research was:

- How can policy makers address the shortage of bus drivers in public transportation in The Netherlands in 2030 by targeting influential factors?

To answer the research question, five sub-questions have been answered through a mixed-method strategy. Interview questions, calculations and justifications of the System Dynamics model can be found in the Appendixes. For access to transcripts, contact the author.

SQ1: Which quantitative developments have taken place in the number of bus drivers in recent years and how will this develop in the coming years if expected developments in the in- and outflow continue to occur?

Over the past eleven years, the number of bus drivers has fluctuated between 20,000 and 29,000. The average count of bus drivers during this period is 24,000, while the count stands at 21,000 in 2023. Through calculations in this research, an estimation of the present and projected future shortage of bus drivers has been identified, as presented in Table 7. The outcomes can be considered conservative, given the low current shortage. While some news articles suggest current (local) shortages of up to 20% (NHNieuws, 2022), no evidence supporting this has been found. Because of considerable uncertainty about the precise proportion of agency workers utilized to fill up shortages, this factor was not considered in this research. Consequently, the actual current shortage could potentially be even greater.

Table 7

Shortage of bus drivers' overview

Year	Shortage of bus drivers	Percentual shortage of bus drivers
2023	901	4.3%
2026	13,000 – 15,000	37.8% - 40.1%
2030	20,000 – 22,000	55.1% - 57.5%

* The numbers in this table are based on the assumption that all factors affecting the shortage of bus drivers remain unchanged. For the calculations and explanation of the numbers in this table see paragraph 4.1 and Appendix B.

This research finds that the shortage is mainly due to the aging bus driver population and a low inflow of new drivers. With over 32% of current bus drivers aged 60 or above and projected to retire by 2030, nearly one-third of the workforce will exit within the next 7 years. This leads to a substantial outflow, resulting in a significant rise in the shortage of bus drivers. It is important to consider that the effects of the new collective agreement for bus drivers are currently unknown and, therefore, not taken into account in this sub-question.

SQ2: What will the developments in the number of bus drivers mean for the provision of bus services and others affected?

This research shows that the lack of bus drivers results in frequent bus cancellations and increased work pressure, contributing to higher rates of sick leave, which in turn reinforces the shortage. These cancellations have a significant impact on passengers who rely on bus transportation for essential aspects of their lives, often causing frustration and prompting them to seek alternative modes of travel. This shift away from buses and the adoption of alternative transport options undermine the government's social and economic goals related to public transport.

SQ3: Which factors explain the behaviour of the system?

A distinction is made between exogenous and endogenous factors. The following exogenous factors have a big impact on the system:

1) passenger growth
2) state of the economy
3) average age
4) labour market pressure

The inflow is being influenced by the following two endogenous factors:

- The attractiveness of the job and recruitment.
- An exogenous factor influencing inflow is labour market pressure.

The outflow is influenced by the following factors:

1) retirement
2) sick leave
3) attractiveness of the job.

There are two balancing feedback loops and two reinforcing feedback loops that influence the shortage of bus drivers. The balancing loops are driven by 1) increased salary and 2) improved benefits due to heightened bargaining power resulting from the shortage, which reduces the

shortage because of an increase in attractiveness of the job. The first reinforcing loop arises from high work pressure which negatively affects the job attractiveness, resulting in fewer employees leading to more work pressure, which further decreases the number of employees, intensifying the shortage. The second reinforcing loop also originates from high work pressure, which increases sick leave which itself further diminishes the number of bus drivers, thus intensifying work pressure in an ongoing cycle.

There are several factors which can be changed to influence the abovementioned endogenous and exogenous factors:

1) employee benefits
2) salary
3) recruitment
4) work pressure
5) image

An additional highly influential factor is labour market pressure; however, it is very hard to change. These changeable factors provide opportunities for implementing measures.

SQ4: What are possible measures that can positively affect the system?

This research identified several measures the government can take to increase the amount of bus drivers to fight the shortage are:

1) increasing grants
2) less requirements for bus transport
3) stimulating innovations.

The public transport companies can take the following actions to attract more bus drivers:

1) more salary
2) better benefits
3) permanent contracts
4) other ways of recruitment

There are also two things bus drivers can do to decrease the need for more bus drivers, namely:

1) improve their image
2) more full-time workers

The overall sentiment of the experts and bus drivers was that the measures the public transport companies can take are the most promising ones. These measures are further discussed in the following sub-question. Mobility-as-a-Service and self-driving vehicles are also considered as possible measures.

SQ5: What are the possible effects of the measures?

The most promising measures have undergone further examination. The combination of customizing schedules and targeting specific groups during recruitment is projected to yield the most substantial impact while remaining highly feasible. Thus, this approach stands as the optimal measure to achieve an increase in the amount of bus drivers. Additionally, promoting the customized schedules to these targeted groups will enhance its effectiveness. Other examined measures, ranked in order of their combination of impact and feasibility are: improved benefits, quicker permanent contracts, and increased salary. The use of innovative solutions such as Mobility-as-a-Service and self-driving vehicles is considered a potential solution, although the latter, in particular, is not regarded as a short-term feasible remedy.

