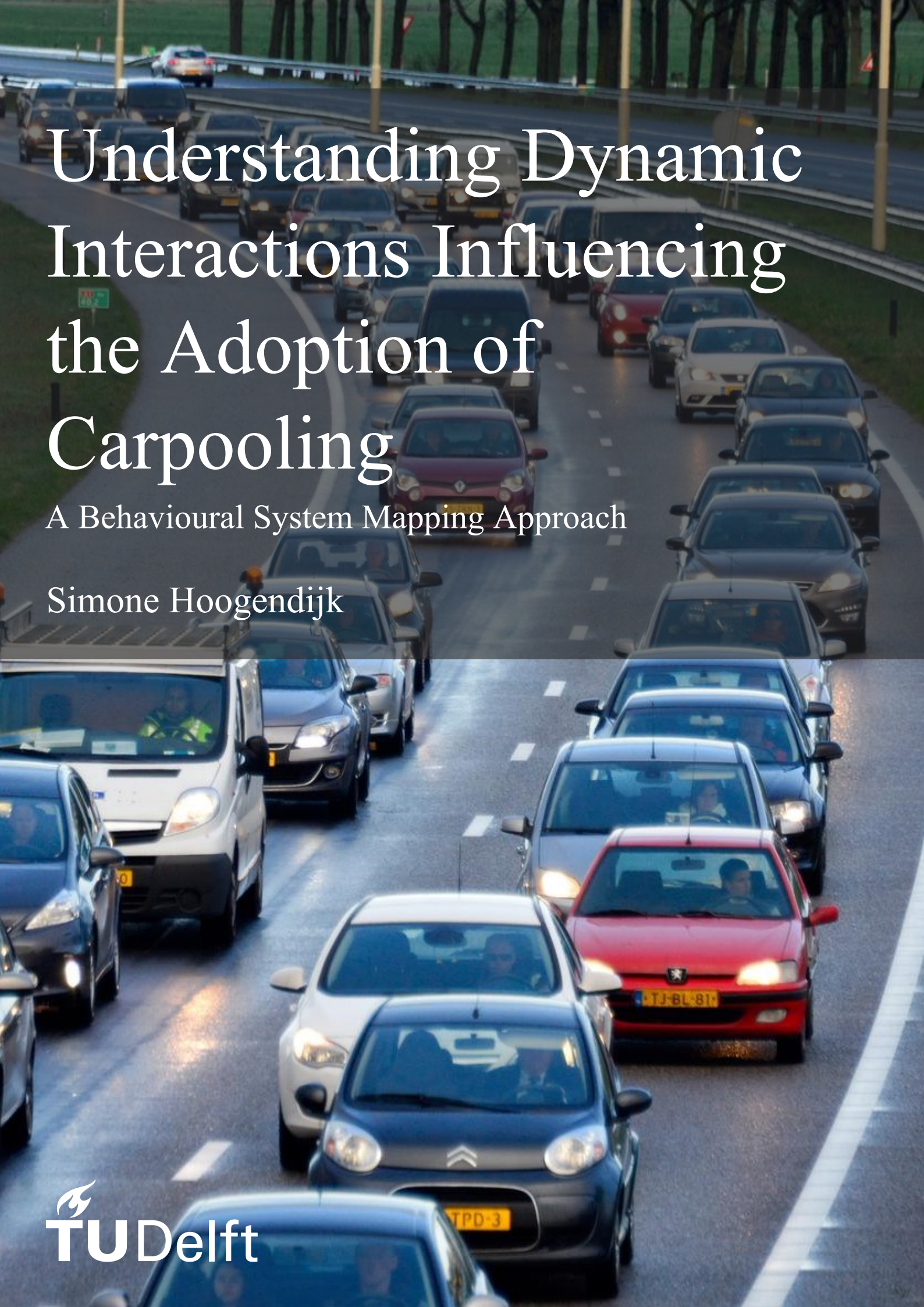


Understanding Dynamic Interactions Influencing the Adoption of Carpooling

A Behavioural System Mapping Approach

Simone Hoogendijk

TU Delft

Understanding Dynamic Interactions Influencing the Adoption of Carpooling

A Behavioural System Mapping Approach

Master thesis submitted to the Delft University of Technology
in partial fulfilment of the requirements of the degree of

MASTER OF SCIENCE

in **Engineering & Policy Analysis**

Faculty of Technology, Policy and Management
Delft Univesity of Technology

Student name: Simone Hoogendijk
Student number: 5405084
Thesis defence date: 07.07.2026

Graduation Committee

Prof. dr. G. de Vries	Multi-actor Systems | TU Delft	Chair
Prof. dr. G. de Vries	Multi-actor Systems | TU Delft	First supervisor
Dr. L. Scholten	Multi-actor Systems | TU Delft	Second supervisor
MSc K.P. Bellmann	Multi-actor Systems | TU Delft	Internal advisor
Dr. G.J. de Maagd	Behavioural Insights | Ministry of I&W	External advisor

Cover photo by Ton Borsboom, Kennisinstituut voor Mobiliteitsbeleid

An electronic version of this thesis is available at http://repository.tudelft.nl/.

TU Delft

Preface

Before you lies my thesis *'Understanding Dynamic Interactions Influencing the Adoption of Carpooling'*, which has been written over the past five months to graduate from the Master of Science *'Engineering & Policy Analysis'* at Delft University of Technology. It represents the outcome of a period of research, reflection, and collaboration. During this process, the interviews I conducted with various actors in the field and the workshop I organised to validate my findings and create policy recommendations were a valuable learning experience. Together, these activities strengthened my qualitative research skills and enabled me to engage with the topic from multiple perspectives. However, I would not have been able to complete this thesis without the help of others.

First of all, I would like to thank my graduation committee for their guidance, feedback, and insights throughout my thesis process. Kai, I would like to thank you for your continuous support and your readiness to help whenever needed. Gerdien, thank you for always thinking along and for your continuous support. Lisa, thank you for offering a different perspective and for your willingness to guide my thesis project, even during your research sabbatical.

Second, I would like to thank the members of the Behavioural Insights Team of the Ministry of Infrastructure & Water Management for their warm welcome and their willingness to support my work. Gert-Jan, thank you for our regular update meetings, in which we discussed any challenges I encountered and explored ways to address them. I would also like to thank my fellow interns for their social support and the pleasant moments we shared, especially our lunch walks. I truly enjoyed conducting my thesis alongside you.

Third, I would like to thank all the experts who participated in this study. Thank you for contributing your time and expertise. Your perspectives and insights have been extremely valuable for the outcomes of this research. Without your contributions, this thesis would not exist.

At last, I would like to thank my family and friends for continuously supporting me throughout this journey.

Enjoy reading my thesis!

Simone Hoogendijk
Delft, July 2026

Summary

The vast majority of commuters drives alone to work, with an average occupancy rate of 1,05 persons per car (Knoope, 2023). This excessive car use not only leads to competition for limited capacity, such as traffic congestion and parking pressure, but also contributes to one of today's grand societal challenges: climate change. Reducing single-occupancy vehicle use in daily commuting presents an opportunity to lower polluting emissions, such as greenhouse gases (GHG), and address capacity issues. One solution proposed by scholars and policy-makers is to promote carpooling: the sharing of a ride between people from a different household. To achieve an increase in the occupancy rate of cars, behaviour change is required. However, behaviour change is not easily achieved. Although several policy measures have been implemented in the past, carpooling has not been adopted on a large scale. In 2025, only 5% of the population engaged in carpooling, which is a reduction compared to 2024 (van Essen et al., 2026). To develop effective policy measures, the understanding of the system needs to be enhanced. Existing literature is mainly focused on individual decision-making and solely incorporates a commuter perspective. A multi-actor perspective and system-level approach is missing. This approach is needed, as mobility choices are made within a complex system of multiple actors who interact and affect the decision-making process of citizens (Cascetta et al., 2007; Enserink et al., 2022). This study addresses this knowledge gap by adopting a novel approach of integrating behavioural science and systems thinking. Individual behavioural determinants and multi-actor interactions are combined to provide an overview of the system as a whole. This study answers the following research question:

'What psychological and contextual factors influence the adoption of carpooling among commuters, considering dynamic interactions between actors in the system?'

To answer this research question, a multi-method approach is used. First, existing literature is reviewed to provide an overview of the psychological and contextual factors identified in scholarly research. To structure the literature review, the Theoretical Domains Framework (TDF) is used to categorise the behavioural determinants in overarching domains (Atkins et al., 2017). A behavioural determinant is an underlying factor of behaviour. Second, twenty semi-structured interviews are conducted to gain insight into the behaviours and perspectives of various actors in the field. This allows for a deeper understanding of the behavioural determinants found in literature and provides insight into the dynamic interactions between multiple actors. Third, a behavioural system map (BSM) is constructed to provide an overview of the

system and the behavioural dynamics within. This BSM can be used as a starting point to develop effective policy measures.

The behavioural determinants that have been found in literature and the interview data enhance the understanding of commuter behaviour on an individual level. The domains *'beliefs about consequences'*, *'environmental context and resources'*, *'social influences'*, and *'emotion'* are all frequently cited in both the literature and interviews. However, there are some notable differences. The domain *'intentions'* is a prominent domain according to literature, while no interview participants acknowledged *'intentions'* as a behavioural determinant. In contrast, the domains *'knowledge'*, *'reinforcement'*, *'memory, attention, and decision processes'*, and *'behavioural regulation'* are frequently cited by interview participants, while they are hardly mentioned in literature. These differences can be attributed to the specific scope of this study. Overall, the behavioural analysis has provided a comprehensive overview of the behavioural determinants that influence individual decision-making.

In addition to enrichment of the behavioural determinants, the interviews have revealed eight key behavioural dynamics that occur within the system, also referred to as themes. Together with the individual behavioural determinants, these themes provide insight into the system as a whole. Table 1 provides an overview of the themes.

Table 1: Overview of themes.

Themes
1. Digital platform dependency of carpooling
2. Financial dependencies, subsidies, and incentives
3. Knowledge sharing, communication, and promotion
4. Multi-level trust as a key driver to carpool adoption
5. Resistance based on lack of control and the pressure to socialise
6. Dependencies on the structural and social environment
7. Integration of carpooling in the mobility system
8. Fragmented roles and absence of shared visions across multiple actors

The behavioural determinants and behavioural dynamics are both represented in the BSM. The BSM has revealed seven feedback loops. Based on these feedback loops, six leverage points are identified. These levers can be used to intervene or change the system. Table 2 gives an overview of the leverage points and feedback loops. Leverage point 4 *'reassure commuters'* is based on feedback loop 4 and 5.

Table 2: Overview of feedback loops and leverage points.

Feedback loops	Leverage points
1. Sharing of knowledge and experiences	1. Centralise knowledge
2. Committing to sustainable mobility	2. Enhance sustainability perspective
3. Continuance of facilitating carpool services	3. Set up a business case
4. Level of trust among commuters	4. Reassure commuters
5. Guaranteed ride home services	
6. Importance of carpool network	5. Establish a carpool network
7. Reinforcement through incentives	6. Incentivise commuters

To address the first leverage point, it is recommended to develop a central knowledge platform that enables professionals to share knowledge and informs commuters on the advantages of carpooling and available facilities. This knowledge platform could also be used to inform employers on sustainable mobility, addressing the second lever. In addition, objectives on the amount of CO_2 emissions could be defined to limit the environmental impact of work-related mobility. For the third lever, *set up a business case*, it is important to understand the broad effects of carpooling and the provision of subsidies. It is recommended to complete a Social Cost-Benefit Analysis (SCBA) and assess the effectiveness of governmental subsidies. To reassure commuters (leverage point 4), it is suggested to restructure the digital platform and display exemplary behaviour. To address the fifth leverage point, policy measures that promote the usage of ride-matching apps could be developed, such as providing financial rewards. Whereas the fifth lever is focused on app users, the last lever is directed at commuters in general, including people who do not have access to or are not willing to use an app. For this sixth lever, it is recommended to incentivise commuters through differentiation of travel cost compensation, preferential parking, or the provision of a shared company car. Together, these levers and recommended policy measures provide a starting point for policy-makers to design policy that encourages carpooling among commuters.

This study provides an overview of the behavioural determinants that influence individual decision-making, reveals key behavioural dynamics that influence the adoption of carpooling, and presents six leverage points that can be used to develop effective policy measures. Overall, this study enriches the understanding of dynamic interactions that influence the adoption of carpooling among commuters.

Contents

Preface i

Summary ii

Nomenclature xi

1 Introduction 1

1.1 Background and policy challenges . . . 2

1.1.1 Previous policy measures . . . 3

1.2 Research problem . . . 4

1.3 Research questions . . . 5

1.4 Relevance of the study . . . 6

1.4.1 Scientific relevance . . . 6

1.4.2 Policy relevance . . . 7

1.4.3 EPA relevance . . . 7

2 Methodology 9

2.1 Literature review . . . 10

2.1.1 Search strategy . . . 11

2.1.2 Processing and analysis of literature . . . 13

2.2 Semi-structured interviews . . . 15

2.2.1 Data collection . . . 15

2.2.2 Behavioural analysis . . . 16

2.2.3 Thematic analysis . . . 17

2.3 Behavioural system mapping . . . 17

2.3.1 Analysis of behavioural system map . . . 19

2.3.2 Expert workshop . . . 20

3 Results 21

3.1 Literature review . . . 21

3.2 Interview results . . . 28

3.2.1 Behavioural analysis . . . 28

3.2.2 Thematic analysis . . . 30

3.3 Behavioural system map . . . 40
3.3.1 Feedback loops . . . 42
3.3.2 Leverage points . . . 50
3.3.3 Reflection behavioural dynamics workshop . . . 52

4 Discussion **54**
4.1 Behavioural dynamics . . . 54
4.1.1 Fragmentation of knowledge . . . 55
4.1.2 Financial dependency . . . 55
4.1.3 Digital platform dependency of carpooling . . . 56
4.1.4 Dynamic versus factor-focused research . . . 57
4.1.5 Levers and implications . . . 58
4.2 Policy recommendations . . . 61
4.2.1 Centralise knowledge . . . 61
4.2.2 Enhance the sustainability perspective . . . 62
4.2.3 Incentivise commuters . . . 63
4.3 Limitations and future research . . . 64
4.3.1 Commuter validation . . . 64
4.3.2 Testing of levers and policy interventions . . . 65
4.3.3 Longitudinal data . . . 65
4.3.4 Focus on app users . . . 65

5 Conclusion **67**
5.1 Behavioural determinants . . . 67
5.2 Behavioural dynamics . . . 68
5.3 Behavioural insights . . . 68

References **70**

A Screening process literature **84**

B Theoretical Domains Framework **86**

C Actor scan **88**

D Interview Guideline **91**
D.1 Interview guideline in Dutch . . . 91
D.2 Interview guideline in English . . . 93

E Human Research Ethics Committee documents **96**
E.1 Human Research Ethics Checklist for human research . . . 97

E.2 Data Management plan 106
E.3 Informed consent form interviews 115
E.4 Informed consent form workshop 117
E.5 Letter of approval from Human Research Ethics Committee 119

F Workshop timetable **121**

G Overview behavioural determinants literature **123**
G.1 Behavioural determinants in Theoretical Domains Framework 123
G.2 References 129

H Overview of quotes **133**

I Behavioural System Map **144**

J Behavioural System Map based on literature **162**

List of Figures

2.1 Flowchart of research process. 10
2.2 Screening process of articles regarding psychological factors. 12
2.3 Screening process of articles regarding contextual factors. 13
2.4 Theoretical Domains Framework mapped to the COM-B model (Moore et al., 2023). 14
2.5 Example of behavioural system mapping. 18
2.6 Overview methodological process of Behavioural System Mapping. 19

3.1 Behavioural System Map of commuters' decision-making when considering carpooling. 41
3.2 Behavioural System Map of commuters' journey when considering carpooling. 42
3.3 Behavioural System Map highlighting the feedback loop *'sharing knowledge and experiences'*. 44
3.4 Behavioural System Map highlighting the feedback loop *'committing to sustainable mobility'*. 45
3.5 Behavioural System Map highlighting the feedback loop *continuance of facilitating carpool services*. 46
3.6 Behavioural System Map highlighting the feedback loop *'level of trust among commuters'*. 47
3.7 Behavioural System Map highlighting the feedback loop *'guaranteed ride home service'*. 48
3.8 Behavioural System Map highlighting the feedback loop *'importance of a carpool network'*. 49
3.9 Behavioural System Map highlighting the feedback loop *'reinforcement through incentives'*. 50

I.1 Behavioural System Map of commuters' decision-making when considering carpooling. 145
I.2 Behavioural System Map of commuters' journey when considering carpooling. 146
I.3 Behavioural System Map highlighting feedback loop 1 *'sharing knowledge and experiences'*. 147

I.4 Behavioural System Map highlighting feedback loop 2 *'committing to sustainable mobility'*. 148
I.5 Behavioural System Map highlighting feedback loop 3 *'continuance of facilitating carpool services'*. 149
I.6 Behavioural System Map highlighting feedback loop 4 *'level of trust among commuters'*. 150
I.7 Behavioural System Map highlighting feedback loop 5 *'guaranteed ride home service'*. 151
I.8 Behavioural System Map highlighting feedback loop 6 *'importance of a carpool network'*. 152
I.9 Behavioural System Map highlighting feedback loop 7 *'reinforcement through incentives'*. 153
I.10 Behavioural System Map highlighting theme 1 *'digital platform dependency of carpooling'*. 154
I.11 Behavioural System Map highlighting theme 2 *'financial dependencies, subsidies, and incentives'*. 155
I.12 Behavioural System Map highlighting theme 3 *'knowledge sharing, communication, and promotion'*. 156
I.13 Behavioural System Map highlighting theme 4 *'multi-level trust a key driver to carpool adoption'*. 157
I.14 Behavioural System Map highlighting theme 5 *'resistance based on lack of control and the pressure to socialise'*. 158
I.15 Behavioural System Map highlighting theme 6 *'dependencies on the structural and social environment'*. 159
I.16 Behavioural System Map highlighting theme 7 *'integration of carpooling the mobility system'*. 160
I.17 Behavioural System Map highlighting theme 8 *'fragmented roles and absence of shared visions across multiple actors'*. 161

J.1 Behavioural System Map of commuters' decision-making when considering carpooling based on literature. 163

List of Tables

1 Overview of themes. iii
2 Overview of feedback loops and leverage points. iv

3.1 Frequency of mentioned TDF domains in literature. 22
3.2 Overview of frequency of mentioned COM-B domains in literature. 23
3.3 Frequency of mentioned TDF domains in interviews. 28
3.4 Description of Themes. 31
3.5 Overview of feedback loops and leverage points. 51

4.1 Overview of levers and implications. 59

A.1 Reasons for excluding articles from the literature review regarding psychological factors. 84
A.2 Reasons for excluding articles from the literature review regarding contextual factors. 85

B.1 Description of Domains TDF – table reproduced from Cane et al. (2014). . . 86

C.1 Overview of actors based on actor scan. 88

F.1 Timetable workshop. 121

G.1 Behavioural determinants found in literature categorised using the Theoretical Domains Framework. 123
G.2 Studies included in the literature review. 129

H.1 Overview of quotes per theme. 133

Nomenclature

Abbreviations

Abbreviation	Definition
ABM	Agent-based modelling
BCT	Behaviour Change Technique
BSM	Behavioural System Map
COM-B	Capability, Opportunity, Motivation, and Behaviour
CO_2	Carbon dioxide
EPA	Engineering & Policy Analysis
EU	European Union
GHG	Greenhouse gas
HOV	High-occupancy vehicle
HREC	Human research ethics committee
KpVV	Kennisprogramma Verkeer en Vervoer (knowledge programme traffic and mobility)
SCBA	Social Cost-Benefit Analysis
SD	System Dynamics
TDF	Theoretical Domains Framework

1

Introduction

The European transport sector accounted for almost a third of all Greenhouse Gas (GHG) emissions in 2023 (European Environment Agency, 2026), contributing to one of today's main challenges: climate change. While other sectors reduced their environmental impact, the transport sector continues to emit more GHG emissions, compared to 1990 (European Environment Agency, 2022b). According to the European Environment Agency (2022a), this trend inhibits the European Union (EU) from reaching their 2050 target of a 90% reduction in GHG emissions (European Commission, 2019). A key area for climate change mitigation is private vehicle use, which is the main contributor to transport emissions, accounting for 72% (European Environment Agency, 2026). Next to environmental pollution, road transport also contributes to another societal challenge: traffic congestion. Traffic congestion is considered one of the most difficult challenges facing urban mobility, with estimated social costs of €270 billion per year in the EU (European Court of Auditors, 2020). In addition, many cities in Europe have to deal with the limited availability of parking spaces (Rye et al., 2022). These capacity issues are caused by excessive car use and low occupancy rates. In Europe, the average occupancy rate of a private car is 1.4 persons (Armoogum et al., 2022), indicating that the vast majority of people drives alone. Reducing single-occupancy vehicle use is needed to mitigate the challenges the mobility sector faces.