The answer to the research question is that the shortage of bus drivers is projected to increase from 901 now to between 20,000 and 22,000 drivers by 2030, primarily as a consequence of an aging population of bus drivers. Nearly one-third of the bus drivers are currently 60 years or older, and they will retire between now and 2030. According to this research the greatest effects of the bus driver deficit are numerous bus cancellations and an increase in work pressure. According to the experts and bus drivers interviewed in this research there are several measures possible for reducing the shortage, of which customizing schedules combined with targeted recruitment efforts aimed at specific groups represents the most realistic and feasible approach to decrease the deficit. Therefore, this research recommends that bus companies and governments prioritize the implementation of this approach in their strategies to attract a greater number of bus drivers in order to decrease the shortage. A combination of the measures discussed in this research could produce the most significant impact.

5.2 Discussion

The findings of this research show that the current shortage of bus drivers will undergo a significant increase in the upcoming years. These results underscore the necessity for alternative courses of action to attract a larger pool of bus drivers; otherwise, the familiar landscape of bus transportation in the Netherlands may cease to exist. Presenting quantitative forecasts of the approaching shortage serves as a crucial addition to the existing body of literature concerning Dutch public (bus) transport, particularly with regard to the discourse surrounding Dutch bus drivers.

To the best of the student-researcher's knowledge, the available public literature lacks a comprehensive visual overview of the Dutch bus driver's shortage problem. This research tried to provide the literature with an extensive model which is based on the literature and interviews with stakeholders. The resulting model and its accompanying overview could provide a solid foundation for future investigations into this subject. Moreover, quantifying the model can potentially yield valuable new insights.

Contrary to the perceptions conveyed by numerous news articles and the opinions of non-bus driver interviewees, the bus drivers who were interviewed are quite satisfied with their salary. They believe they are fairly compensated for their work. However, this should not be confused with other benefits, as they are not always satisfied with those.

Numerous individuals featured in the news, including politicians, warn that the shortage will increase as a result of the aging population of bus drivers. This research can provide a certain degree of quantitative support for such statements. This information can be utilized to emphasize the significance of increased funding or alternative strategies.

6. Implications

6.1 Practical implications

If the outcomes of this research and the proposed further research are successfully implemented, they could have implications beyond addressing the bus driver shortage. Reducing the shortage will result in fewer bus cancellations, enhancing Dutch citizens confidence in bus transportation. It is probable, as mentioned by interviewed passengers, that this heightened confidence in bus transport will lead to increased use of it. This could significantly influence the Dutch government's goals, which aim to facilitate and enhance public transport to achieve improvements in (KiM & CPB, 2009):

- liveability, environment, and safety
- accessibility and congestion
- social participation
- economic and competitive position

Reducing the shortage of bus drivers by attracting new individuals could have implications for other sectors in the Netherlands. If the new bus drivers are drawn from other sectors, while the labour market pressure remains high, it could lead to a heightened shortage in those other sectors.

Further research is needed on the implementation of large-scale schedule customization. Nonetheless, it can be assumed that this would involve additional effort and expenses, at least in the early stages. These costs would likely be covered by the companies themselves or through government funding, with the former option leading to increased financial burdens for the companies. As a result, ticket prices may rise or greater subsidies may be required. If the government allocates more funds, this could reduce resources for other expenses, potentially necessitating tax rises or increased government debts.

6.2 Reflection

This research was intended to be way more quantitative than it turned out. The willingness of cooperation of the bus companies was in advance to positively estimated. Because the lack of willingness to cooperate, the research had to make a shift to a more qualitative research approach. Where possible the quantitative aspects remained.

The aim of this study might have been a little too ambitious in retrospect. Forecast calculations are often studies by themselves. As a result, it is possible that certain things were not included in the calculations. However, the best effort was made.

6.3 Policy recommendations

If bus companies and governments want to reduce the bus driver shortage, it is important to consider the entire system around the shortage of bus drivers as outlined in this and other researches and literature (Vennix, 1996). While the proposed actions in the conclusion section can aid in decreasing the shortage, it is essential that other factors within the system of public transport also remain at an acceptable level. For instance, if an increase in salaries leads to financial instability for a bus company, potentially resulting in bankruptcy, it might not be the appropriate way to decrease the shortage of bus drivers.

Using a mix of the suggested approaches from this study as well as other proven methods could be a wise choice in addressing the shortage. It is likely that the recommended approach alone might not fully solve the issue, making it a good idea to include additional research, funding and a variety of measures.

6.4 Recommendations for further research

Conducting additional research into which groups should be targeted during recruitment holds the potential for a substantial impact on the recruitment and inflow of bus drivers. According to the findings of this research, bus companies often employ broad recruitment campaigns, occasionally with an emphasis on young people. However, the category of 'young people' is diverse, and they may require a distinct approach from older people. Precise targeting of specific groups could enhance the campaigns' effectiveness.

Other areas for future investigation that have surfaced from this study include exploring the implementation of large-scale customized schedules, designing training strategies for refugees, immigrants, and non-Dutch speakers to proficiently operate buses with all associated tasks.