The need to reduce single-occupancy vehicle use is particularly severe in the Netherlands, where both environmental and capacity issues are increasing to a level that demands structural change. To this day, travelling by car remains the main mode of transportation (de Haas et al., 2024). This is especially evident in commute trips, where almost 70% of all kilometres travelled were done by car (Centraal Bureau voor de Statistiek, 2024). While for domestic trips the average occupancy rate of a car is 1,36, it is only 1,05 persons for commute trips

(Knoope, 2023). This low occupancy rate leads to high traffic volumes and an increasing congestion rate during rush hour. In 2024, the severity of traffic jams has increased by 11,7%, leading to a historic high (Rijkswaterstaat, 2025b). In addition, the largest municipalities are all confronted with an increasing parking pressure (Heersink and Slagboom, 2023). Moreover, similarly to the European transport sector, the environmental impact of the Dutch transport sector continues to grow with an increase of 3% of the yearly emitted GHGs compared to 2010 (Centraal Bureau voor de Statistiek, 2025). Despite the negative impact road transport has, the total number of kilometres travelled by car is expected to increase in the coming years (de Haas et al., 2024). To address the challenges the mobility sector faces, the current way of travelling needs to change.

1.1. Background and policy challenges

Carpooling, also known as ride-sharing, is proposed by scholars as a solution to reduce single-occupancy vehicle use (Dörrzapf et al., 2023). There are distinctive approaches to define carpooling, with some researchers only looking at carpooling between people from a different household (Aguiléra and Pigalle, 2021), while others include carpooling among family members as well (Shaheen and Cohen, 2018). The key differentiation criterion is the relationship between the ride sharers. In scholarly research, four types of carpooling are distinguished: fampooling, co-worker carpooling, casual carpooling and IT-based casual carpooling (Shaheen and Cohen, 2018). Fampooling is described as carpooling with family or acquaintances. Sharing a ride with a colleague is characterised as co-worker carpooling. Casual carpooling can be seen as informal ride-sharing without the use of technology, while in IT-based casual carpooling an app is used to facilitate the sharing of rides.

This study focuses on IT-based casual carpooling between commuters, as ride-matching apps create the opportunity to achieve a high number of shared rides (Gkartzonikas and Dimitriou, 2025). However, since this study is adopting a system-level approach, carpooling without the use of an app is included as well. The focus lies on commuters, which includes co-workers as well as people who work at different companies within the same city. Within this target group, the adoption of carpooling is both feasible and effective for three reasons. First, the average occupancy rate of cars used for commuting is only 1,05 persons (Knoope, 2023), which means that the majority of commuters drives to work alone. Only a small share of the commuters needs to carpool to already see a significant increase in the occupancy rate of cars. Second, most commuters travel during similar hours, which means that there is a lot of opportunity for people to carpool (Vanoutrive et al., 2012). At last, increasing the occupancy rate of cars during commuter trips could significantly reduce the amount of congestion, as congestion usually emerges during rush hours.

To encourage the adoption of carpooling, structural behaviour change is required. However, behaviour change is not easily achieved. Despite the clear effects on the environment, human health, parking pressure, and congestion, carpooling has not been adopted on a large-scale (Olsson et al., 2019). In the Netherlands, carpooling already emerged around 1974 after an oil and energy crisis (NRC, 1989). Since then, the popularity of carpooling has fluctuated over time. To date, primarily financial incentives and structural measures have been used to promote carpooling. Nevertheless, commuters are still sceptical about adopting carpooling as a standard way of travelling to work (Dinesh et al., 2021). To this day, the majority of commuters travel to work alone. This is a challenge that is not only faced by the Netherlands, but by Europe as a whole (European Environment Agency, 2022a).

1.1.1. Previous policy measures

Existing policy measures have had limited success in promoting carpooling as a way of travelling. To advise policy-makers on effective policy measures, it is important to understand the behaviour of commuters as well as the dynamic interactions within the system influencing their behaviour. By adopting a system-level approach, this study aims to gain insight into the behavioural interactions that affect the adoption of carpooling among commuters. In this section, measures that have been considered in the past are discussed. This provides a valuable starting point for this study, as insights are gained into the effectiveness of various types of measures.

A common measure that has been taken to stimulate the adoption of carpooling is the introduction of financial incentives. There are two different types of financial incentives: 'carrot policies' and 'stick policies'. In 'carrot' policies, carpooling is encouraged by providing financial compensation for those who carpool. In 'stick' policies, driving alone becomes more expensive, for example through distance-based road pricing. Data from Belgium shows that a combination of both measures resulted in the highest occupancy rate of 1,5 persons per car, compared to a base scenario of 1,3 (Franckx, 2023). Despite these incentives, the occupancy rate of cars remains limited. The effects of financial incentives are mixed. Some studies have found that financial incentives are a strong motivator for people to carpool (Hunecke et al., 2021), while others only find a marginal effect (Mattia et al., 2021). In a Belgian case study for example, financial incentives have not been found to lead to the desired occupation rates (Franckx, 2023). Thus, financial incentives alone are not enough to bring carpooling to the desired level (Bulteau et al., 2021).

Another incentive employers could provide is to arrange reserved or free parking spots for employees who carpool (Shaheen et al., 2018). This measure can be seen as a 'carrot policy', as it makes carpooling more attractive, especially when parking spaces are limited. This method

can also be used to discourage people from driving alone. By making parking spots for solo drivers more expensive, carpooling becomes more attractive. This 'stick' method appears to be more effective than the 'carrot' method of providing free or reserved parking spots for those who carpool (Neoh et al., 2015). Nevertheless, the 'carrot' method has a higher acceptance rate among employees (Baldassare et al., 1998).

In addition, a high-occupancy vehicle (HOV) lane was introduced to reduce the travel time of people who carpool. In 1993, the first HOV lane in Europe was opened between Diemen and Muiderberg in the Netherlands (Rijkswaterstaat, 2016). Solely cars with three or more persons were allowed to make use of this lane. While there appeared to be an increase in carpool activities, this did not last for long (Trouw, 1994). In 1994, the HOV lane was turned into a regular lane, as its use was limited and traffic congestion remained. To make a HOV lane effective, it is important that there are clear travel time savings and that this is communicated properly (M. C. Cohen et al., 2021). Data from the United States shows that introducing a HOV lane has a positive effect on the number of people willing to carpool (M. C. Cohen et al., 2022). However, no significant increase could be found for one of the three HOV lanes in Israel that was studied. A possible explanation could be that this specific HOV lane had a required occupancy rate of three persons per car instead of two. In addition, this lane was only one-directional, meaning that there would be no time savings for the return trip (M. C. Cohen et al., 2022).

1.2. Research problem

To make carpooling a standard way of travelling, behaviour change is required. As discussed in Section 1.1.1, several efforts have been made to change the way people travel. However, these interventions have appeared to be ineffective, as to this day the majority of people drive alone to work. It has become clear that large-scale adoption of carpooling is not an easy task (Guidotti et al., 2016; Meloni et al., 2025). The habit of driving alone is perceived as an enjoyable choice and is difficult to change (Crotti et al., 2026). Life-changing events, such as starting a new job, moving to another city or expanding your family, are rare moments at which people reconsider their behaviour, which includes their mobility choices (Muconsult, 2025). The choice of a certain transport mode depends on both psychological and contextual factors on the individual level as well as on the broader behavioural dynamics within the system.

While the behaviour of commuters regarding carpooling is extensively researched, there is still an important knowledge gap that remains. Existing literature is mainly focused on isolated behaviour, disregarding the interaction between different actors in the system. Several meta-analyses have shown that most studies explore individual behavioural determinants, rather than dynamic interactions (Neoh et al., 2015; Olsson et al., 2019). These behavioural determinants

are often measured through surveys that focus on the perspective of the commuter. The perspective of other actors is not taken into account. The literature review presented in Section 3.1 confirms this observation. The behavioural determinants that are identified only provide insight into individual decision-making processes, without capturing the dynamic interactions that shape carpool behaviour. A multi-actor perspective and system-level approach is missing. This approach is needed, as mobility choices are made within a complex system of multiple actors who interact and affect the decision-making process of citizens (Cascetta et al., 2007; Enserink et al., 2022). To create effective policy measures that encourage the adoption of carpooling among commuters, the understanding of the system that evolves around carpooling needs to be enhanced

To address this knowledge gap, this study incorporates the behaviour of commuters as well as governmental organizations, employers and facilitators. Through semi-structured interviews, an expert workshop and the construction of a behavioural system map (BSM), this study aims to make a novel contribution to both policy-making and academia by analysing the behavioural interactions within the whole system. This systems thinking perspective can be defined as *'the art and science of making reliable inferences about behaviour by developing an increasingly deep understanding of underlying structure'* (Richmond, 1994). To gain insight in the dynamic interactions affecting carpool adoption, this study presents a BSM that incorporates the behaviour of multiple actors and how they interact with each other. Recent research in behavioural sciences demonstrates that such a system perspective can improve the understanding of complex policy challenges (Bellmann et al., 2025; Hale et al., 2022; Lunetto et al., 2022; West et al., 2020). By adopting this novel system-level approach, this study aims to enhance the understanding of carpool behaviour on a system-level and provide pathways to system-wide adoption of carpooling.

1.3. Research questions

This study aims to gain insight into the psychological and contextual factors influencing the adoption of carpooling, through a systemic lens informed by policy-makers and mobility experts. By adopting a multi-actor perspective, this study makes a novel contribution to both academia and policy-making. The knowledge gap identified in Section 1.2 will be addressed by answering the following research question:

What psychological and contextual factors influence the adoption of carpooling among commuters, considering dynamic interactions between actors in the system?

To answer this research question, three sub-questions have been defined. The first sub-question dives into the psychological and contextual factors identified in literature that influence carpool

behaviour. The goal of the second sub-question is to incorporate the insights from policy-makers, mobility experts and facilitators to enhance the understanding of the system. The third sub-question is focused on analysing and interpreting the behavioural dynamics found to identify leverage points that can be used to achieve behaviour change. The three sub-questions are formulated as follows:

1. *What psychological and contextual factors influencing carpool behaviour have been identified in peer-reviewed research?*
2. *What behavioural determinants and dynamic interactions are perceived by multiple actors that affect carpool behaviour?*
3. *What leverage points can be identified that affect the participation of commuters in carpooling services?*

Overall, answering these research questions enhances the understanding of the individual behavioural determinants and the dynamic interactions between multiple actors that influence the adoption of carpooling. The methodology to address research questions 1-3 is described in Chapter 2, the results are presented in Chapter 3, and the main findings are discussed in Chapter 4.

1.4. Relevance of the study

1.4.1. Scientific relevance

The adoption of carpooling involves the interaction of multiple actors, whose roles and interests collectively shape commuter participation. The uptake of carpooling is not driven by commuters alone, but also depends on employers, facilitators and governmental organizations. However, most studies that look into factors influencing carpool behaviour, are solely focused on the behaviour of the commuter. Neoh et al. (2015) for example, conducted a meta-analysis incorporating 22 articles, of which most were focused on the choices and behaviour of the commuters. Also in a meta-analysis by Olsson et al. (2019) consisting of 18 articles, most studies do not take into account the interests and behaviour of other actors. Because of this individual-level approach, the context in which the behaviour takes place and the behavioural interactions that occur within the system are missing (Bellmann et al., 2025). Several researches have stressed the importance of moving beyond the individual level and look at the broader system (Chater and Loewenstein, 2022; Lunetto et al., 2022). To the best of the author's knowledge, this study will therefore be the first to adopt a behavioural systems approach when looking at carpool behaviour of commuters.

To gain more insight into how the behaviour of multiple actors interacts and how this affects

the adoption of carpooling, this study will establish a BSM. This BSM provides insight into the interactions between different actors and how system-wide change can be achieved. By using a BSM, this study contributes to the growing literature on this approach and calls for more applications of it. As current studies are mostly focused on carpool behaviour on the individual level, this study aims to make a novel contribution to the research field of the behavioural sciences, by using a system-level approach. The insights that are gained from this study enhance the understanding of carpool behaviour on a system level.

1.4.2. Policy relevance

Carpooling is an effective way to reduce car use among commuters, without needing additional infrastructure (Olsson et al., 2019). Despite the benefits and existing measures, behavioural change toward the adoption of carpooling remain limited. Internal motivations are insufficient to make carpooling a standard way of travelling to work (Xiao et al., 2024). Interventions such as external incentives are needed to encourage the use of carpooling and actually change the way people commute (Hu et al., 2015. As discussed in Section 1.1.1, several measures have been taken in the past to encourage carpooling, but without much success. These measures have in common that there has been insufficient consideration of the system, as the measures are mainly focused on the individual.

To contribute to policy-making for the adoption of carpooling, this study has a dual approach. First, this study provides insight into commuter behaviour and its underlying factors, based on a literature review. Second, together with insights from policy-makers and experts, this review forms the basis for the construction of a BSM. This map provides a clear overview of the key actors involved and how they interact with each other. By mapping the relationships between the behaviours of multiple actors, leverage points can be identified that can be used by policy-makers to create effective measures. By analysing the system from a multi-actor perspective, this study aims to guide policy-makers in the establishment of adequate measures to stimulate the adoption of carpooling among commuters.

1.4.3. EPA relevance

Reducing single-occupancy vehicle use is needed to mitigate one of today's grand societal challenges: climate change. Not only in the Netherlands, but in Europe and globally, the transport sector continues to emit more pollutants (Carlin et al., 2024). Carpooling could provide a solution to tackle this international challenge. However, large-scale adoption of carpooling is not easily achieved. The decision-making context of commuters is embedded in a complex system of multiple actors and behavioural interactions. To achieve structural behaviour change, a full understanding of the system and all its interrelationships, dynamic interactions, and underlying factors is required. This thesis aims to enrich the understanding of the system by incorporating

a multi-actor perspective and adopting a system-level approach.

This research aligns with the Engineering and Policy Analysis (EPA) programme, as it guides policy-makers in developing effective policy measures to tackle grand societal challenges. To achieve this, this study incorporates the views of multiple actors to gain insight into the behavioural dynamics within the complex system of commuter mobility behaviour.

2

Methodology

This chapter presents the thesis' methodology. To address the research questions presented in Section 1.3, a behavioural systems approach is used. To the best of the author's knowledge, existing literature has not applied this approach to carpooling, which makes this study the first. This approach integrates systems thinking and behavioural science to effectively investigate complex societal issues (Lunetto et al., 2022). Where behavioural science provides insights on individual decision-making, systems thinking offers a rich understanding of the dynamic interactions within complex systems (Parkinson et al., 2025). These two methodological approaches are integrated by combining a behavioural analysis from the behavioural sciences field with multi-actor thinking from systems analysis. Connecting this micro and macro-level approach is a novel lens to understand today's grand societal challenges. Following this behavioural systems framework, a multi-method approach is used.

To give an overview of the different methods that are used, Figure 2.1 presents a flowchart of the different steps of the research process. The numbers 1 -3 correspond to the research questions presented in Section 1.3. After exploring the system and conducting an actors scan, the first research question is addressed by identifying behavioural determinants found in literature. Concurrently, multiple actors within the system have been interviewed to gain insight into the behavioural determinants identified by experts and their views on the behavioural dynamics within the system. Through this behavioural and thematic analysis, the second research question is addressed. Subsequently, the behavioural determinants found in literature are compared to those identified by experts. In parallel, a Behavioural System Map (BSM) is constructed to provide an overview of the system as a whole. This BSM is based on both the behavioural analyses and the thematic analysis, providing insight into the behavioural dynamics and underlying psychological mechanisms that influence the adoption of carpooling. The behavioural

dynamics that emerge in the interview data are validated through an expert workshop. The insights from this workshop are used to refine the found behavioural dynamics and the BSM. At last, the BSM is interpreted by identifying feedback loops and leverage points to enhance the understanding of the dynamic interactions within the system and to provide insight into potential policy directions.

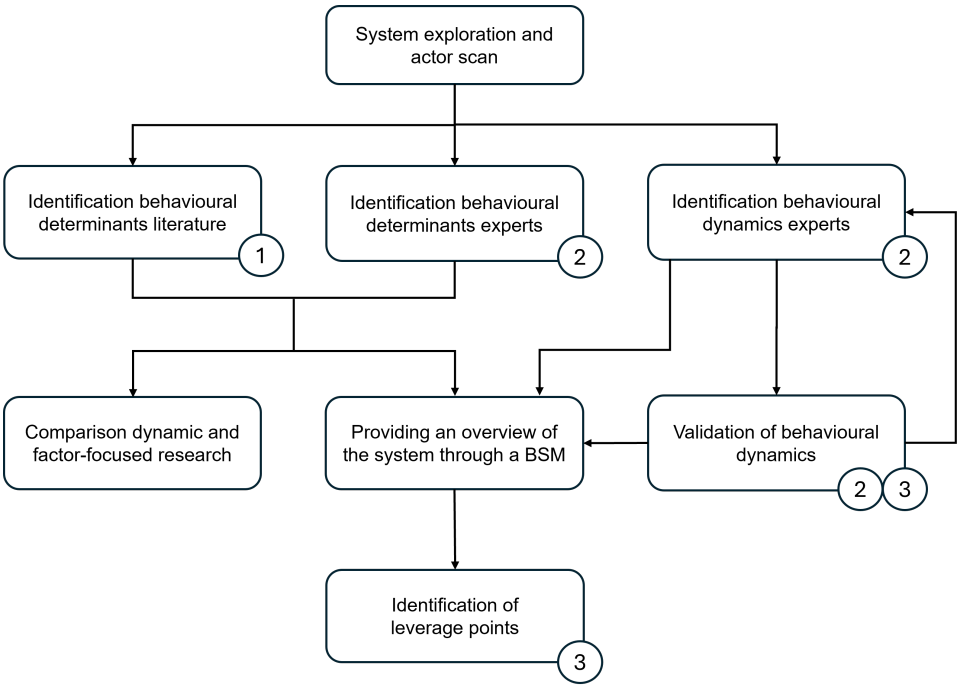


Figure 2.1: Flowchart of research process.

Process steps that are placed in the same row are conducted concurrently. The arrows show the flow of the research process. The number 1-3 correspond to the research questions.

This research design is inspired by a guide for behavioural system mapping consisting of the following steps: 1. system exploration & boundary setting, 2. data collection & behavioural analysis, 3. construction of the map, 4. validation & refinement of the map, and 5. analysis & interpretation of the map (Bellmann, 2025). Beyond the steps of this guide, this study includes a literature review to gain insight into the behavioural determinants that influence individual decision-making. Section 2.1 discusses the methodological approach of the literature review. Section 2.2 describes the process of conducting interviews. Section 2.3 outlines how the behavioural system map is constructed and analysed.

2.1. Literature review

Through a state-of-the-art literature review, this study provides an overview of the psychological and contextual factors that influence carpool behaviour. A literature review is a suitable approach, as it collects and combines existing literature, creating an overview of all relevant

behavioural determinants which serves as a basis for further analyses (Snyder, 2019). Articles have been searched regarding psychological and contextual factors influencing carpool behaviour. Psychological factors refer to individuals' beliefs, attitudes, motivations and other internal processes (Koenig, 2018), which play a central role in human behaviour. Contextual factors concern external factors, such as the travel distance to work and the social norm, which influence travel behaviour. Instead of adopting a barrier-focused approach, this literature review outlines factors that can be both drivers and barriers. Whether a factor is a driver or a barrier often depends on perceptions (Nilsen, 2026). For example, one's attitude toward a transport mode can either be positive or negative and therefore acting as a barrier or driver. With a factor-based approach, dynamic system characteristics are identified rather than static determinants. This literature review contributes to the understanding of carpool behaviour of commuters and forms a basis for the semi-structured interviews and the behavioural system map. The results of this literature review are used to answer the first sub-question presented in Section 1.3.

2.1.1. Search strategy

To gather relevant literature, articles have been searched regarding psychological and contextual factors. With these broad search terms, this review provides a comprehensive overview of the relevant factors influencing carpool behaviour that are identified in scholarly research. Both the databases Scopus and Web of Science are used to collect relevant literature. In total, four searches have been executed. The terms 'autonomous vehicle' and 'autonomous vehicles' are excluded as carpooling with autonomous vehicles is out of scope for this study.

On Scopus the following search queries are used:

- (ridesharing OR ride-sharing OR carpool OR carpooling) AND (psychological OR psychology) AND NOT ("autonomous vehicle' OR "autonomous vehicles")
- (ridesharing OR ride-sharing OR carpool OR carpooling) AND contextual AND NOT ("autonomous vehicle" OR "autonomous vehicles")

On Web of Science the following search queries are used:

- (ridesharing OR ride-sharing OR carpool*) AND psycholog* AND NOT "autonomous vehicle*"
- (ridesharing OR ride-sharing OR carpool*) AND contextual AND NOT "autonomous vehicle*"

Following the search queries stated above, 76 unique articles are found: 51 articles regarding

psychological factors and 25 articles regarding contextual factors. These articles are screened based on the title and abstract. Selected articles explicitly included all of the following:

- Behavioural determinants of carpooling
- Focus on commuters
- Carpooling with a private car

In Figure 2.2, an overview is given of the screening process of the collected articles regarding psychological factors influencing carpool behaviour.

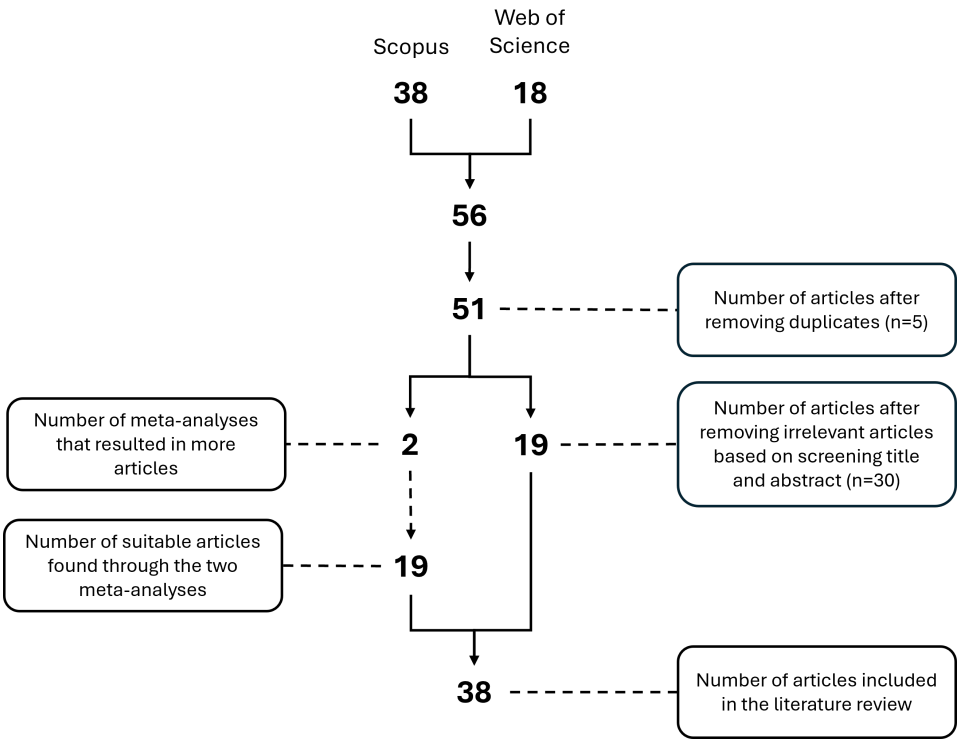


Figure 2.2: Screening process of articles regarding psychological factors.

This screening process resulted in the removal of thirty articles that did not meet the inclusion criteria. Articles with a different topic, such as ride-hailing (n=7), or a different focus, such as Covid-19 (n=3), are excluded. In Table A.1 in Appendix A, an overview is given of the reasons for exclusion. The remaining articles consist of two meta-analyses with specific references to the reviewed articles. These studies are used to collect more articles. From the two meta-analyses, 19 additional articles are found. These articles are selected based on the title and abstract, following the inclusion criteria stated above. This results in a total of 38 articles on psychological factors.

Figure 2.3 shows the screening process of the articles collected regarding contextual factors.

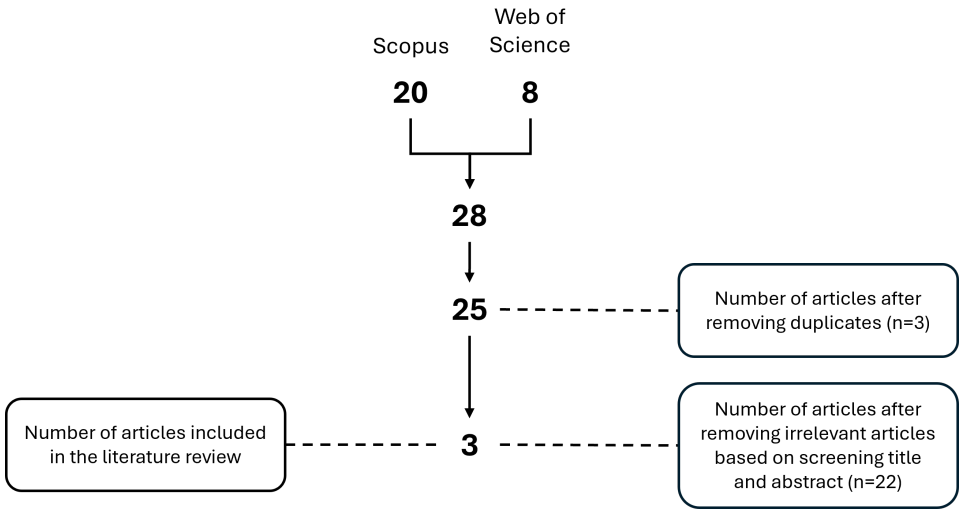


Figure 2.3: Screening process of articles regarding contextual factors.

Reviewing both the title and abstract led to the exclusion of 22 articles. Examples of exclusion reasons are research on ride-sourcing (n=4) or the focus on older adults (n=2). Table A.2 in Appendix A provides an overview of the reasons for exclusion. At the end, three articles are considered relevant. In total, 41 articles are included in the literature review.

2.1.2. Processing and analysis of literature

To guide the literature review, the Theoretical Domains Framework (TDF) is used. The TDF is an integrated theoretical framework that is based on multiple theories relevant to implementation questions (Atkins et al., 2017). The TDF is an extension of the Capability, Opportunity, Motivation and Behaviour (COM-B) model (Michie et al., 2011). Within the COM-B model, the domains capability, opportunity, and motivation interact and influence behaviour. In turn, behaviour affects these domains. Capability is defined as *"the individual's psychological and physical capacity to engage in the activity concerned"*. Opportunity is referred to as *"all the factors that lie outside the individual that make the behaviour possible or prompt it"*. Motivation is defined as *"all those brain processes that energize and direct behaviour, not just goals and conscious decision-making"* (Michie et al., 2011). The TDF is an extension of the COM-B model and consists of 14 domains that can be used to analyse and categorise behavioural determinants. While the COM-B model has links between its components, the TDF does not propose verifiable relationships between domains (Atkins et al., 2017). The TDF merely provides a theoretical lens on the underlying factors of behaviour. The TDF is commonly used for the analysis of qualitative data (Y. Zhou et al., 2024), as it allows qualitative coding into theoretical domains (Atkins et al., 2017). Figure 2.4 shows the relationship between the theoretical domains and the COM-B model. This figure shows the granularity of the TDF compared to the COM-B model. This granularity level allows for a more detailed analysis of the behavioural

determinants. Appendix B provides a description of the different domains.

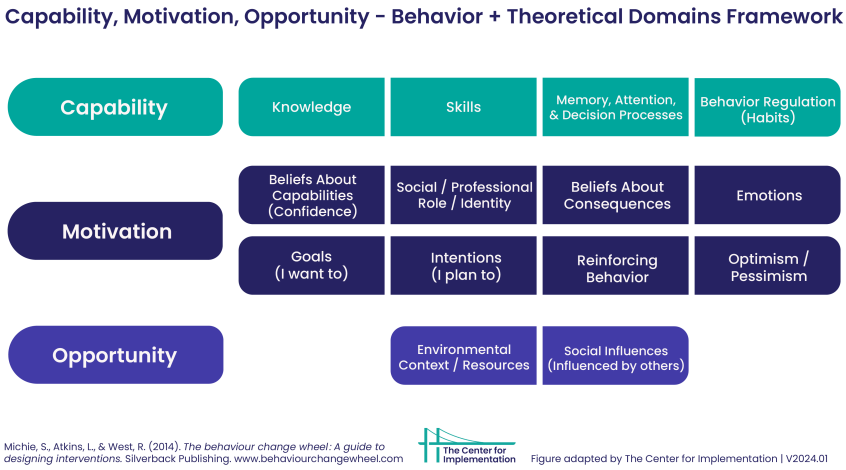


Figure 2.4: Theoretical Domains Framework mapped to the COM-B model (Moore et al., 2023).

With the classification of behavioural determinants in theoretical domains, this study provides a clear overview of the psychological and contextual factors influencing carpool behaviour identified in scholarly research. This classification process consists of different steps. These steps are inspired by research papers that follow a similar methodological approach (Allemann et al., 2016; Cowdell and Dyson, 2019). First, a long list of psychological and contextual factors is created by reviewing the articles collected. Second, factors with a similar meaning are grouped through combined coding. For example, *'altruism'* and *'helping others'* are combined and represented as *'helping others'*, as these factors are both defined as selflessness and the tendency to support others. Third, the factors are classified into the 14 theoretical domains. This classification is based on the domain descriptions presented in Appendix B, following a similar approach as in existing literature (Urquhart et al., 2025). For example, *'helping others'* is categorised into the domain *'social/professional role and identity*, as it can be seen as a personal quality which is displayed in social setting. For each domain, the number of research papers acknowledging the domain as a behavioural determinant is noted. To highlight the prominence of individual behavioural determinants within a domain, the frequency of mentioning is recorded. At last, the capacity, opportunity, and motivation domains of the COM-B model are added as overarching domains. Combining the COM-B model with the TDF allows for a more thorough analysis of the behavioural determinants and contrasting the two versions of the Behavioural Change Framework.

2.2. Semi-structured interviews

To gain insight into the behavioural interactions of multiple actors and their perspective on the system, semi-structured interviews are conducted. Semi-structured interviews are based on a predefined set of questions, but are not tied to them (Leavy, 2020). The purpose of conducting interviews is to capture the perspective of policy-makers and mobility experts on carpool behaviour among commuters. In contrast to other methods (e.g. Delphi panel or surveys), conducting interviews allows for in-depth exploration of behavioural determinants and dynamic interactions (Oranga and Matere, 2023). As this study is focused on mapping various relevant factors and incorporating the behaviour of multiple actors, conducting semi-structured interviews is more suitable.

2.2.1. Data collection

For this study, twenty interviews have been conducted with people from various fields that have been involved in carpooling, including governmental organisations (on multiple levels), knowledge institutes, employer coalitions, app providers and people involved in carpool pilots. With this set of interviews, this study collects expert perceptions, rather than commuter views. To determine the types of actors to approach for an interview, an initial actor scan is conducted. Relevant actors are identified through an instrumental identification technique (Cunningham and Hermans, 2018). With this instrumental view, actors are identified that are formally involved in the following:

- Actors who stimulate shared mobility in general, carpooling specifically
- Actors who facilitate ride-matching
- Actors who (financially) support carpooling

This actor scan resulted in a long list of actors, which is presented in Appendix C. Based on this list of actors and the connections from the Ministry of Infrastructure & Water Management, suitable participants have been approached by e-mail. In the first round of recruitment, thirteen people have been invited to participate, from which ten people were approached through contacts of the Ministry of Infrastructure & Water Management. Eleven people accepted, one person referred to another person for an interview, and one person did not respond. In total, twelve interviews were conducted through the first round of recruitment. After the first interview, additional interviews were gradually scheduled through snowball sampling, which is recruitment based on the recommendations of other interviewees (Ahmed, 2024). In total, twelve additional people have been approached. Eight people accepted, two people declined as they did not view themselves as experts, one person declined due to time constraints and one person did not respond in time. The minimum sample size of participants is based on theme sat-

uration. Theme saturation is the point in qualitative research where collecting additional data does not generate new meaningful themes or insights (Wutich et al., 2024). After conducting approximately fifteen interviews, substantial interpretive richness has already been achieved. From that point, no new interviews were scheduled. Twenty interviews were conducted, as the last five interviews were already scheduled before theme saturation was achieved.

To structure the interviews, a predefined set of questions is used as a guideline. This guideline is inspired on the interview guidelines used in existing studies that adopt a behavioural system mapping approach (Bellmann et al., 2025; Davan Wetton et al., 2025). The set of questions is divided into three core themes. Within the first theme, the participant is asked which actors play a role within the decision-making context of commuters. The second theme dives into the decision-making process of commuters themselves and the determinants that underlie commuters' behaviour. Lastly, interviewees are invited to think about policy interventions that could encourage the adoption of carpooling. The interview guideline is presented in Appendix D.

To uphold to ethical standards, the guidelines of the TU Delft Human Research Ethics Committee (HREC) are followed. All interviews are audio recorded and transcribed, to analyse the data. Each participant has been made aware of the data collection, processing, and storage and has provided their consent through an informed consent form. In addition, a data management plan has been established and the HREC checklist has been filled out. These documents have all been approved by the HREC, with approval number 6406. The informed consent form, data management plan, checklist and letter of approval have been included in Appendix E.

2.2.2. Behavioural analysis

Similarly to the literature review, the interview data are used to gain a deeper understanding of the behavioural determinants of actors' behaviour. Open coding is used as a method to identify behavioural determinants. This method consists of labelling data and marking key insights (McLeod, 2024). The TDF is used to structure the behavioural analysis (Atkins et al., 2017). Each behavioural determinant is labelled with the overarching theoretical domain. This labelling is based on the domain descriptions presented in Appendix B. For example, if an interviewee outlines that the awareness of a certain topic influences one's behaviour, this would be coded as the theoretical domain *'knowledge'*. This coding is conducted with Atlas.ti software, which is a software program that allows for a systematic analysis of the interview data ("ATLAS.ti Scientific Software Development GmbH", 2024). To analyse the perceived importance of the different theoretical domains found in the interviews, the frequency counts of each domain is assessed. In addition, the theoretical domains found in the interview data are used to show the determinants of commuter behaviour in the BSM. The inclusion of behavioural

determinants in the BSM provides richer insights into the behavioural underpinnings.