Another valuable direction for future research involves quantifying the model for the purpose of policy testing. This quantification could enable the testing of the measures proposed in this research.

As this research has indicated, the bus driver population is generally older, as confirmed by data in paragraph 4.1. To achieve a lower average age among drivers, it is according to the experts and bus drivers advisable to proactively attract younger employees.

The sick leave rate among bus drivers is over twice the average of other professions in the Netherlands, see paragraph 4.2. To improve bus drivers’ employability, it is advisable to investigate strategies aimed at reducing this sick leave rate.

6.5 limitations

The outcomes of this study cannot be directly copied and applied to other fields, jobs, or countries. This is because the job market is complex, involving many different people and groups. Each job, area, and country has its own unique factors that affect it. So, what works here might not work exactly the same way somewhere else. Still, this does not mean that the research is not valuable to other researchers.

The factors and solutions described in this study were not quantified, it is obtained through qualitative interviews and literature review. This could limit the certainty with which the impact of them can be expressed. The model development was not done through group model building, but by interviewing all stakeholders separately. A wide variety of interviewees were chosen to improve reliability and validity. No group model building was a result of planning and collaborating issues. This prevented stakeholders discussing the model among themselves. To validate any modifications to the model, stakeholders were given the chance to review the model and the changes made to it. However, the final person who reviewed the model did not have their work double-checked, which reduces the validity of the final feedback. The forecasts used in this research are based on WLO-scenarios, which assumes a policy-poor future. Political decisions may change the outcomes of these scenarios and therefore the forecast and this research.

Because of the limited time and resources, it is not possible to survey all, or a large sample, of the bus drivers in public transportation. Because this research is being conducted by one student, it is not feasible to conduct many (in-depth) interviews. This is why interviews with a wide variety of stakeholders were chosen. This can mean that not all the possible input from stakeholders will be taken into account. However, every effort was made to achieve as much input as possible.

This research relies heavily on third-party data. As a result, the data collection goals were changed during the research. It was very difficult, almost impossible, to get in touch with the right people within the public transport companies for quantitative data collection, requests were ignored or rejected. This is why alternative ways of collecting quantitative and qualitative data were used.

To compute the future quantity of bus drivers, a merged dataset of both bus and tram drivers' information was employed. The data could not be exclusively narrowed down to bus drivers, resulting in the inclusion of tram drivers. Notably, these statistics primarily exists of bus drivers, as outlined in section 2.1.4.3. This dataset proved most valuable for the research; however, a limitation is recognized.

An important note: absolutely valid models do not exist; a model is always a simplification of the reality. This means that it is impossible to perfectly model the real system. Therefore, the outcome of this research can never be one hundred per cent accurate (Vennix, 1996).

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Appendix A. Interview questions

Expert interview questions:

Beste mevrouw/meneer,

Bedankt dat u wilt mee werken aan mijn onderzoek door dit interview te doen. Allereerst een kleine introductie: het onderzoek gaat over het tekort aan buschauffeurs in de het openbaar vervoer in Nederland. Het onderzoek poogt te berekenen wat het te kort in 2030 zal zijn als geen beleidswijzigingen zijn. Daarnaast zal er door middel van een (kwantitatief) (System Dynamics) model gekeken worden naar welke beleidsmogelijkheden effectief zijn om dit te kort aan te pakken.

Het onderzoek focust zich alleen op de organisaties die onder de CAO streekvervoer vallen, of ook wel de organisaties die vallen onder de vereniging werkgevers openbaar vervoer, VWOV. (Arriva, Transdev, EBS, Keolis, Qbuzz and RET)

Vindt u het goed als ik dit interview opneem zodat mijn volledige aandacht naar u kan gaan? De conclusies die uit uw interview getrokken zullen worden zal ik eerst verifiëren bij u voor dat het daadwerkelijk gebruikt zal worden. Bij naam genoemd worden in mijn onderzoek?

SQ2: What will the developments in the number of bus drivers mean for the provision of bus services and others affected?

1. Hoe groot denkt u dat het te kort aan buschauffeurs is op dit moment?
2. Hoe groot denkt u dat het tekort aan buschauffeurs is in 2030?
3. Op wie heeft het (toekomstig) te kort aan buschauffeurs effect? Hoe groot is dit effect?
4. *Wat denkt u dat het effect van het tekort is op het aanbod van bus diensten? Hoeveel procent rijdt niet denkt u?*
5. Hoeveel reizigers gebruiken dagelijks/jaarlijks de bus?

Voor de volgende vragen maken we onderscheid tussen factoren die binnen de invloedsferen van de ov-sector liggen en door factoren waar geen invloed op uitgeoefend kan worden. Interne VS autonome factoren

SQ4: Which internal factors explain the behaviour of the system?

1. Wat zijn volgens u interne factoren die hebben geleid tot het te kort aan buschauffeurs (oorzaak)?
2. Welke factoren hebben het meeste effect? Waardoor heeft dit effect? Hoeveel procent van het probleem komt door deze factoren?
3. Hoe groot is de rol van ziekteverzuim? Is die veranderd door de jaren heen?

SQ3: Which autonomous factors explain the behaviour of the system?