2.2.3. Thematic analysis

Next to the behavioural analysis, a thematic analysis is conducted. The purpose of conducting a thematic analysis is to identify and analyse patterns within the data (Braun and Clarke, 2006). To identify these themes, each interview transcript is systematically analysed through open coding using Atlas.ti software ("ATLAS.ti Scientific Software Development GmbH", 2024). Whereas for the behavioural analysis, determinants are labelled by the overarching theoretical domain, the thematic analysis requires more detailed coding. Each code tag is a short label that marks a key point within the data (Saldana, 2025). The code tags include actors' behaviour, roles, views, or underlying factors. To illustrate, if an interviewee would talk about the decision-making process of commuters when considering travelling with public transport and they mention the distance to a public transport station as a behavioural determinant, the code tag *'accessibility of a public transport station'* could be assigned.

To establish a compact and insightful set of code tags, several iterations have been made in which code tags have been adjusted, combined, or removed. The process of coding the interview data to identify themes is inspired on the first steps of a guide for manually constructing Causal Loop Diagrams based on coded transcripts, which consists of discovering and sorting themes (Newberry and Carhart, 2023). Once a final set of code tags is obtained, overarching code groups are identified. These groups represent a certain aspect of the system and form the basis for the identification of themes. For example, the code tags *'accessibility of a public transport station'*, *'availability of ticket machines'*, and *'the number of waiting areas at the station'* could be grouped into the code group *'availability of facilities'*.

By analysing the relationships between the different code groups, overarching themes are established. In the example illustrated above, the code group *'availability of facilities'* could be categorised in a theme named *'reliance on structural conditions'*. Each theme represents a behavioural dynamic that plays an important role in the adoption of carpooling, as perceived by the interview participants. Through the construction of these themes and other additional insights from the interview data, the second sub-question presented in Section 1.3 is answered.

2.3. Behavioural system mapping

To gain a deeper understanding of the dynamic interactions between multiple actors within the system and the influences on commuter behaviour, a behavioural system map (BSM) is constructed. Behavioural system mapping is a novel method in the field of behavioural sciences. It is a tool that can help understand and change human behaviour in complex systems (Allison et al., 2024; Bellmann et al., 2025; Davan Wetton et al., 2025; Hale et al., 2022). Behavioural

system mapping builds on a long tradition of system mapping, such as causal loop diagrams (Barbrook-Johnson and Penn, 2022; Veldhuis et al., 2025). It can provide insight into the behaviours of multiple actors, their interrelationships, and underlying factors. The purpose of using behavioural system mapping in this study is to gain a deeper understanding of the system as a whole, instead of solely analysing the factors influencing commuters' behaviour on an individual level (Bellmann, 2025). For example, whereas in traditional research the relationship between the implementation of a bus-line and the tendency of commuters to travel with public transport is studied, in behavioural system mapping, multiple actors, behavioural interactions, and determinants are mapped to enrich the understanding of the system. This example is illustrated in Figure 2.5. The actors are noted in bold between brackets and the behavioural determinants are highlighted in grey. The black arrows show the causal relationships between the behaviours. By mapping the behaviour of multiple actors, their interrelationships, and behavioural determinants, this study aims to provide insight into multi-actor dynamics influencing the adoption of carpooling.

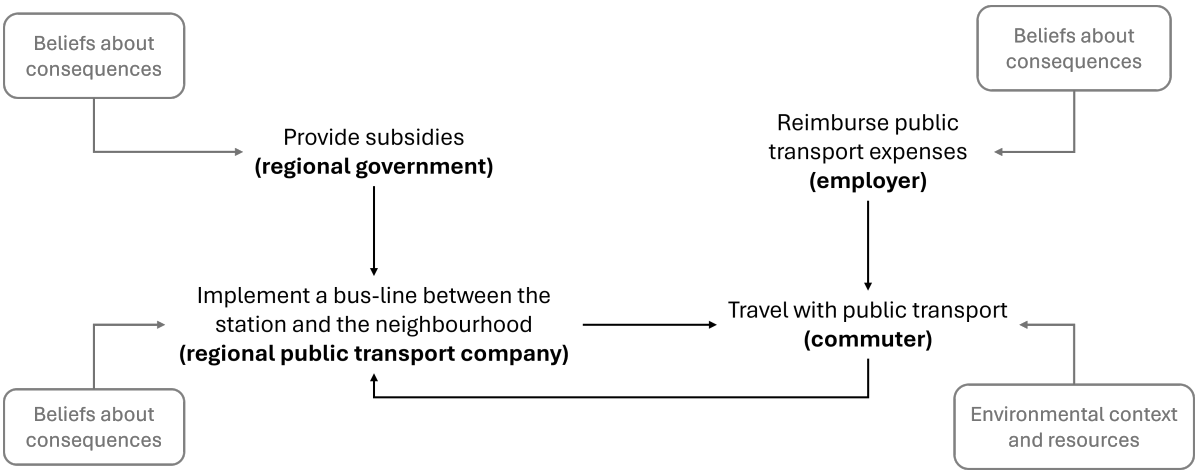


Figure 2.5: Example of behavioural system mapping.

The text nodes show behaviours. The actors are noted in bold between brackets. The black arrows show the causal relationships between behaviours. The behavioural determinants are shown in grey.

The construction and analysis of the BSM follow a systematic approach. Figure 2.6 provides an overview of the methodological process. The BSM is based on the individual behavioural determinants classified using the TDF and the themes that represent the key behavioural dynamics perceived by experts. The set of code tags assigned to the interview data is used to create a long list of behaviours, corresponding actors, and overarching themes. The identified commuter behaviours informs the development of the decision-making process commuters go through when considering carpooling. This commuter journey is placed as the centre of the map and is used as a starting point. Gradually, the behaviours of other actors are added per

theme. These behaviours are extracted from the long list of behaviours created from the interview data. While adding the themes separately gives more structure in the process of creating the map, the eventual map does not have a clear division of themes. Due to the complexity of the system, all themes are interconnected, influencing each other. The BSM is analysed and interpreted by identifying feedback loops and corresponding leverage points. These analysis steps are explained in more detail in Section 2.3.1.

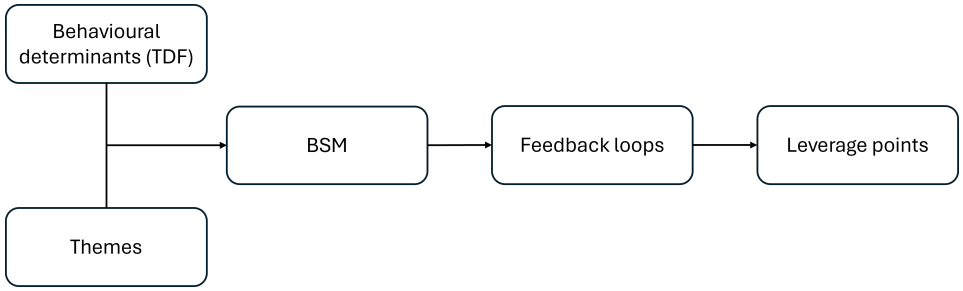


Figure 2.6: Overview methodological process of Behavioural System Mapping.

Steps that are placed in the same column are executed concurrently. The arrows show the flow of the methodological process.

2.3.1. Analysis of behavioural system map

The analysis follows a similar approach as existing studies using behavioural system mapping (Bellmann et al., 2025; Davan Wetton et al., 2025; Hale et al., 2022). First, the main feedback loops are identified to reveal key behavioural dynamics. A feedback loop is a closed loop of behaviours that consecutively influence each other. In the example illustrated in Figure 2.5, the behaviours *'implement a bus-line between the station and the neighbourhood'* and *'travel with public transport'* form a feedback loop as an increase in commuters who travel with public transport, might lead to the implementation of an extra bus-line if there seems to be demand. Based on the types of relations, positive or negative, a feedback loop is either balancing or reinforcing. Balancing feedback loops show a fluctuation as positive influences lead to negative influences and vice versa. Reinforcing feedback loops present a behaviour that is continuously strengthened by solely positive or solely negative influences. Each feedback loop presents a behavioural dynamic that influences the adoption of carpooling. By analysing these feedback loops, the understanding of the system can be enriched.

Second, leverage points are identified based on the feedback loops. Leverage points are points within the map that have a large influence on the system and cause ripple effects. These levers can be used to intervene and change the system. For each feedback loop, a leverage point is identified. The total set of leverage points shows for which aspects of the system interventions are needed to structurally change the system and encourage the adoption of carpooling.

2.3.2. Expert workshop

In the last phase of the study, the findings of the BSM are discussed and interpreted through an expert workshop. An expert workshop is used to review the themes that are reflected in the BSM and design interventions to improve the system (Barbrook-Johnson and Penn, 2022). The workshop consisted of four participants with various backgrounds: governmental organisations, mobility experts and people involved in carpool pilots. The participants are recruited by reusing the list of suitable interview participants and approaching potential participants who are recommended during snowballing. In total, sixteen people have been invited, of which fourteen people have been interviewed before. Twelve people declined, as they were not available at the time of the workshop. Of the four workshop participants, three participants have been interviewed before.

The workshop took place on the 12th of May 2026 at the Ministry of Infrastructure & Water Management in the Hague. The expert workshop consists of two parts and was moderated by the researcher and supervisor of the Ministry of Infrastructure & Water Management. Appendix F shows the timetable of the workshop. The goal of the first part is to validate the themes and their reflection in the BSM. During this round, each theme is presented and discussed. Through a discussion between multiple actors, who all have a unique perspective, new insights can be gained in the behavioural dynamics that are represented by the themes. The results of this discussion can be used to refine the BSM if needed and enrich the themes, which is a common validation method in behavioural system mapping (Bellmann et al., 2025; Hale et al., 2022).

In the second part of the workshop, the leverage points are presented. The goal of this round is to come up with a set of policy measures to advise policy-makers on which type of measures should be investigated. After all leverage points are presented, each participant, as well as the researcher and supervisor, receives a leverage point. Each person then gets a few minutes to come up with measures that could be implemented to intervene in this leverage point. This method is derived from the last phase of Group Model Building, in which participants are asked to list as many suitable intervention areas as possible (Guariguata et al., 2020). This exercise is done two times, meaning that each person gets to see three leverage points. Through the rotation of leverage points, participants are invited to look at the previously identified interventions with a critical lens and come up with ideas to overcome certain barriers. At the end, every participant receives the leverage point they had first and presents the main findings to the rest of the group.

3

Results

This chapter discusses the results of this study. Section 3.1 presents the psychological and contextual factors found in literature. Section 3.2 explains the key findings of the interviews, through a behavioural and thematic analysis. Section 3.3 presents the behavioural system map that has been constructed and discusses the feedback loops and leverage points.

3.1. Literature review

This section discusses the results of the search queries stated in Section 2.1.1. In total, 94 behavioural determinants are found across 41 studies. The behavioural determinants are organised using the TDF and the COM-B model. Table 3.1 shows the frequency of each domain mentioned. The frequency with which theoretical domains of the TDF are acknowledged varies between 0 and 30 papers (n=41). This variation indicates that not all theoretical domains are of equal importance. The five domains that appeared most prominently are *'6. beliefs about consequences'* (n=30), *'11. environmental context and resources'* (n=26), *'13. emotion'* (n=20), *'8. intentions'* (n=13), and *'12. social influences'* (n=11). Next to the frequency of domains, there is also an imbalance in the number of behavioural determinants found per domain. The number of determinants identified per domain varies between 0 and 29 determinants. The domains *'6. beliefs about consequences'* (n=29), *'11. environmental context and resources'* (n=14), and *'13. emotion'* (n=12) have the highest concentration of behavioural determinants. The domain with the most behavioural determinants, *'6. beliefs about consequences'*, consists of twice as many determinants as the second-largest domain *'11. environmental context and resources'*. The length of the in-text descriptions of the domains reflect the number of distinctive determinants. In Appendix G, a full table of behavioural determinants categorised in the

TDF is shown.

Table 3.1: Frequency of mentioned TDF domains in literature.

Domain	Frequency* (n=41)
1. Knowledge	2 (5%)
2. Skills	2 (5%)
3. Social/Professional Role and Identity	9 (22%)
4. Beliefs about Capabilities	4 (10%)
5. Optimism	0 (0%)
6. Beliefs about Consequences	30 (73%)
7. Reinforcement	7 (17%)
8. Intentions	13 (32%)
9. Goals	10 (24%)
10. Memory, Attention, and Decision Processes	5 (12%)
11. Environmental Context and Resources	26 (63%)
12. Social influences	11 (27%)
13. Emotion	20 (49%)
14. Behavioural Regulation	2 (5%)

*number of papers identifying at least one behavioural determinant for the theoretical domain.

Table 3.2 shows the frequency of the domains *'capability'*, *'opportunity'*, and *'motivation'*, to analyse the behavioural determinants more thoroughly. The theoretical domains presented in Table 3.1 are mapped to the COM-B model, following the categorisation presented in Figure 2.4. Capability appears to be the least prominent domain in literature. Only 24% of the reviewed papers mention behavioural determinants that are related to one's capability. This indicates that capability does not play a major role in the decision to share a ride, according to existing literature. 76% of the papers acknowledge behavioural determinants that are related to one's opportunity, especially determinants related to one's environmental context and resources are frequently mentioned. The most prominent domain, with 95% of the research papers confirming its influence, is motivation. This prominence is due to high number of theoretical domains that relate to one's motivation. Especially the domains *'beliefs about consequences'* and *'emotion'* contribute to this high share of papers acknowledging motivation as a domain.

Table 3.2: Overview of frequency of mentioned COM-B domains in literature.

COM-B	Frequency* (n=41)	TDF domains
Capability	10 (24%)	Knowledge
		Skills
		Memory, Attention, and Decision Processes
		Behavioural regulation
Opportunity	31 (76%)	Environmental context and resources
		Social influences
Motivation	39 (95%)	Beliefs about capabilities
		Social/professional role and identity
		Beliefs about consequences
		Emotions
		Goals
		Intentions
		Reinforcement
		Optimism

*number of papers identifying at least one behavioural determinant for the theoretical domain.

Knowledge

Research shows that the awareness of carpooling being a way of travelling influences one's decision to carpool (Bulteau et al., 2019). Citizens who are not aware carpooling is an option, are unlikely to share a ride. Not only awareness of the mode of transport itself, but also one's environmental awareness plays a role in the choice of a transport mode. People with a higher level of environmental awareness tend to choose more sustainable transport modes, such as carpooling (Wang et al., 2018).

Skills

Existing literature indicates that skills do not play a major role in the decision to carpool. While passengers hardly need any skill to carpool, the only skill required for drivers is the ability to drive a car (Correia and Viegas, 2010; Xiao et al., 2024). As the ultimate goal is to encourage carpooling among commuters who currently drive alone, the availability of a driver's licence is not a limiting factor.

Social/ professional role and identity

Within the domain *'social/ professional role and identity'*, social status has been frequently identified as a behavioural determinant (Nielsen et al., 2015; Wang et al., 2019; X. Zhang et al., 2022). The status of carpooling depends on the social environment. In most cultures,

social status comes with owning and driving a car (Nielsen et al., 2015), whereas in other circles, travelling more sustainably, including carpooling, could improve one's status (Wang et al., 2019). Another factor that reflects one's social role is the perceived experience of helping others (Hoerler et al., 2025; Margolin et al., 1978). Especially people who adhere to the traditional idea of carpooling, are motivated by altruistic values (Hoerler et al., 2025). One's identity is reflected through factors such as personal norm and dispositional trust (Bachmann et al., 2018; Tsai et al., 2021). Dispositional trust can be seen as a personality trait and is the general level of trust someone has in others. People with a higher level of dispositional trust are more willing to depend on others and therefore more likely to share a ride.

Beliefs about capabilities

Perceived behavioural control, self-efficacy, and perceived trialability are factors that reflect one's beliefs about capabilities. Whereas self-efficacy influences one's view on their carpool capabilities (Dinesh et al., 2021), perceived behavioural control refers to the belief of changing one's behaviour, for example switching from driving alone to sharing a ride (Bachmann et al., 2018; Shi et al., 2024). Perceived trialability, the possibility to try or test, is related to one's self-efficacy, as trying out carpooling could convince them of their carpool capabilities (Burghard and Scherrer, 2022).

Optimism

No behavioural determinants have been found for this domain.

Beliefs about consequences

The domain *'beliefs about consequences'* captures all perceived outcomes of certain behaviour. Perceived economic benefits is most frequently cited as a behavioural determinant (Delhomme and Gheorghiu, 2015; Shaheen et al., 2016; Shi et al., 2024). In addition to economic benefits, perceived environmental benefits, socialisation benefits, and time savings also appear to play a role in the decision to carpool (Mattia et al., 2021; Nielsen et al., 2015; Tsai et al., 2021; X. Zhang et al., 2022). There is no consensus on the relative importance of the different benefits. Some studies have found that perceived economic benefits is the most important motivator (Delhomme and Gheorghiu, 2015; Hunecke et al., 2021), while others have found social benefits and enjoyment to be more important (Tsai et al., 2021). Various studies indicate that the influence of perceived economic benefits depends on the target group, such as the income level (Margolin et al., 1978; Nielsen et al., 2015; Park et al., 2018). Time savings appears to be most relevant for people with a long commute distance (Tahmasseby et al., 2015). The influence of perceived environmental benefits is disputed. While some researchers acknowledge it as a behavioural determinant (Delhomme and Gheorghiu, 2015; Mattia et al., 2021), others state that environmental benefits are merely an unintended consequence (Shaheen et al., 2016).

In contrast to perceived benefits, perceived safety risks negatively influence the decision to

carpool. Various studies identified perceived safety risks as a behavioural determinant (Dinesh et al., 2021; Gkartzonikas and Dimitriou, 2025; Wang et al., 2018). Some researchers found that the perceived level of safety weighs more heavily for females (Wang et al., 2024; T. Zhou et al., 2022). Not only one's physical safety, but also privacy risks, such as the sharing of personal data and location is a barrier for people to engage in carpooling (Hunecke et al., 2021; Tsai et al., 2021; Wang et al., 2019). There appears to be a lack of trust, while this is essential in the relationship between drivers, passengers and facilitating platforms (Jiang and Lau, 2021; X. Zhang et al., 2022). This type of trust is different from dispositional trust. While dispositional trust can be seen as a personality trait, trust within the domain *'beliefs about consequences'* is context-dependent. To encourage the adoption of carpooling, it is important that these concerns are addressed (Gkartzonikas and Dimitriou, 2025; Wang et al., 2024).