1. Wat zijn volgens u autonome factoren die effect hebben op het te kort aan buschauffeurs?
2. Welke factoren hebben het meeste effect? Waardoor heeft dit effect? Hoeveel procent van het probleem komt door deze factoren?
3. Het effect van pensionering? Gemiddelde leeftijd? Leeftijdsopsbouw?

SQ5: What are possible measures that can positively affect the system?

1. Wat wordt er op dit moment gedaan om het te kort aan buschauffeurs op te lossen of te verminderen? Wat is het effect hier van?
2. Wat zijn volgens u nog andere mogelijke (combinaties van) oplossingen om het te kort aan buschauffeurs op te lossen of te verminderen?
3. Kunt u dat verder onderbouwen?

Interview questions passengers

Het gebrek aan buschauffeurs vormt een groeiend probleem dat uitdagingen met zich meebrengt voor zowel openbaarvervoerbedrijven als degenen die dagelijks reizen. Voor mijn onderzoek naar het tekort aan buschauffeurs, de oorzaken, gevolgen en oplossingen wil ik je graag een paar vragen stellen.

- Hoe vaak reis jij met de bus?
- Met welk doel reis jij met de bus?
- Wat merk jij van het tekort aan buschauffeurs?
- Wat heeft dit voor effect op jou(w) leven? (Bijv. je werk, mobiliteit, sociale gevolgen etc.)
- Veranderd dit iets aan jouw reisgedrag?
- Wanneer zou jij vaker met de bus reizen?
- Waarom denk jij dat er een tekort aan buschauffeurs is?
- Zou jij meer geld over hebben voor een busrit als dat zou zorgen voor meer buschauffeurs en de positieve gevolgen daarvan? Zo ja, hoeveel? Zo nee, waarom niet?
- Zou jij willen dat de overheid meer (belasting)geld uittrekt om het beroep van buschauffeur aantrekkelijker te maken?
- Hoe aantrekkelijk vind jij het beroep buschauffeur? (Schaal 1 tot 10)
- Bonusvraag: Hoe zou het tekort aan buschauffeurs opgelost of verminderd kunnen worden?

Interview questions bus drivers

Interview Bus chauffeurs

- Wat merk je van het tekort aan buschauffeurs?
- Hoe denk jij dat het tekort is ontstaan?
- Wat zijn redenen waarom mensen voor het beroep kiezen?
- Wat zijn redenen om er mee te stoppen?
- Wat zou er moeten gebeuren om het beroep aantrekkelijker te maken dat er meer mensen buschauffeur worden?
- Hoe realistisch is dit? Hoe groot zou dit effect zijn?
- Heeft u het idee dat het tekort groter of kleiner wordt?
- Na Corona zijn er minder buschauffeurs, wat is het effect hiervan op de werkdruk?

Appendix B. Calculations of SQ1

Table B1

Calculation 1.1 growth percentage disaggregated to bus only

Share of travellers km in BTM	
	2018
Bus	33%
Snelbus	3%
Bus HOV	29%
Total	65%

Mode of transport	**2030 L growth expectation**	**2030 H growth expectation**	**Weightage on the basis of 2018**[1]	**Growth 2030 L**	**Growth * weightage**	**Growth 2030 H**	**Growth * weightage**
Bus	-2%	3%	50.77%	-2	-1.015384615	3	1.523076923
Snelbus	0%	5%	4.62%	0	0	5	0.230769231
Bus HOV	15%	22%	44.62%	15	6.692307692	22	9.815384615
			100%		5,68		11.57
Total	13%	30%		**% growth 2030 L**	5.68%	**% growth 2030 H**	11.57%

* [1] Share of travellers km in BTM / total share of bus km in btm (65%)

Why this calculation? The 2030 growth scenarios are based on bus streetcar metro and buses are only 65% of this group. This gave a distorted picture because e.g. HOV streetcar is growing very fast.

First the share each bus type has on km travelled in 2018 was weighted. e.g. bus: 33% / 65%, express bus: 3% / 65% etc.

With this weighting the share of this bus type in the growth of the whole could be determined. So: (bus 2030L): -2 * 50.77%.

The reason for this is that a growth of 5% for the express bus in 2030H can be a bigger growth than that of the regular bus(3%), however, the share of passenger km of the express bus is a lot lower.

With these calculations I arrived at an improved growth rate than previously known, which was 11-18%.

For 2026 there were not enough data available to make the same calculation.

Table B2

Calculation 1.2 Bus driver km ratio calculation

		Correction ratio:	0.65
Year	**Total amount of bus drivers**	**Corrected travelled km with bus**	**Corrected Travelled km / bus drivers = km's per bus driver**
2013	29,000	3,575,000.000	123,275.86
2014	23,000	3,510,000.000	152,608.70
2015	21,000	3,770,000.000	179,523.81
2016	20,000	3,835,000.000	191,750.00
2017	25,000	3,575,000.000	143,000.00
2018	25,000	4,225,000.000	169,000.00
2019	29,000	4,225,000.000	145,689.66
2020	28,000	1,885,000.000	67,321.43
2021	22,000	2,275,000.000	103,409.09
2022	21,000	Average ->	122,760.89
2023	21,000		

* 2020 & 2021 are excluded in the average because of COVID-19. The correction ratio is based on numbers of 2018, there is assumed that the correction ratio was the same for the other years. The correction ratio refers to the fact that 65% of the total travelled km (bus, tram and metro) was done with bus (ProRail, 2021). Without correction the travelled km was much higher and less relevant.

Table B3

Calculation 1.3 Toekomstige travelled km calculation

Comparison year	**Travelled km with bus per year**	**Calculation year**	**Growth percentage**	**Growth**	**Growth * Travelled km**	**Source**
2018	4,225,000.000	2026 L	3%	1,03	4,351,750,000	(Kim, 2022, p.5)
2018	4,225,000.000	2026 H	7%	1,07	4,520,750,000	(Kim, 2022, p.5)
2019	4,225,000.000	2030 L	5.68%	1.0568*	4,464,980,000	(ProRail 2021, p.69)
2019	4,225,000.000	2030 H	11.57%	1.1157*	4,713,832,500	(ProRail 2021, p.69)

*Growth percentage of 2030 L & H is corrected according calculation 1.1

Table B4

Calculation 1.4 → input for main table

Formulas	Calculation 1.3	Calculation X	Expected km travelled / km bus driver ratio	1 - (average amount of bus drivers / needed bus drivers)	Needed bus drivers - average amount of bus drivers	32,21% of 21.000 bus drivers
Calculation year	Expected km's travelled	Average km bus driver ratio	Needed bus drivers to maintain km bus driver ratio	Percentual shortage	Number of shortage	Shortage including retirement outflow
2026 L	4,351,750,000	122,760.89	35,449	32.30%	11,449	12,482
2026 H	4,520,750,000	122,760.89	36,826	34.83%	12,826	13,859
2030 L	4,464,980,000	122,760.89	36,371	34.01%	12,371	19,135
2030 H	4,713,832,500	122,760.89	38,398	37.50%	14,398	21,162

Average amount of bus drivers over last 11 years	24c000

Of the 21c000 bus drivers in 2022 and 2023, 32.21% are 60 years of age or older.

21,000*0.322114 = 6764,4

Number of shortage 2030 + 6,764.4 is the shortage taking into account retirement outflow

Of the 21,000 bus drivers in 2022 and 2023, 4.92% are 65 years of age or older.

21,000*0.0492 = 1033

Number of shortage 2026 + 1033, is the shortage taking into account the retirement outflow

Current shortage

There are 8,800 vacancies in transport across land in The Netherlands according to CBS (2023-f).

Bus drivers represent 10.24% of the total population of people in ‘transport across land’ (CBS, 2023-e).

10.24% of 8,800 vacancies is 901. The 901 is added on top of the shortage including retirement flow of Tabel B4.

Appendix C. Justification each link SD model

Table C1

Justification of each link in the System Dynamics model

Variable	Link polarity	Variable	Source
Shortage of bus drivers	+	Work pressure	(Gallie, 2005)
Shortage of bus drivers	+	Salary	Market forces. Strikes: (Verkeerskunde, 2023) (Expert A & B)
Shortage of bus drivers	+	Employee benefits	(Interview bus drivers) & (Expert A & B)
Work pressure	+	Sick leave	(Tse, Flin, & Mearns, 2006)
Work pressure	-	Attractiveness of the job	(Vann, Wessel & Spisak, 2000)
Sick leave	+	Shortage of bus drivers	(Interviews bus drivers 7 & 9)
Sick leave	+	Outflow	(Interview bus drivers 7 & 9)
Average age of bus drivers	+	Retirement	(Rijksoverheid, n.d.-c)
Average age of bus drivers	+	Sick leave	(CBS, 2023-b (CBS, 2023-c)
Retirement	+	Outflow	(Interview bus drivers) & (Expert A & B)
Employee benefits	+	Attractiveness of the job	(Lannoo and Verhofstadt 2016, p. 251) (Vann, Wessel and Spisak, 2000)
Attractiveness of the job	+	Inflow	Lee and Mowday (as cited in Dass & Baruah, 2013) and Tett and Meyer (1993)
Attractiveness of the job	-	Outflow	Lee and Mowday (as cited in Dass & Baruah, 2013) and Tett and Meyer (1993)
Labour market pressure	-	Inflow	(CBS, n.d.-a).
Recruitment	+	Inflow	(Expert B) & Logic
Impact COVID-19	-	Passenger growth	(KiM, 2022, p. 8)
Population Growth	+	Passenger growth	(KiM, 2022, p. 15)
Income growth	+	Passenger growth	(KiM, 2022, p. 15).
Number of student	+	Passenger growth	(KiM, 2022, p. 15).
Passenger growth	+	Number of passengers	(KiM, 2022, p. 15).
Number of passengers	+	Revenue	(de Jong, Vogels, van Wijk, & Cazemier, 2011, p. 65
Number of passengers	+	Total number of bus hours	(Expert D)
Revenue	+	Economic situation transport companies	(CROW, 2013).
Government grants	+	Economic situation transport companies	(CROW, 2013).