Moreover, perceived reliability and flexibility appear to be prominent factors as well (Abrahamse and Keall, 2012; Li et al., 2007; Nielsen et al., 2015). These factors can act as drivers or barriers. Perceived flexibility is one of the main motivators to drive alone (Li et al., 2007), while it acts as a barrier for carpooling. However, carpooling is perceived to be more flexible than public transport, as there is no standard pick-up and drop-off location (Nielsen et al., 2015; Park et al., 2018). Similarly, perceived reliability is seen as a positive aspect of carpooling compared to public transport, as travelling with public transport entails the risk of being delayed due to technical disruptions (Abrahamse and Keall, 2012; Nielsen et al., 2015).

In addition, perceived convenience and comfort also play a role in the decision to carpool (Delhomme and Gheorghiu, 2015; Shaheen et al., 2016; T. Zhou et al., 2022). These factors are perceived as a positive or a negative aspect of carpooling. Some commuters view carpooling as inconvenient, as there are often stops in-between. However, compared to public transport, carpooling is perceived to be more convenient, as commute times are often shorter (Shaheen et al., 2016). Similarly, carpooling is perceived as a more comfortable mode of transport compared to public transport (Nielsen et al., 2015). Nevertheless, non-carpoolers still view driving alone as the most convenient and comfortable way of travelling (Delhomme and Gheorghiu, 2015).

At last, the attitude of people towards carpooling has emerged as a prominent factor as well. While people with a positive attitude view carpooling as a good alternative to current transport modes, people with a negative attitude could show aversion towards it. Various studies have confirmed that attitude significantly affects the acceptance of carpooling (Burghard and Scherrer, 2022; Shi et al., 2024). In general, a positive attitude towards carpooling weighs more heavily than a negative attitude (De Almeida Correia et al., 2013). However, in some studies attitude has not been found significant (Bachmann et al., 2018). A possible explanation for this contradictory finding is that the attitude of people depends on the social environment people

are in and that the survey participants were unfamiliar with carpooling as a way of travelling. All in all, the majority of studies underline that the attitude of people plays an important role in the decision to carpool.

Reinforcement

Through reinforcement mechanisms, commuters are motivated to repeatedly share rides. Examples of reinforcement mechanisms are financial incentives and non-monetary rewards (Correia and Viegas, 2010; Shi et al., 2024; Xiao et al., 2024). Financial incentives differ from perceived economic benefits, which is classified in the domain *'beliefs about consequences'*. Financial incentives are additional rewards that reinforce behaviour, whereas perceived economic benefits are defined as one's beliefs about the financial attractiveness of a transport mode. The fuel cost, for example, could affect perceived economic benefits, but is not a financial incentive. However, through the provision of financial rewards, perceived economic benefits can be enhanced. In addition, employers could provide parking benefits to those who carpool to further incentivise employees to share rides (Margolin et al., 1978; Park et al., 2018).

Intentions

The intentions people have not always result in actual behaviour (Grimmer and Miles, 2016). This is called the intention-behaviour gap. Because of this gap, many researchers distinguish between the intention to share a ride and the actual behaviour of sharing a ride (Bachmann et al., 2018; Dinesh et al., 2021; X. Zhang et al., 2022). There are no other intentions found as this study focuses on one single target behaviour: sharing a ride.

Goals

Various studies have established that environmental concerns and goals of reducing one's environmental impact influence the decision to carpool (Li et al., 2007; Shi et al., 2024; Tahmasseby et al., 2015). Commuters with a pro-environment attitude are more likely to carpool than people who care less for the environment (Hoerler et al., 2025; Mohammadi-Mavi et al., 2024). Among carpoolers, reducing the environmental impact appears to be one of the main motivators (Gheorghiu and Delhomme, 2018).

Memory, attention, and decision processes

The main factor that has come forward within the domain *'memory, attention, and decision processes'* is the previous experience with carpooling. While some researchers observed a positive effect between previous experience and carpooling (Tahmasseby et al., 2015; X. Zhang et al., 2022), others found that previous experiences negatively affect the intention to share a ride, due to the inconvenience of coordinating (Mohammadi-Mavi et al., 2024). The type of relationship depends on the type of experience.

Environmental context and resources

Trip characteristics, such as travel time, departure time, commute distance, and commute costs, are important contextual factors identified in scholarly research (Bulteau et al., 2019; Lee et al., 2015; T. Zhou et al., 2022). In general, people with longer commute times are more willing to carpool than people who only have to travel a short distance (Mohammadi-Mavi et al., 2024). To encourage people to share a ride, time savings can be increased by introducing a high-occupancy vehicle (HOV) lane (R. J. Javid et al., 2017). In addition to these trip characteristics, one's personal situation also influences their behaviour. People who do not have access to a car are more likely to share a ride with others (Correia and Viegas, 2010; Hoerler et al., 2025; Xiao et al., 2024). In contrast, people who have other responsibilities, such as dropping off children at school, are less likely to engage in carpooling (Correia and Viegas, 2010).

Social influences

People often let their behaviour depend on what their social environment is doing (Bachmann et al., 2018). The entourage (behaviour of family, friends and colleagues) appears to play a key role in carpooling participation (Bulteau et al., 2019). Individuals could even experience social pressure to participate in carpooling, if their acquaintances do so (Gheorghiu and Delhomme, 2018). Next to these descriptive norms, subjective norms also influence the intention to share a ride (Akbari et al., 2020; Shi et al., 2024). People who believe their social environment expects them to carpool, are more likely to do so.

Emotion

Emotion covers a broad range of feelings and behavioural reactions of an individual. Within the context of carpooling, the feeling of enjoyment has emerged as the most prominent factor in literature (Tsai et al., 2021; X. Zhang et al., 2022). Individuals who enjoy social interaction are more willing to share a ride (Li et al., 2007; Margolin et al., 1978; Shi et al., 2024), while individuals who enjoy driving alone are less likely to engage in carpooling (Mohammadi-Mavi et al., 2024). Other factors that can be perceived as emotional barriers are the feeling of dependence (Abrahamse and Keall, 2012; Delhomme and Gheorghiu, 2015; Park et al., 2018) and the feeling of privacy invasion (Hoerler et al., 2025; Hunecke et al., 2021; Mohammadi-Mavi et al., 2024).

Behavioural regulation

Routine-seeking is a behavioural regulation mechanism defined as the tendency to establish routines and to engage in behaviours that are consistent with those routines (Burghard and Scherrer, 2022). Similar to routine-seeking, habit has also been found as a relevant factor that influences the intention to share a ride (X. Zhang et al., 2022). Both routine-seeking and habit can act as a driver or barrier to carpool adoption. A mismatch between carpooling and established routines could discourage people to share a ride, whereas a high compatibility could

encourage carpooling and even establish a habit of sharing rides.

3.2. Interview results

3.2.1. Behavioural analysis

To gain a deeper understanding of the behavioural determinants underlying actors' behaviour, a behavioural analysis is conducted. Similarly to the literature review, the behavioural determinants are organised using the TDF and COM-B model. Table 3.3 shows the frequency of each theoretical domain mentioned.

Table 3.3: Frequency of mentioned TDF domains in interviews.

Domain	Frequency* (n=20)
1. Knowledge	14 (70%)
2. Skills	1 (5%)
3. Social/Professional Role and Identity	13 (65%)
4. Beliefs about Capabilities	3 (15%)
5. Optimism	0 (0%)
6. Beliefs about Consequences	20 (100%)
7. Reinforcement	20 (100%)
8. Intentions	0 (0%)
9. Goals	5 (25%)
10. Memory, Attention, and Decision Processes	13 (65%)
11. Environmental Context and Resources	20 (100%)
12. Social influences	14 (70%)
13. Emotion	13 (65%)
14. Behavioural Regulation	13 (65%)

*number of interviewees mentioning at least one behavioural determinant for the theoretical domain.

All interview participants mentioned *'6. beliefs about consequences'*, *'7. reinforcement'*, and *'11. environmental context and resources'* as behavioural determinants (n=20). Within the domain *'6. beliefs about consequences'*, perceived financial benefits is most frequently cited. This factor also emerged from a survey conducted among users of a ride-matching platform. One participant notes: *"What we also found interesting in that survey is that the main reason people carpool is cost savings. Around 80% of respondents indicated that this is a reason for them to carpool."* (I-12). As perceived financial benefits are considered an important factor, many participants mentioned financial incentives as a reinforcement strategy. In addition, parking benefits emerged as a strong incentive. As one participant describes: *"What is very*

effective in these kind of situations is when the boss says, 'If you carpool, then we have ten parking spots available for you.' So then you can still come by car. That makes carpooling very attractive." (I-08). Within the domain *'11. environmental context and resources'*, factors such as the availability of a car, the accessibility of the work place, or the mobility options provided by the employer are named as behavioural determinants. One participant explains: *"If people have no alternative, then they might be more likely to do it* [carpooling]*, right? But if people are given an alternative like 'here is your company car,' then they won't do it."* (I-05).

Next to the domain *'11. environmental context and resources'*, also the domains *'1. knowledge'* (n=14), *'3. social/professional role and identity'* (n=13), *'10. memory, attention, and decision processes'* (n=13), *'12. social influences'*, *'13. emotion'*, and *'14. behavioural regulation'* are mentioned by the majority of participants. Related to the domain *'1. knowledge'*, participants highlighted that people are not always aware that carpooling can be used as a mode of transport. Especially in the Netherlands, carpooling is not a common way to travel. One participant describes: *"In France if you say carpooling app everybody will get it.* […] *This is like something that everybody already know in France. In the Netherlands carpooling app: huh? What is it?"* (I-18). Within the domain *'social/professional role and identity'*, social status emerged as a prominent behavioural determinant. Car ownership and driving a nice car are both connected to the image of social status. This image appears to have become more important over the years. As one participant describes: *"And status, we can talk about it for a long time and pretend it's not the case. But if you look at the size of the average car nowadays, it has little to do with the necessity of driving and much more with the fact that you can drive such a big thing, so to speak."* (I-03).

For the domain *'10. memory, attention, and decision processes'*, one behavioural determinant has been mentioned by various participants: the implicitness of the mobility choice of commuters. The majority of participants perceives commuting as habitual behaviour and argues that the mobility choices one makes are not reconsidered every day. Some participants even stated that there is no decision-making process involved at all: *"I think it is largely habitual behaviour.* [...] *For commute trips, I don't think there is any decision-making process involved beforehand."* (I-13). The domain *'12. social influences'* considers the effect of one's social environment on the decision to carpool. Various participants have mentioned that the choice to engage in carpooling could be positively influenced by the number of colleagues who participate in carpooling as well. Especially people who are doubtful about carpooling, could be convinced through people in their social circle. One participant states: *"Of course there is the peer effect, colleagues influencing one another, which is an important factor, especially for those who are unsure and then end up being pulled along."* (I-02).

Within the domain *'13. emotion'*, various psychological factors have been identified. Enjoy-

ment appeared to be a prominent factor that positively affects one's choice to carpool. However, one's emotion could also have a negative effect on the decision to carpool. Some people, for example, might get anxious when having to talk to strangers. This social anxiety could act as barrier to engage in carpooling. One participant explains: *"What you often hear is that people find it difficult to start a conversation with strangers. And this mainly applies when they have to share a ride with unfamiliar people. They can find that quite intimidating."* (I-19). In addition, the domain *'14. behavioural regulation'* is considered to play a key role in one's travel behaviour. Many participants pointed out that travel behaviour is a habit which is not easily changed. One participant explains: *"Mobility isn't something you reconsider every day.* […] *There are very few people who actually vary their commute. For most people, commuting is just routine behaviour."* (I-01). However, there are moments at which people do reconsider their travel behaviour. Examples of such moments are starting a job, changing jobs, moving, or when children come into the picture. Across interviews, participants referred to these moments using different terms, such as 'compelling events', 'life-changing moments', and 'windows of opportunity'. Domains that are rarely mentioned by interview participants are *'2. skills'* (n=1), *'4. beliefs about capabilities'* (n=3), and *'9. goals'* (5). *' 5. Optimism'* (n=0) and *'8. intentions'* (n=0) are not mentioned by any participant.

3.2.2. Thematic analysis

Through a thematic analysis of the interview data, eight themes are identified that each capture an important aspect of the system. These themes form the foundation of the BSM and provide insight in the behavioural dynamics across multiple actors. Table 3.4 provides an overview of the eight themes. In Appendix H, a list of quotes is given per theme. In Appendix I, each theme is highlighted separately in the BSM. These themes have been validated through an expert workshop.

Table 3.4: Description of Themes.

Theme	Description
1. Digital platform dependency of carpooling	Digital platforms can accelerate carpool adoption while it also creates an extra dependency between users and app providers as well as employers and app providers.
2. Financial dependencies, subsidies, and incentives	Subsidies and financial incentives are needed to start up a carpool pilot project and get people to share rides. To permanently facilitate the matching of users a strong business case is needed.
3. Knowledge sharing, communication, and promotion	The sharing of knowledge between actors, such as governmental organizations, knowledge institutes, and employers and the communication toward commuters is essential to put carpooling on the map.
4. Multi-level trust as a key driver to carpool adoption	Trust within a carpool project and among commuters themselves is essential for the general attitude toward carpooling.
5. Resistance based on lack of control and the pressure to socialize	Control beliefs and socialisation expectations reduce the willingness to carpool as people do not want to sacrifice their own personal space.
6. Dependencies on the structural and social environment	Structural conditions and social demands such as the availability of a car, the need to drop off children at school, or the accessibility of a public transport station influence to decision to carpool.
7. Integration of carpooling in mobility system	Integrating carpooling in the mobility system, such as including public transport schedules and tickets in carpool apps, shapes its uptake as it increases the accessibility of carpooling and sets a social norm.
8. Fragmented roles and absence of shared visions across multiple actors	Fragmented roles and the set-up of multiple regional projects lead to the lack of a central vision on the roll-out of carpooling.

Theme 1: Digital platform dependency of carpooling

The digital platform dependency of carpooling captures two interconnected sub-dynamics. On the one hand, commuters could depend on the availability of a digital ride-matching platform to establish a carpool match. A ride-matching platform is defined here as a platform that matches users based on location, departure time, and profile. On the other hand, regions and employers could depend on digital platforms to facilitate and promote carpooling among commuters. A digital ride-matching platform could be a tool for employers to provide carpooling services to their employees.

Dependency of commuters

The first behavioural sub-dynamic, the dependency between commuters and the platform to

establish a carpool match, is driven by the notion that digital platforms can ease the matching of commuters. Technological innovation could create new opportunities to carpool. As one participant illustrated: *"Back then, things were pretty improvised. If you wanted to carpool, you had to call people or scribble names on a list. These days you'd expect apps to make that much easier, so maybe that opens up new possibilities."* (I-04). However, digital platforms are not strictly required to establish a carpool match. One described: *"But you know, if it's a colleague you already know, then you don't even need a carpool app anymore. A carpool app is really only there to bring together the supply and demand of people who don't know each other."* (I-11). For large organisations, digital platforms could enable employees to share a ride with colleagues outside their direct professional circles. Furthermore, digital platforms facilitate the matching of commuters who work at different companies. Especially for regions in which multiple companies are located in close proximity, such as large business parks, digital platforms can be beneficial. Overall, the dependency on digital platforms mainly arises when there are little to no carpool matches in one's personal circle.

Dependency of employers and regions

The second behavioural sub-dynamic, the dependency between the digital platforms and the employers and regions, results from the observation that all carpool pilots that were discussed during the interviews facilitate digital ride-matching. Although digital ride-matching could accelerate the adoption of carpooling, it also means an additional party is involved. This is where the dependency is created. Employers are sometimes hesitant to close a deal with an app provider, as it is uncertain whether it will be successful. Commenting on the process after a pilot period ends, one participant describes: *"After that,* [an app provider] *may offer you a contract. And we've already seen that, that doesn't work yet. Employers are still like: 'Well, no, we still find that too risky.'"* (I-12).

Registration of shared rides

Moreover, digital ride-matching could contribute to the registration of shared rides. Since 2024, organisations of 100+ employees are obligated to report on work-related mobility. Although carpooling is not included in this obligation yet, this could change in the future (RVO, 2025a). To incorporate carpooling into the reporting obligation, an adequate and reliable registration of rides is required. Facilitating carpool services through a digital ride-matching platform could ease the registration of shared rides. The inclusion of carpooling in the reporting obligation could therefore create an additional dependency between employers and digital ride-matching platforms. In addition, the registration of shared rides also helps build a network for new potential users. Using a digital platform enables others to join shared rides and provides them with a greater set of potential matches. A financial incentive can help motivate people to register their shared rides. As one participant explained: *"What I've noticed is that the €2 might not actually help to keep people carpooling, because once they've found someone, they'll*

probably keep doing it anyway. But it does make them keep registering the ride, which keeps it in the app, and that helps build the network for others." (I-12).

Theme 2: Financial dependencies, subsidies, and incentives

Financial dependencies, the provision of subsidies, and the implementation of incentives all play an important role in the adoption of carpooling. There are two aspects within this theme. The first aspect regards the financial dependency of app providers on the support of governmental organisations and employers. The second aspect concerns the influence of financial incentives on the number of shared rides. These two dynamics are linked, as an increased need for financial incentives leads to an increased dependency on public financial support. These dynamics share the same fundamental issue: carpooling does not yet function for neither party involved.

Financial dependency of app provider

The financial dependence of ride-matching platforms is particularly evident in current carpool pilots. Examples of carpool pilots yielded in the interviews were all subsidised by the government and indicated that this applies to the broader system. Several of these projects temporarily offer an additional financial reward to drivers. This financial reward is partially paid by the passenger and partially funded by the government. However, the provision of these financial rewards is not sustainable in the long term. One participant described: *"They're apps that charge a fee per ride, which the government, or the bus company, or someone has to pay.* [...] *And if you scale that up, the costs for the government will skyrocket."* (I-10). Governmental organisations see the subsidies they provide as a temporary incentive to start up the project and get people to share rides. Ultimately, they would like to see the project to be financially independent. One participant indicates: *"I would like for us, as a municipality, to eventually withdraw. Currently we pay for people to share a ride, while more ideally, I would want for us as a municipality to not pay at all and for people to share a ride voluntary."* (I-16). However, app providers have different perspectives on the extent to which they should receive government subsidies. The interviews revealed that some companies aim for financial independence, while others position themselves more as public transport providers that depend on ongoing government support. There is a mismatch in expectations between the app provider and governmental organisation. In general, the extent to which the allocation of public funds is justified depends on the societal value it creates.