Profit margin	+	Economic situation transport companies	(CROW, 2013) (Expert A)
Profit margin	-	Quality of services	(CROW, 2013).
Governmental requirements	+	Concession demands	(Van de Velde et al. 2008, p. 1154)
Concession demands	+	Quality of services	(Rijksoverheid, n.d.-b) & (Van de Velde et al. 2008, p. 1154)
Concession demands	+	Desirable amount of bus drivers	(Rijksoverheid, n.d.-b) & (Van de Velde et al. 2008, p. 1154)
Total number of bus hours	+	Desirable amount of bus drivers	(Expert D)
Desirable amount of bus drivers	+	Shortage of bus drivers	The more drivers are desired, the higher the shortage
Salary	+	Attractiveness of the job	(Dass and Baruah, 2013)
Dutch bus drivers	-	Shortage of bus drivers	Market forces
Image	+	Attractiveness of the job	(Interviews bus drivers) (Expert A)
State of the economy	+	Passenger growth	(Expert A)
State of the economy	+	Labour market pressure	(Expert A)
Number of hours worked per bus driver	-	Desirable amount of bus drivers	If bus drivers work less hours, more drivers are needed for same amount of bus hours driven

Appendix D. Codes used during coding process

Table D1

Codes and code groups of expert interviews

Code	Grounded	Code Groups
○ Aantal buschauffeurs	1	Gevolgen tekort
○ Aantrekkelijkheid bedrijf	2	Oplossingen
○ Aantrekkelijkheid beroep	5	Aantrekkelijkheid van het beroep Uitstroom Oplossingen
○ Aantrekkelijkheid OV	6	Oplossingen
○ Afschalen dienstregeling	9	Gevolgen tekort
○ Alternatieve vervoersmethoden	2	Gevolgen tekort
○ Arbeidsmarkt	5	Uitstroom Oorzaken tekort
○ Belastend werk	3	Aantrekkelijkheid van het beroep
○ CAO	13	Aantrekkelijkheid van het beroep Oplossingen
○ Concurreren	7	Oorzaken tekort
○ Corona	4	Instroom Uitstroom Oorzaken tekort
○ Decentralisatie openbaar vervoer	3	Oorzaken tekort
○ Dienstregeling	6	Gevolgen tekort
○ Dynamische sector	1	Oorzaken tekort
○ Effect van salaris op tekort	6	Oorzaken tekort Oplossingen
○ Geografische verschillen	2	Aantrekkelijkheid van het beroep
○ Gevolgen tekort	4	Gevolgen tekort
○ Imago	11	Aantrekkelijkheid van het beroep Oorzaken tekort Oplossingen
○ Inflatie	2	Oorzaken tekort
○ Jonge mensen	2	Instroom Oplossingen
○ Klachten	1	Gevolgen tekort
○ Kosten OV bedrijven	1	Oorzaken tekort
○ Kwaliteit openbaar vervoer	8	Gevolgen tekort
○ Milieu effecten	1	Gevolgen tekort
○ Privé - werkbalans	7	Aantrekkelijkheid van het beroep Oplossingen
○ Reizigersgroei	1	Oorzaken tekort
○ Roostering	6	Oplossingen
○ Salaris	17	Oorzaken tekort Oplossingen
○ Secundaire arbeidsvoorwaarden	11	Oorzaken tekort Oplossingen

○ Sociale veiligheid	5	Aantrekkelijkheid van het beroep Oplossingen
○ Staken	3	Gevolgen tekort
○ Stand van de economie	2	Oorzaken tekort
○ Subsidie	6	Oorzaken tekort Oplossingen
○ Tekort aan buschauffeurs	19	Tekort buschauffeurs
○ tekort chauffeurs andere branches	2	Tekort buschauffeurs
○ Thuiswerken	1	
○ Uitstroom buschauffeurs	1	Oorzaken tekort
○ Verantwoordelijkheid overheid	8	Gevolgen tekort Oplossingen
○ vergelijking andere branches	12	Tekort buschauffeurs
○ Vergelijking OV bedrijven	2	Instroom
○ Vergrijzing	9	Uitstroom Oorzaken tekort
○ Verlof	7	Gevolgen tekort
○ vicieuze cirkel	2	Oorzaken tekort
○ Werkdruk	7	Aantrekkelijkheid van het beroep Gevolgen tekort Oorzaken tekort
○ Werkplezier	12	Aantrekkelijkheid van het beroep Oplossingen
○ Werkzaamheden buschauffeurs	5	Aantrekkelijkheid van het beroep
○ Werving	22	Instroom Oplossingen
○ Winst	1	winstgevendheid
○ Winst verdeling	1	winstgevendheid
○ Winstmarges	2	winstgevendheid
○ Ziekteverzuim	4	Uitstroom Gevolgen tekort Oorzaken tekort

Table D2

Codes and code groups of passenger interviews

Code	Grounded	Code Groups
○ Aantrekkelijkheid beroep	6	Aantrekkelijkheid van het beroep Effecten van het tekort Oorzaken tekort
○ Aantrekkelijkheid beroep - cijfer	7	Aantrekkelijkheid van het beroep Oorzaken tekort
○ Alternatieve beroepen	1	Oorzaken tekort
○ Alternatieven voor bus	9	Effecten van het tekort
○ Bereid om meer te betalen	4	Aantrekkelijkheid van het beroep
○ Doorgroei mogelijkheden	1	Aantrekkelijkheid van het beroep Oplossingen tekort