Financial incentives commuters

Perceived economic benefits and financial incentives are consistently identified as a behavioural determinant in the interview data. For commuters, the ability to share fuel costs is the most important financial component. In addition, the travel cost compensation provided by the employer could enhance the attractiveness of carpooling. Currently, commuters travelling

with personal transport, public transport, or carpooling are entitled to a travel cost compensation of €0.23 (RVO, 2025b). The fiscal regulations regarding carpooling distinguish between organised carpooling and unorganised carpooling (RVO, 2025c). When employees carpool themselves, which is defined as unorganised carpooling, both the driver and passenger are entitled to a travel cost compensation excluding detour kilometres. When an employer organises carpooling, the driver is entitled to a travel cost compensation including detour kilometres. However, the fiscal regulations regarding organised carpooling are complicated. One participant's comments about organised carpooling are: *"I would say: just don't do it, don't use it. It's nothing but hassle. What works much better is just the two or three of you in the car, and one person pays one day and the other pays the next."* (I-08).

To further motivate participation, additional financial rewards are introduced. Whether the implementation of additional financial rewards is beneficial, is disputed. The effectiveness of financial rewards depends on the target group. Low-income commuters, for example, are more sensitive to financial incentives than high-income commuters. Nevertheless, financial incentives are often mentioned as a general instrument to motivate people to share rides. This over-reliance on financial incentives is viewed critically by the participating experts. One participant states: *"I think we have a bit of a malleability mindset, in which we assume that if we just provide a strong enough financial incentive, people will automatically make that choice. But I think it actually quite depends on what the system of a person looks like on such a day"* (I-15).

Theme 3: Knowledge sharing, communication, and promotion

Knowledge sharing, communication, and promotion concerns all forms of information dissemination among multiple actors. Knowledge sharing consists of presenting research findings, sharing experiences and exchanging ideas. As multiple actors are involved in the implementation of carpooling initiatives, it is important that acquired knowledge is shared to enable collective learning and ensure efficient use of resources. Initiatives to improve knowledge sharing are already in place, including an informal bi-monthly meeting between carpool pilots in the Netherlands. Nevertheless, there is still a lot of unused potential. One participant expressed: *"I hope that somehow we'll find a way to bring all that knowledge together, so that something genuinely useful can come out of it and that it won't just be experiments that get evaluated once and then end up in a drawer somewhere."* (I-19).

Communication

Whereas knowledge sharing focuses on the exchange of insights, communication between different actors concerns information provision that plays a key role in ensuring effective implementation. At the moment, the communication between governmental bodies and employers about the regulatory frameworks around carpooling appears to be insufficient. The interview

data indicate that employers are often unaware of the fiscal regulations that apply to providing travel cost compensation to employees who carpool. One participant described: *"I think in general, the Netherlands should have a clear focus on carpooling because there is a lot of grey zones still.* [...] *If you are a passenger are you still allowed this money from your employers? Not sure about it, it's a grey zone. Should you pay taxes on the benefits that you're making from carpooling? Also grey zone, we don't know."* (I-18).

Promotion

At last, the promotion of carpooling concerns all campaigns and advertisements, as well as the promotion of carpooling within personal circles. Promotion can be an effective tool to encourage participation, as long as it is accompanied by a clear course of action. Examples of promotion instruments are e-mail, intranet, flyers, stickers, and physical stands. The effectiveness of these different instruments is disputed. One participant explained that it is not about one single promotion instrument, but a combination of them: *"If you want people to carpool, you need to have multiple touch points. So you need to stand there. You need to send an e-mail, maybe there needs to be a flyer somewhere, maybe they need to see it online another time. So that they see multiple times that this is something new and is also a travel option."* (I-12).

Social influences

Moreover, the number of people who carpool in one's social environment also appears to be of influence on one's own decision to carpool. If one's direct colleagues are carpooling, they are also more inclined to do so. One participant explains: *"But what turns out is that there's a small group already doing it. They motivate others to do it more often, and they inspire other people as well."* (I-06). A promotion instrument that makes use of this social factor is the display of exemplary behaviour.

Theme 4: Multi-level trust as a key driver to carpool adoption

Trust between actors plays an important role on multiple levels. Among commuters, the level of trust influences the decision to establish a carpool match and share a ride. Fear of the unknown is often mentioned as an underlying factor that negatively influences one's willingness to share a ride. This fear can partially be attributed to the safety risks one perceives. When the perceived safety risks are high, one's level of trust is lower. This type of trust is categorised in the theoretical domain *'beliefs about consequences'*, as it relates to one's perceptions of carpooling. The perceived safety risks are lower when one shares a ride with a colleague, even if they are not acquainted. One participant explains: *"Maybe you don't know the other person as they work at a different department, but it is nice that you know you're sharing a ride with a colleague. That can also play a role in the level of trust of users."* (I-16). The fact that the person you share a ride with works at the same company could provide a sense of familiarity and lower one's fear. Another important factor that affects one's level of trust, is one's previ-

ous experiences. One participant describes: *"One bad experience with someone can already lead to you not wanting to do it again. So, trust is hard to gain, but easy to lose."* (I-20).

Mitigation of barriers

App providers and employers attempt to mitigate the trust barriers by providing guaranteed ride home services, incorporating search filters, and introducing a rating functionality in the app. The guaranteed ride home service enables users to get an alternative transport mode once their return trip is cancelled. As many commuters are afraid of not getting home once their return trip is cancelled, their level of trust in carpooling is affected. The guaranteed ride home service could take away that fear by guaranteeing a ride home. In addition, search filters can be used to restrict one's potential matches to one's preferences. This filter could for example be applied by women to indicate that they only want to be matched with other women. As women generally have a high perceived safety risk of carpooling, especially when carpooling with men, this filter could provide a solution to increase their level of trust. Another mitigation measure several app providers have implemented is the option to provide a rating of another app user after having shared a ride. This rating is then added to one's profile and can be viewed by other app users as well. When checking the profiles of potential matches, a high rating could increase one's trust in that person as other people have had good experiences in the past.

Trust between commuters and app provider

Moreover, all app users are obligated to verify their identity through ID verification. Due to the additional financial reward provided to the driver, this safety measure is needed to prevent misuse. As one participant explains: *"People will try to get that €2 for free."* (I-06). Through experiences app providers have witnessed or experienced themselves, their level of trust is affected. To reduce security risks, various app providers have installed anti-fraud systems, including the verification of the user's identity. However, the obligation to verify one's identity could also introduce additional barriers. Citizens may be hesitant to provide sensitive identification documents through an app, as they are concerned about the security of the app and the safety of their data. Also the sharing of personal data, such as one's location and travel routes, could act as a barrier. These barriers reflect the importance of trust between commuters and app providers.

Trust between employers and app providers

At last, the level of trust between employers and app providers influences the decision to start a carpool project and facilitate digital ride-matching. As indicated in the first theme, employers tend to find it risky to close a deal with an app provider. This reluctance is due to the uncertainty of the successfulness of the project. The involvement of a governmental organisation could increase the level of trust among employers. One participant explains: *"It also helps, when you sit down with different parties, that the municipality is present, rather than it only being*

a commercial party." (I-16). Especially when the project runs for a longer period of time and the government intends to play a structural role, employers are more willing to participate. Another barrier that employers identify, is the sharing of sensitive data of their employees. Not only personal information, but also location data has to be shared. For this reason, employers often choose to let employees register voluntarily.

Theme 5: Resistance based on lack of control and the pressure to socialize

Perceived lack of control, dependence on others, and the pressure to socialise are all factors that lead to resistance among commuters. Both control beliefs and socialisation expectations are related to the unwillingness of sacrificing one's personal space. Driving alone is perceived as a comfortable way of travelling, while carpooling is perceived as inconvenient. This also relates to the previous theme *'multi-level trust as a key driver to carpool adoption'*, as driving with other requires trust.

Control beliefs

Control beliefs capture the perceived level of control in the type of route, the time of departure, and the type of ride. Lack of control acts as a barrier that prevents people from sharing a ride. One participant states: *"People want to stay in control and you sacrifice a part of your autonomy of your journey."* (I-05). In addition, one's flexibility and freedom is limited as well. When sharing a ride, agreements have to be made on the time and place of departure. One participant mentions: *"And that is also apparent in carpooling. You need to make clear agreements.* […] *You need to have commitment, so it limits your flexibility and freedom."* (I-01).

Socialisation expectations

The social dimension of carpooling cuts both ways. It attracts individuals who value social interaction, while deterring those who prefer to avoid it. One participant outlines: *"How do you experience travelling with someone? Do you enjoy having some time to yourself after work, or do you actually like travelling to work together with colleagues? I think that can really vary depending on the situation."* (I-17). The majority of people who participate in carpooling mention that social interaction is a motivator to them. Nevertheless, there are also people that might feel pressured to socially interact when sharing a ride, while actually preferring to stay silent. One participant explains: *"When there is someone next to you, you get the feeling of needing to entertain that person."* (I-04). This pressure to socialise could withhold people from participating in carpooling all together.

Theme 6: Dependencies on the structural and social environment

The structural and social environment captures all external influences and conditions that affect one's travel behaviour. This theme can be linked to the theoretical domain *'environmental*

context and resources' and consists of numerous factors that all play a role in the decision to carpool.

Structural conditions

Structural conditions, such as the availability of a car, the availability of a parking space at work, or the availability of a carpool place, determine the set of travel options. Not only the availability, but also the attractiveness of these facilities shape the choices one makes. One participant mentions: *"I also think about the physical environment. I think such a carpool location should be easily accessible, whatever that may mean for you. So maybe there should be good parking facilities, or that it's well lit so you feel safe in that place."* (I-07). The location of the company someone works at influences one's travel behaviour as well. Companies in the harbour for example, are poorly accessible by train, leading to many people travelling by car. However, there also companies where taking the train is the most logical option. One participant highlights: *"But of course, there are also many companies that are located close to a train station, so for those employees it would actually be very logical to come by train or other public transport."* (I-17). Overall, the choice one makes depends on structural conditions such as the availability and attractiveness of facilities.

Social demands

Next to structural conditions, social demands also influence one's travel behaviour. Social responsibilities, such as having to bring children to school, are often a reason to not share a ride. Whether these social demands are of influence depends on the situation. One participant explains: *"I think it really depends on what that person's daily activities look like and how these activities are combined. For example, taking a child to school in the morning can already be a reason to use a car, simply because it works better time wise. Whereas if that child went to school on their own, you might have a bit more flexibility to use public transport instead."* (I-15). Next to the responsibilities one might have, the situation at home also determines the type of transport one takes. Whether there is a car available and the agreements that are made regarding the use of that car, determine whether carpooling is an option. One participant describes: *"I think the household you live in is an important predictor. How do you coordinate things within the household? For example, if there is only one car, who gets to use it? How do you decide that together? The family composition is an important explanatory factor."* (I-14). Both examples illustrate how one's personal situation affect their travel behaviour.

Theme 7: Integration of carpooling in mobility system

To date, carpooling is not perceived as a common mode of transport. Integrating carpooling in the mobility system would mean that carpooling is facilitated through existing mobility services and is recognized as a viable transport alternative. Currently, carpooling, as well as other shared mobility services, often remain unnoticed. One participant highlights: *"It is*

always the personal car or public transport. It is never about the mode in between. And that makes that a lot of people don't know what shared mobility is. And I think people also don't really know what carpooling is." (I-09). Carpooling still needs to find its position within the mobility system.

Position compared to public transport

The ride-matching platforms position carpooling services as an addition to public transport. Their vision is to facilitate carpooling in those regions, where public transport is less available. Their goal is to complement, rather than compete. One participant outlined: *"That is the goal on the long term for every project that is to be really a part of public transport and that's just being a stand alone and I think this is really important, we are not competing with public transport, not at all, we are complementing it."* (I-18). This type of system is already in place in other countries. In Denmark for example, a carpooling platform complements the public transport system by focusing on the first and last mile of travellers. One participant comments about Denmark's system: *"They ran a large pilot project there and designed it so that people could carpool with each other to a public transport hub, for instance. So the focus wasn't on sharing the entire journey together, but rather on getting people to public transport hubs."* (I-19).

Beyond mobility hubs

The integration of carpooling goes beyond mobility hubs. Including carpooling in the mobility policy of employers also contributes to the integration within the mobility system. As one participant outlines: *"An employer can also do something with the company car arrangement, that people who qualify for a company car can get one if they start carpooling."* (I-20). Putting carpooling as a condition to the provision of company cars, signals that it is expected to share a ride and sets a social norm. By setting this norm through the mobility policy of employers, a wide range of people can be reached and the integration of carpooling in the mobility system could be enhanced.

Theme 8: Fragmented roles and absence of shared visions across multiple actors

The involvement of multiple actors, such as governmental organisations, regional accessibility organisations, and app providers, leads to policy fragmentation. Initiating carpool projects requires a lot of coordination and alignment between actors. One participant mentions: *"Of course, there are also provinces that pursue their own plans and want something quite different."* (I-06). Managing these differences can be difficult and slows down the process.

Regional initiatives

The carpool projects in the Netherlands have all been initiated at a regional level. Because of this regional focus, multiple projects are going through the same steps without interacting with each other. One participant describes: *"What I find difficult at times is that, in this country, we*

have all these separate little pilot projects and there isn't really one vision for them. We're all experimenting on our own and then something is supposed to come out of that." (I-19). The lack of interaction between these regional projects is a missed opportunity to learn from each other and could lead to unnecessary efforts being made.

Lack of national guidance

Regional projects seek guidance from the national government to know which direction to go to. As one participant describes: *"I think on a national level, more guidance could be given or a broader context could be sketched on where we want to go with this, so you get less blanks and more collaboration to move in the right direction."* (I-19). While the national government is willing to advise regional projects, they are not willing to initiate it. As one participant describes: *"We're not going to do it ourselves. We can only advise them and say: this is how you should do it, this is the way."* (I-08). This indicates that the initiative should come from the regions themselves.

3.3. Behavioural system map

The Behavioural System Map (BSM) shown in Figure 3.1 presents an overview of the relevant actors, the behavioural interactions, and the underlying factors that together shape the system in which commuters potentially decide to share a ride. This BSM is constructed based on the literature review and interview data. The map reflects the themes discussed in section 3.2.2 and shows the key behavioural dynamics that influence the adoption of carpooling. In Appendix I, the themes are highlighted separately in the map.

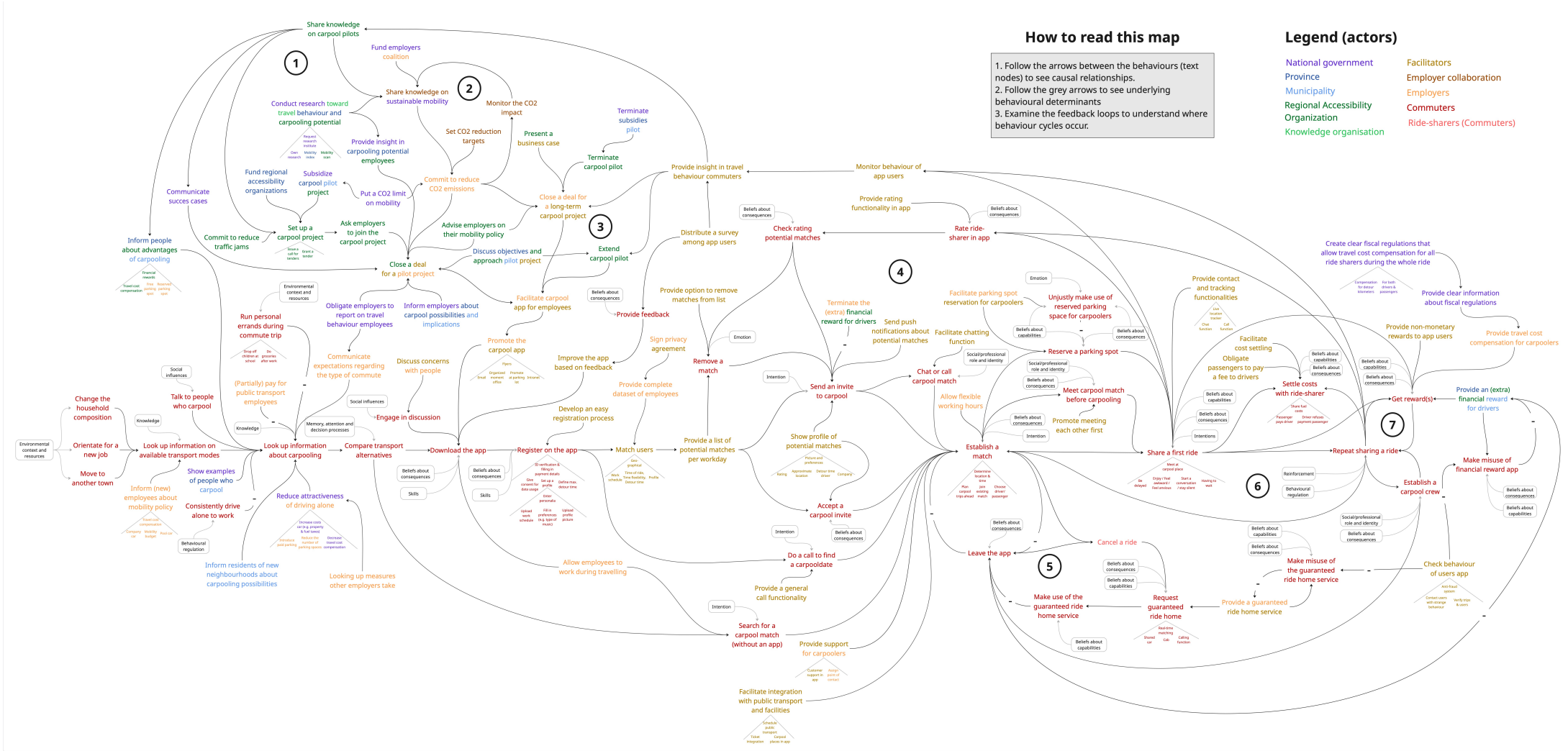


Figure 3.1: Behavioural System Map of commuters' decision-making when considering carpooling.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. This map can be viewed digitally via https://miro.com/app/board/uXjVHAO2_QM=/?share_link_id=553557726951.