○ Een tonig werk	1	Aantrekkelijkheid van het beroep
○ Gevolgen	6	Effecten van het tekort
○ Gevolgen - Te laat komen	7	Effecten van het tekort
○ Humeur chauffeur	2	Aantrekkelijkheid van het beroep
○ Imago buschauffeurs	6	Effecten van het tekort Oorzaken tekort
○ Krapte op de arbeidsmarkt	3	Oorzaken tekort
○ Onzekerheid dienstregeling	6	Effecten van het tekort
○ Oplossing - arbeidsmigratie	2	Oplossingen tekort
○ Oplossing - bonus systeem	2	Oplossingen tekort
○ Oplossing - gesprek aangaan	1	Oplossingen tekort
○ oplossing - overheidsmaatregelen	2	Oplossingen tekort
○ Oplossingen - arbeidsvoorwaarden	7	Oplossingen tekort
○ Prijzen bus	4	Aantrekkelijkheid van het beroep
○ Slechte arbeidsvoorwaarden	5	Aantrekkelijkheid van het beroep Oorzaken tekort
○ Staking	4	Effecten van het tekort
○ Uitval bussen	9	Effecten van het tekort
○ Veranderd reisgedrag	5	Aantrekkelijkheid van het beroep
○ Verantwoordelijkheid overheid	7	Oplossingen tekort
○ Verantwoordelijkheid vervoersmaatschappijen	2	Oplossingen tekort
○ Vertraging	4	Effecten van het tekort
○ Wanneer vaker met de bus	4	Aantrekkelijkheid van het beroep
○ Werkdruk	5	Aantrekkelijkheid van het beroep
○ Werving en behoud personeel	3	Oplossingen tekort
○ Zelfrijdende bussen	3	Oplossingen tekort

Table D1

Codes and code groups of bus driver interview

Code	Grounded	Code Groups
○ Aantrekkelijkheid CAO	6	Arbeidsvoorwaarden Oplossingen tekort Instroom
○ Aantrekkelijkheid werktijden	4	Gevolgen van het tekort Oplossingen tekort Instroom
○ bezuinigingen	1	Arbeidsvoorwaarden Oorzaken van het tekort
○ Druk op de arbeidsmarkt	3	Oorzaken van het tekort
○ Effect corona	6	Oorzaken van het tekort
○ Effect op werkplezier	3	Gevolgen van het tekort
○ Effect van het tekort	8	Gevolgen van het tekort
○ Effect van nieuwe CAO	6	Arbeidsvoorwaarden
○ Ervaring van het tekort	2	Gevolgen van het tekort
○ geen chauffeurs beschikbaar	2	Gevolgen van het tekort

○ Geen effect corona	2	A typische antwoorden
○ Geen extra werkdruk	1	A typische antwoorden
○ Geïrriteerde passagiers	9	Gevolgen van het tekort
○ Gelijk blijvend tekort	2	Beweging in het tekort
○ Groeiend tekort	5	Beweging in het tekort
○ Houding buschauffeurs	9	Oorzaken van het tekort Oplossingen tekort
○ Imago	8	Gevolgen van het tekort Oorzaken van het tekort Oplossingen tekort
○ Instroom	12	Oorzaken van het tekort Oplossingen tekort Instroom
○ Jonge collega's	12	Oplossingen tekort
○ Krimpend tekort	3	Oplossingen tekort Instroom Beweging in het tekort
○ Minder uren werken	6	Oorzaken van het tekort
○ Na pensioen doorwerken	1	Gevolgen van het tekort Oplossingen tekort
○ Nadelen beroep	5	Oorzaken van het tekort
○ Nieuwe instroom genereren	22	Oplossingen tekort Instroom
○ Onregelmatigheidstoeslag	2	Arbeidsvoorwaarden
○ Oorzaak tekort	6	Oorzaken van het tekort
○ Passagiers	1	Gevolgen van het tekort
○ Pensionering	6	Oorzaken van het tekort
○ Reden van instroom	8	Oplossingen tekort Instroom
○ Reden van uitstroom	10	Gevolgen van het tekort Oorzaken van het tekort
○ Rijtijden	5	Oorzaken van het tekort
○ Roostering	10	Oorzaken van het tekort Oplossingen tekort
○ Salaris	11	Arbeidsvoorwaarden Instroom
○ Somber toekomst beeld	1	Gevolgen van het tekort
○ Stil staande bussen	1	Gevolgen van het tekort
○ Te korte pauze's	5	Arbeidsvoorwaarden Gevolgen van het tekort
○ Te laat geanticipeerd	1	Oorzaken van het tekort
○ Uitstroom	13	Oorzaken van het tekort
○ Uitval diensten	12	Gevolgen van het tekort
○ Uitzendkrachten	13	Oorzaken van het tekort
○ Vast contract	9	Arbeidsvoorwaarden Oorzaken van het tekort Instroom
○ Verbeteren arbeidsvoorwaarden	3	Oplossingen tekort