At the centre of the map, the commuter journey is presented. The commuter journey shows the different steps that a commuter takes before sharing a ride. There are two paths to sharing a ride. The first path is to make use of a digital ride-matching platform, which matches users based on their location, preferred departure time, and profile. The second path is to search for people to share a ride with, without making use of a digital platform. Both these paths are included in the commuter journey. Figure 3.2 shows the commuter journey. In Figure I.2, this figure is displayed at a larger size. The first path is highlighted in blue and the second path is highlighted in orange. The path highlighted in purple shows the part of the commuter journey where both paths come together. The first purple part of the commuter journey represents the orientation phase, in which commuters look up information, talk to others and compare alternatives. The blue and orange parts are phases in which the commuter engages with carpooling, by either registering on a digital ride-matching platform or actively searching for people to share a ride with. The third and purple part presents the phases of realisation and continuance. In the realisation phase, commuters actually establish a match and share a ride. In the continuance phase, commuters repeat sharing rides and potentially establish a group to share rides with.

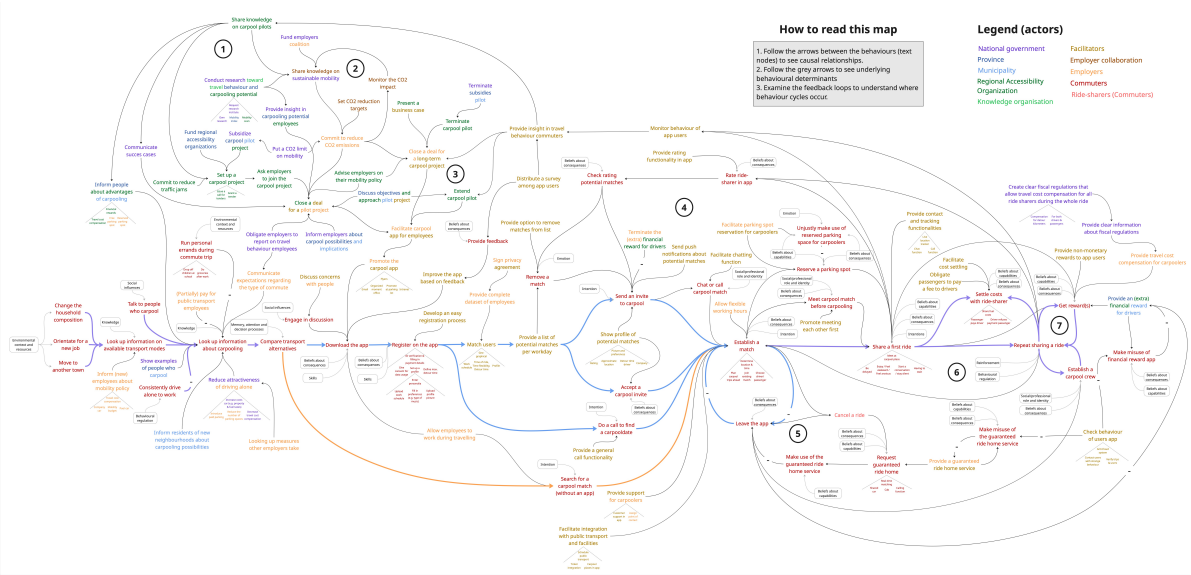


Figure 3.2: Behavioural System Map of commuters' journey when considering carpooling.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The coloured arrows show the commuter journey. In Figure I.2, the BSM is displayed at a large size.

3.3.1. Feedback loops

The BSM shows the key behavioural dynamics that influence the adoption of carpooling through seven feedback loops. These feedback loops are indicated with the numbers 1-7 in Figure 3.1. This section discusses each feedback loop to provide a deeper understanding of the behavioural

dynamics within the system.

Sharing of knowledge and experiences

The first feedback loop captures the importance of sharing knowledge and experiences among multiple actors. This feedback loop relates to theme 3 *'knowledge sharing, communication, and promotion'*, which highlights the importance of exchanging information and experiences. Sharing knowledge and exchanging experiences on carpool pilots and sustainable mobility could encourage other regions and employers to initiate similar projects. An increase in the number of pilots, in turn, generates additional insights through the evaluation of effects and the monitoring of commuter behaviour. Sharing this knowledge allows regions to learn from each other and encourages other regions to participate in carpooling as well. In Figure 3.3, this feedback loop is highlighted in green. In Figure I.3, the BSM is displayed at a larger size. The feedback loop spans a substantial part of the commuter journey, as commuters must first participate in carpooling before their behaviour can be monitored and knowledge can be shared.

This *'sharing of knowledge and experiences'* loop, consisting of multiple parallel paths and the majority of actors, is the largest cycle of the system, with approximately 13 behaviours. The size of this loop is a result of the incorporation of the commuter journey. The sharing of knowledge indirectly shapes the orientation phase of the commuter. The behaviour *'inform people about the advantages of carpooling'*, that could be displayed by governmental organisations on multiple levels, influences the commuter behaviour *'look up information about carpooling'*. The behavioural determinant of this commuter behaviour is the domain *'knowledge'*, as the awareness of carpooling influences the behaviour of looking up more information.

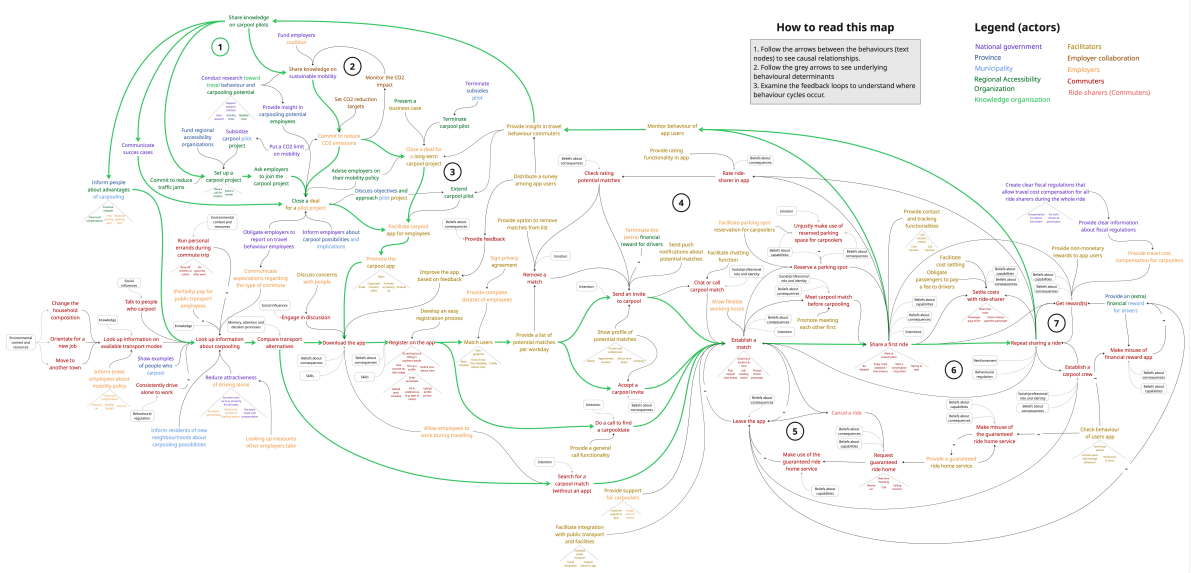


Figure 3.3: Behavioural System Map highlighting the feedback loop *'sharing knowledge and experiences'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure I.3, the BSM is displayed at a large size.

Committing to sustainable mobility

The second feedback loop shows the enhancement of the sustainability goals of employers, which is expressed as the commitment of employers to reduce CO_2 emissions. This feedback loop relates to theme 3 *'knowledge sharing, communication, and promotion'*, as the sharing of knowledge on sustainable mobility motivates employers to commit to reducing their environmental impact. This loop is also connected to theme 8 *'fragmented roles and absence of shared visions'*, as the national vision on sustainable mobility influences the commitment of employers. By monitoring the CO_2 impact of employers' sustainable mobility policy, additional insights can be gained in the effectiveness of different sustainable policy measures. These insights can be shared with other employers to increase their knowledge on sustainable mobility. Figure 3.4 shows the feedback loop highlighted in green. In Figure I.4, the BSM is displayed at a larger size.

This *'committing to sustainable mobility'* loop consists of only three behaviours and is one of the smallest feedback loops in the BSM. It is not directly linked to the commuter journey, as it captures the behavioural dynamics that determine which mobility options are prioritised, developed, and ultimately offered to commuters. As the feedback loop indirectly influences what is provided to commuters, it connects to the realisation phase of the commuter journey.

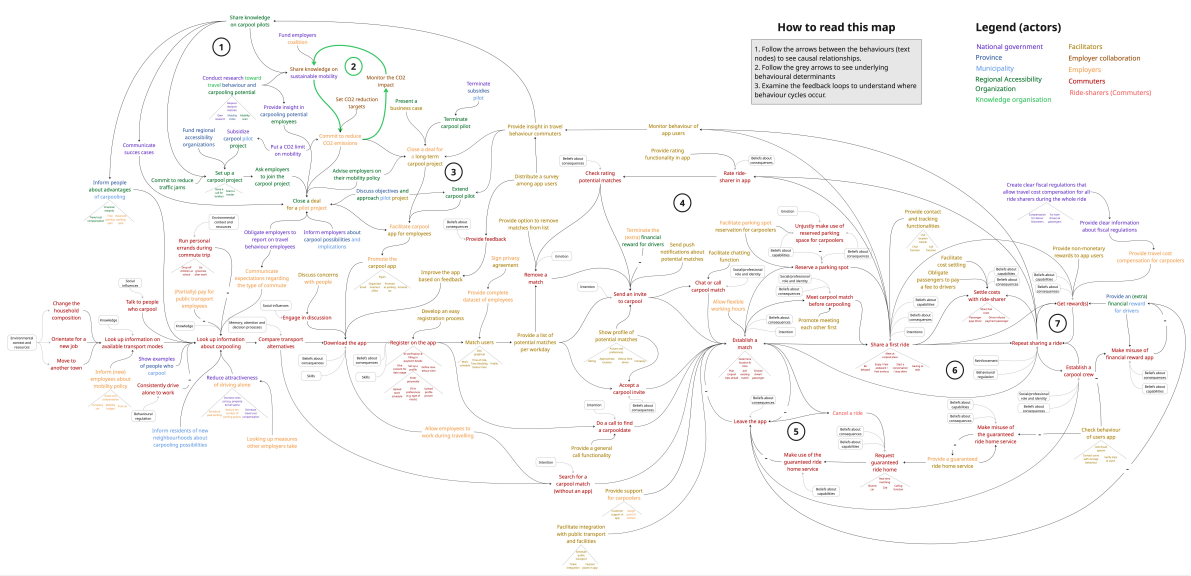


Figure 3.4: Behavioural System Map highlighting the feedback loop *'committing to sustainable mobility'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure I.4, the BSM is displayed at a larger size.

Continuance of facilitating carpool services

The third feedback loop presents the dynamics that precede the potential continuance of facilitating carpooling services, by either extending the pilot or starting a long-term carpooling project between the employer and platform provider. This feedback loop is related to theme 2 *'financial dependencies, subsidies, and incentives'*, as the financial dependency of app providers and the availability of governmental subsidies influence the continued facilitation of carpool services. The continuance of a carpool project could occur in two ways. The first option is that the region decides to extend the pilot if the results look promising, but the project cannot continue without subsidies yet. The second option is that the region decides to terminate the subsidy provision, but the employer decides to close a deal for a long-term project directly with the platform provider. In both cases, the facilitation of carpooling services is continued. The continued use of carpooling services generates additional insights into the effectiveness of carpooling and influences the decision to continuously facilitate carpooling services. In Figure 3.5, this feedback loop is highlighted in green. In Figure I.5, the BSM is displayed at a larger size.

Similar to the first feedback loop, a part of the commuter journey is integrated in the cycle. Within this loop, the decision-making process of the commuter is influenced in the engagement phase. The behaviour *'promote the carpool app'*, which is displayed by the employer and app provider, affects the commuter behaviour *'download the app'*. The underlying deter-

minants of this commuter behaviour are *'beliefs about consequences'* and *'skills'*. Eventually, the sharing of rides leads to additional insights that can be used to decide on the continuance of the facilitation of carpool services.

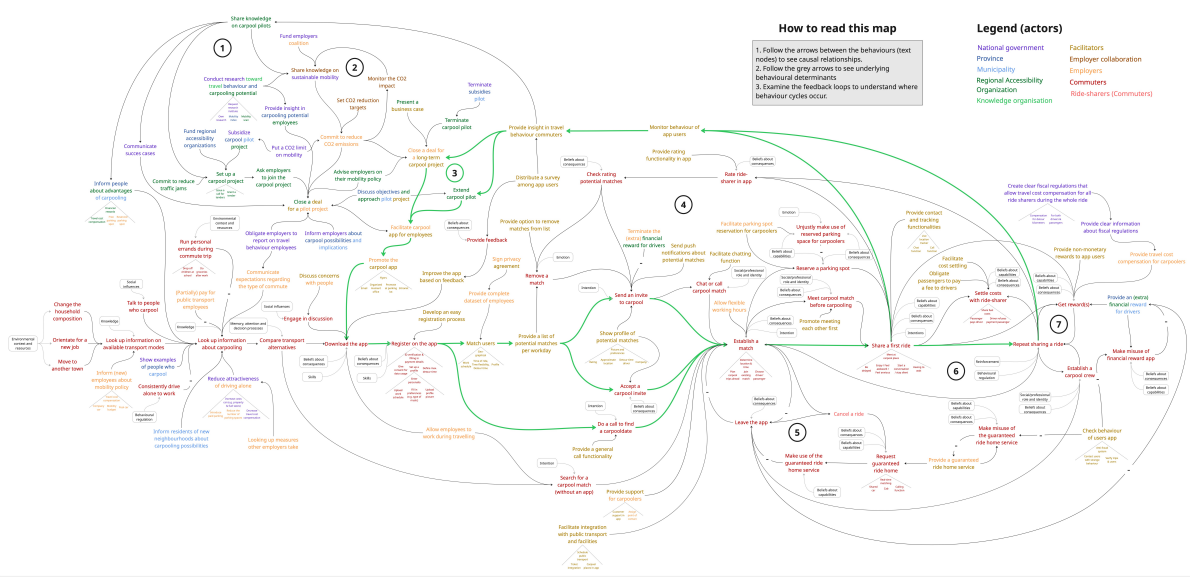


Figure 3.5: Behavioural System Map highlighting the feedback loop *continuance of facilitating carpool services*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure I.5, the BSM is displayed at a larger size.

Level of trust among commuters

The fourth feedback loop captures how the level of trust among commuters can be increased by providing a rating functionality in the app. This loop relates to theme 4 *'multi-level trust as a key driver to carpool adoption'*, as the possibility to rate other commuters could increase commuters' trust in each other. This rating functionality allows users to rate each other after they have shared a ride. The ratings a user receives are added to their profile and shown to other users who are a potential match. A high rating could increase the level of trust and encourage people to establish a match. This is illustrated in the map through the positive relation between the behaviour *'check rating potential matches'* and the establishment of a match. One of the key behavioural determinants of *'establish a match'* is *'beliefs about consequences'*, which includes trust as well.

The feedback loop *'level of trust among commuters'* only incorporates the realisation phase of the commuter journey, as users are only allowed to rate people with whom they have shared a ride with. The rating functionality results in a reinforcing feedback loop as an increase in shared rides could lead to more ratings, which in turn could lead to more matches being established.

Figure 3.6 presents the feedback loop in green. In Figure I.6, the BSM is displayed at a larger size.

In addition to this rating functionality, the platform could provide the option to remove potential matches from the list with proposed matches. This allows users to remove matches who are not a personal fit or have a low rating score. This removal is mutual, meaning that the user who removes is also removed from the potential matches list of the removed user. This mutual removal could reassure commuters and increase their level of trust, as it gives them more control on who to establish a match with.

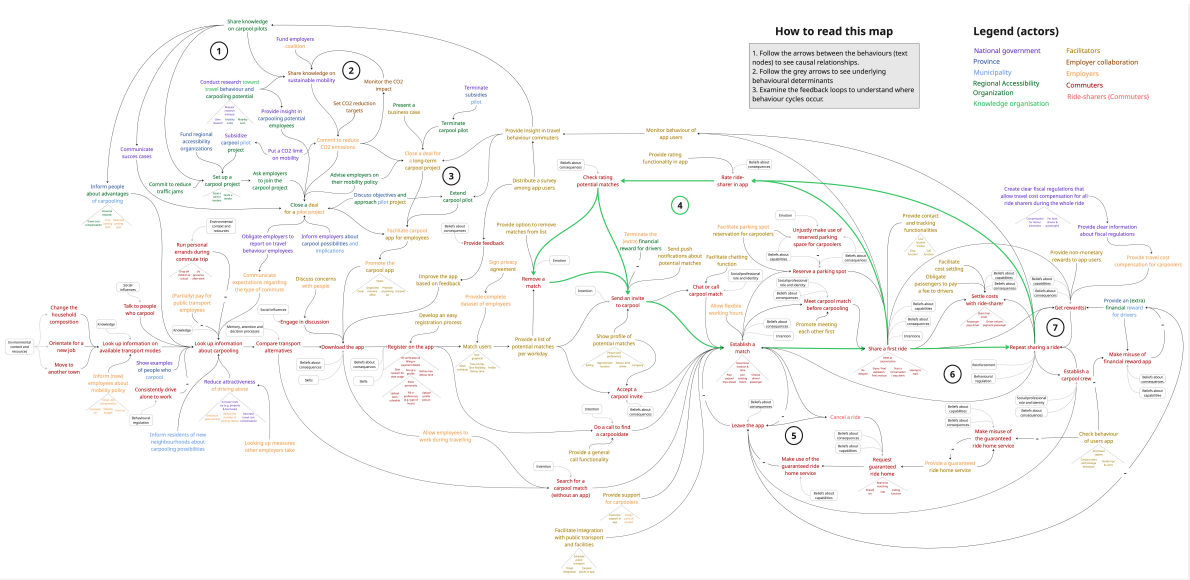


Figure 3.6: Behavioural System Map highlighting the feedback loop *'level of trust among commuters'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure I.6, the BSM is displayed at a larger size.