○ Vergrijzing personeel	5	Oorzaken van het tekort
○ Voordelen beroep	18	Instroom
○ Werkdruk	16	Gevolgen van het tekort Oorzaken van het tekort
○ Werkomstandigheden	1	Arbeidsvoorwaarden Gevolgen van het tekort
○ Werkplezier	1	Instroom
○ Werving	16	Oorzaken van het tekort Oplossingen tekort Instroom
○ Werving campagnes	14	Oorzaken van het tekort Oplossingen tekort Instroom
○ Wisselende tijden	5	Arbeidsvoorwaarden Oorzaken van het tekort Instroom
○ Zelf oplossen problemen	4	Gevolgen van het tekort
○ Ziekteverzuim	4	Oorzaken van het tekort
○ Zomer tekorten	3	Oorzaken van het tekort

Appendix E. Feedback loops

Figure E1

Feedback loop R1 "work pressure"

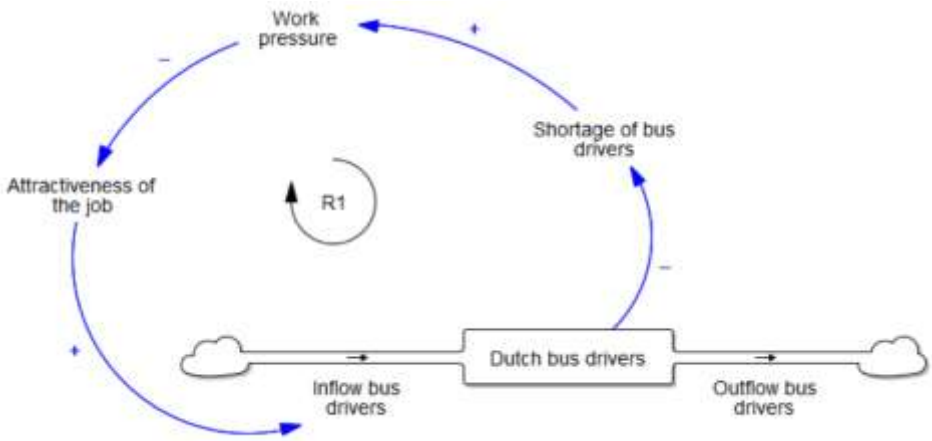

Figure E2

Feedback loop R2 "sick leave"

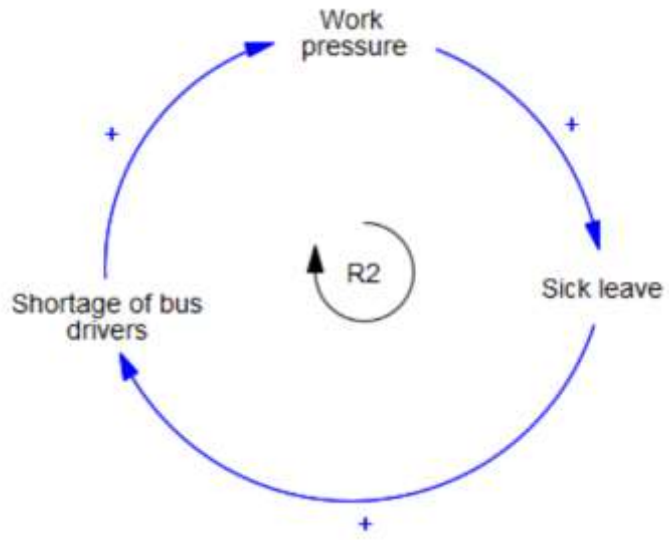

Figure E3

Feedback loop B1 "salary"

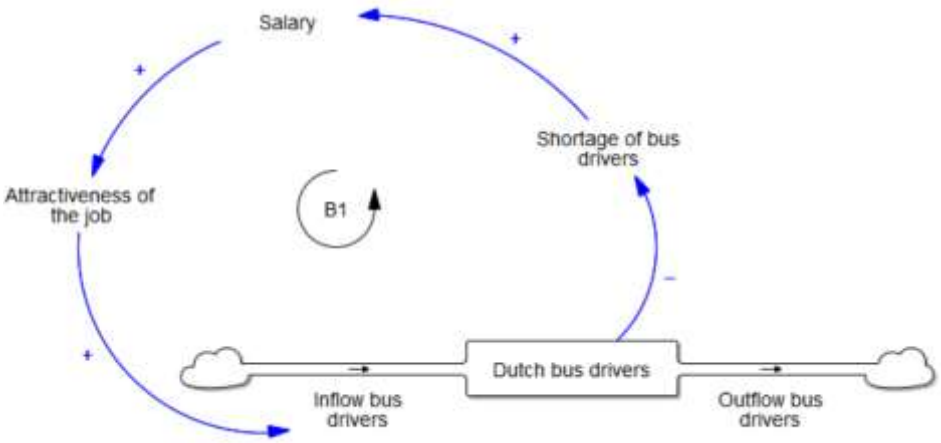

Figure E4

Feedback loop B2 "employee benefits"