Guaranteed ride home service

The fifth feedback loop shows the behavioural interactions that could occur once a ride is cancelled. To ensure that passengers of a cancelled shared ride get home, the employer or ride-matching platform could provide a guaranteed ride home service. Similarly, to the fourth feedback loop, this loop is related to theme 4 *'Multi-level trust as a key driver to carpool'* as well. The provision of a guaranteed ride home service addresses the level of trust commuters have in carpooling as a reliable mode of transport. A guaranteed ride home service consists of a free transport alternative, such as a shared car, a free public transport ticket, or a cab. If a commuter has a cancelled ride and makes use of this service, their trust in carpooling is maintained and they are more likely to continue with sharing rides. This is illustrated in the map through the negative relation between the commuter behaviour *'make use of the guaranteed*

ride home service' and the behaviour *'leave the app'*. In Figure 3.7, this feedback loop is shown in green. In Figure I.7, the BSM is displayed at a larger size.

Similarly to the rating functionality within the fourth feedback loop, this guaranteed ride home service is part of the realisation phase of the commuter journey. Only after a match is established, a commuter could be faced with a cancelled ride. The possibility of a ride being cancelled also plays a role in the decision to establish a match. This is reflected through the behavioural determinant *'beliefs about consequences'* that underlies commuters' behaviour to establish a match.

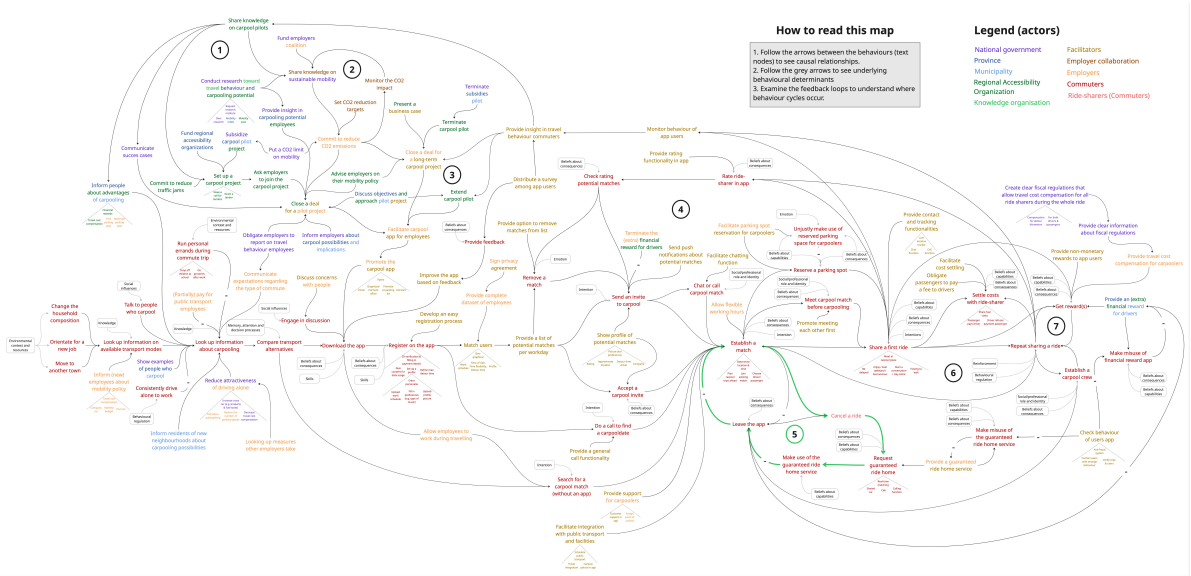


Figure 3.7: Behavioural System Map highlighting the feedback loop *'guaranteed ride home service'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure I.7, the BSM is displayed at a larger size.

Importance of a carpool network

The sixth feedback loop presents how structural carpooling is important for the establishment of a carpooling network. A carpool network is a network of people that participate in digital carpooling. This feedback loop relates to theme 1 *'digital platform dependency of carpooling'*, as digital platforms are needed to develop a digital carpool network. The establishment of a carpool network is essential to increase the availability of potential matches for both current and future ride-sharers. By repetitively sharing rides and registering these rides on the app, there are more potential matches for new users of the platform. If these new users also engage in structural carpooling, the network expands and the availability of matches increases. Figure 3.8 presents the feedback loop in green. In Figure I.8, the BSM is displayed at a larger size.

The *'importance of a carpool network'* loop is connected to the continuance phase of the com-

muter journey. The behaviour *'repeat sharing a ride'* has *'behavioural regulation'* as a determinant, as repetitively sharing a ride could turn carpooling into a habit. When a certain behaviour has become a habit, this behaviour will likely be continued. This feedback loop also includes a small loop regarding the establishment of a carpool crew. Structural ride-sharers often share rides with the same group of people, which encourages them to continuously share rides. Therefore, the establishment of carpool groups could contribute to the retention and expansion of the carpool network.

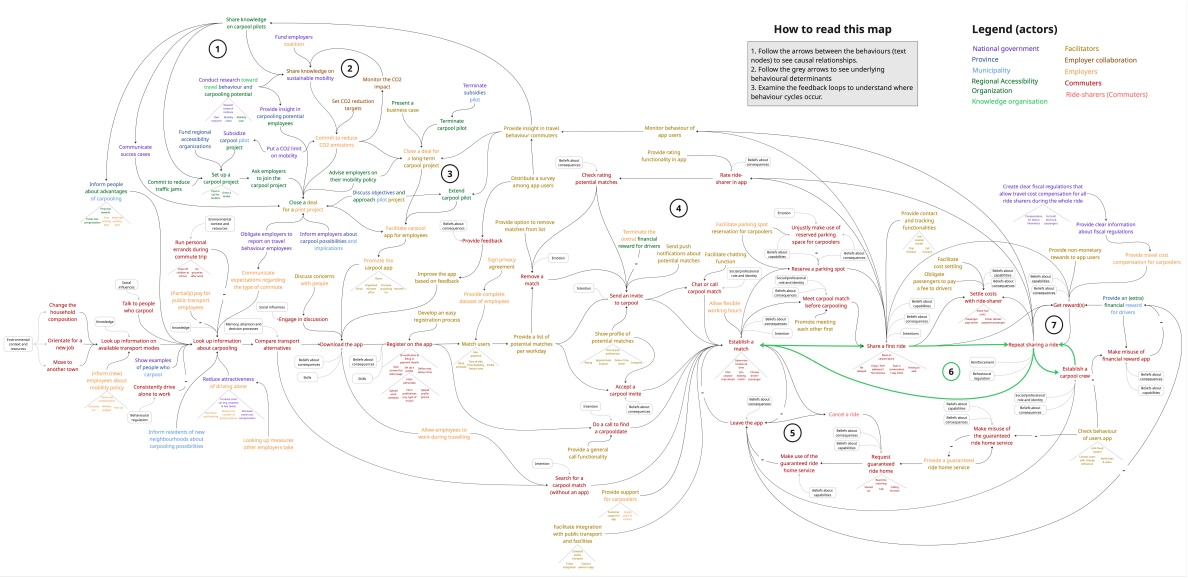


Figure 3.8: Behavioural System Map highlighting the feedback loop *'importance of a carpool network'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure I.8, the BSM is displayed at a larger size.

Reinforcement through incentives

The last feedback loop shows that providing incentives encourages commuters to repeatedly share rides. This loop is partially related to theme 2 *'financial dependencies, subsidies, and incentives'*, as financial incentives are a reinforcement mechanism that could be used to motivate commuters to carpool. The provision of incentives not only motivates people to engage in carpooling for the first time, but it also encourages people to continuously participate in the digital platform and share rides. This reinforcement does not necessarily require additional financial rewards. The provision of travel cost compensation for both driver and passenger, could already be an incentive for people to share a ride. Especially when the employer provides a lower compensation to employees who drive alone. In Figure 3.9, the feedback loop is shown in green. In Figure I.9, the BSM is displayed at a larger size.

The *'reinforcement through incentives'* loop is a relatively small loop that captures the reali-

sation and continuance phase of the commuter journey. The continuance phase is presented through the behaviour *'repeat sharing a ride'*, which has *'reinforcement'* as one of its key determinants. In addition, the continuance of carpooling is also encouraged through an increase in the carpooling network. These reinforcement mechanisms contribute to structural carpooling and therefore enable new users to find a carpool match as well.

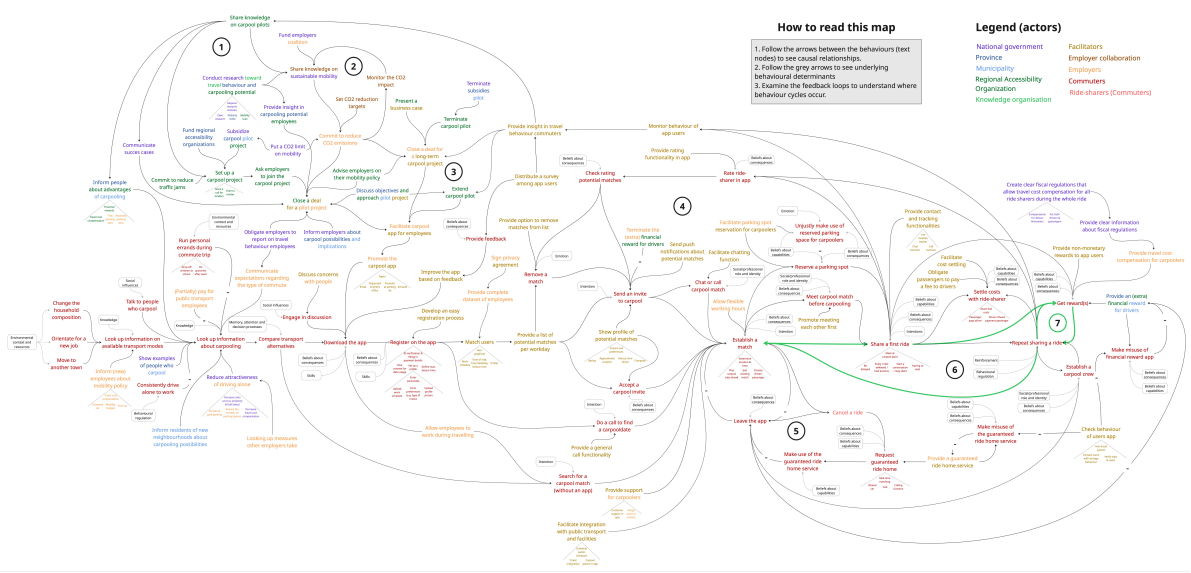


Figure 3.9: Behavioural System Map highlighting the feedback loop *'reinforcement through incentives'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure I.9, the BSM is displayed at a larger size.

3.3.2. Leverage points

To gain insight into how the system and its behavioural dynamics can be influenced, six leverage points have been identified. These leverage points stem from the feedback loops discussed in Section 3.3.1. Each leverage point is a point within the system that causes ripple effects. These points can be used to intervene or change the system. Table 3.5 provides an overview of the leverage points and corresponding feedback loops. Leverage point 4 *'reassure commutes'* is based on both the fourth and fifth feedback loop. The levers point toward policy directions and can be used to develop concrete policy measures. In this section, each leverage point is briefly discussed. Section 4.1.5 provides an overview of the policy measures that can be used to address the leverage points. Section 4.2 discusses the main policy recommendations in more detail.

Table 3.5: Overview of feedback loops and leverage points.

Feedback loops	Leverage points
1. Sharing of knowledge and experiences	1. Centralise knowledge
2. Committing to sustainable mobility	2. Enhance sustainability perspective
3. Continuance of facilitating carpool services	3. Set up a business case
4. Level of trust among commuters	4. Reassure commuters
5. Guaranteed ride home services	
6. Importance of carpool network	5. Establish a carpool network
7. Reinforcement through incentives	6. Incentivise commuters

Centralise knowledge

The first leverage point focuses on the centralisation of knowledge. Multiple actors obtain knowledge of the carpool behaviour of commuters and experiences with pilots. Sharing this knowledge stimulates communication about carpooling and pilots that have been successful or an informative experience. In turn, informing commuters and employers about carpooling increases its uptake (Theme 3, Feedback loop 1). However, the knowledge obtained often stays within regional organisations (Theme 8). This fragmentation of knowledge constrains the ability to learn from each other and could lead to unnecessary duplication of efforts. Centralising knowledge enables actors to all obtain the same information and communicate about carpooling in an efficient manner.

Enhance sustainability perspective

The second leverage point is the enhancement of the sustainability perspective. The increasing importance of sustainable mobility could encourage carpooling initiatives. The commitment of employers to reduce CO_2 emissions could be a motivator for employers to facilitate carpooling services (Feedback loop 2). In addition, sustainability objectives of the government could encourage employers to focus on sustainable mobility. The reporting obligation on work-related mobility for example, could lead to voluntary change among employers. Enhancing the sustainability perspective increases the intrinsic motivation of both employers and commuters to participate in carpooling.

Set up a business case

The third leverage point concerns the business case of a ride-matching platform. All carpool pilots that have been discussed in the interviews are subsidised by governmental organisations, as digital ride-matching platforms often do not have an independent business case (Theme 2). As many governmental organisations intend to eventually terminate the financial support, ride-matching platforms need to become financially independent in order to continue their services.

To facilitate ride-matching services in the long term and on a large scale, a clear business case is needed (Feedback loop 3).

Reassure commuters

The fourth leverage point addresses the level of trust among commuters. Trust has been identified as an important factor that can act as a barrier and influences the decision to share a ride. A lack of trust could stem from the fear of the unknown, perceived safety risks, or the fear of a cancelled ride (Theme 4). Employers and ride-matching platforms aim to increase the level of trust by providing a rating functionality and a guaranteed ride home service (Feedback loop 4, Feedback loop 5). The reassurance of commuters could lead to more commuters establishing a carpool match and therefore acts as a lever that could influence the adoption of carpooling.

Establishing a carpool network

The fifth leverage point is to establish a carpool network. If commuters repetitively share rides and potentially establish a carpool crew, the carpool network increases and maintains its size. This gives new app users the opportunity to find sufficient and suitable matches (Feedback loop 6). However, the crew-seeking tendency of commuters could have a negative effect on the establishment of a carpool network as commuters who find a crew might continue carpooling without the app. Therefore, to ensure people continue to make use of the app, the attractiveness of structurally sharing and registering rides needs to be increased.

Incentivise commuters

The last leverage point focuses on incentivising commuters to carpool. The number of shared rides can be increased by providing rewards to those who carpool (Feedback loop 7). As the number of shared rides positively influences the performance of matching services, the attractiveness of sharing a ride influences the success of the carpooling project. Reinforcement mechanisms not only convince people to join a ride-matching platform, but also encourage people to keep participating.

3.3.3. Reflection behavioural dynamics workshop

Participants of the workshop have confirmed that all themes can be observed within the system of carpooling among commuters. The workshop did not lead to any changes of the BSM, as the main behavioural dynamics were acknowledged. The workshop generated three key additional insights that are related to the levers and potential policy recommendations, rather than the analytical insights of the thematic analysis. First, whether the government should play a role in initiating carpool projects and provide subsidies is disputed. One participant argued that government involvement is justified only when it generates societal value that would otherwise not be achieved. Another participant, however, noted that parking pressure within urban areas is a societal challenge, and that carpool initiatives can contribute to addressing this

issue. Overall, participants agreed that a social cost–benefit analysis is required that not only considers financial aspects, but also incorporates environmental impacts, congestion effects, and parking pressure. In addition, the effectiveness of the provision of subsidies should be assessed to determine whether governmental support is justified.

Second, theme 1 *'digital platform dependency of carpooling'* evoked a discussion about the need for a digital ride-matching platform. One participant noted that the majority of people who currently participate in carpooling do not use a digital platform at all. However, another participant pointed out that for large companies, a digital ride-matching platform could enable employees to carpool with people outside their own department. The extent to which digital ride-matching can unlock the growth potential of carpooling remains uncertain. Nevertheless, most interventions are focused on (potential) digital platform users. For example, to increase the level of trust among commuters, several app providers have implemented a filter, a rating functionality, and a guaranteed ride home service. One participant highlighted that these services only matter to a small group of people. A question that was raised is how to approach people who are not willing to use a digital platform. This observation also extends to the registration of rides that is needed to incorporate carpooling in the reporting obligation. One participant raised the question of whether a digital ride-matching platform is truly necessary to register shared rides, and how people who do not use a digital platform can be included.

Third, the introduction of theme 7 *'integration of carpooling in the mobility system'* led to a discussion on the position of carpooling within the mobility system. One participant mentioned that the added value and negative externalities of carpooling should be researched. The ultimate goal is a higher occupancy rate of cars, whereas carpooling is a means that can be used and not a goal on its own. Another participant mentioned that the substitution patterns of transport modes should be analysed. In the context of sustainable mobility, the goal is to attract commuters who are currently driving alone, not those who travel by public transport. According to a participant, the Parisian mobility system has a clear place for carpooling: a financial reward is only provided when there is no suitable public transport alternative. In addition, one participant emphasized that carpooling is particularly relevant in sectors where public transport is not a viable option due to limited accessibility or irregular working hours. For sectors such as the healthcare sector and the Port of Rotterdam, carpooling may therefore offer a practical solution for employees. In line with this, several participants noted that further research into different target groups is needed to identify where carpooling could serve as an effective measure.

4

Discussion

This study aimed to enrich the understanding of dynamic interactions influencing the adoption of carpooling. By adopting a system-level approach, this study provides insight into all relevant actors and their behavioural interactions within the system. This chapter discusses the main findings of this thesis and positions them within the context of existing literature. Section 4.1 discusses the key behavioural dynamics that have been found. Section 4.2 provides policy recommendations based on the interview data and workshop notes. Section 4.3 addresses the limitations of this study and presents suggestions for future research.

4.1. Behavioural dynamics

This study has revealed a set of behavioural dynamics that shape the decision-making process of commuters and the adoption of carpooling. This extends existing research on carpooling by illuminating what interactions affect carpool behaviour (Neoh et al., 2015; Olsson et al., 2019). As discussed in section 1.2, existing literature focuses on individual-level behaviour and solely incorporates the perspective of commuters. A multi-actor perspective and system-level approach is missing. This approach is needed, as mobility choices are made within a complex system of multiple actors who interact and affect the decision-making process of citizens (Cascetta et al., 2007; Enserink et al., 2022). This study addresses this knowledge gap, by adopting a novel approach of integrating behavioural science and systems thinking. Connecting individual decision-making with dynamic interactions enriches the understanding of commuter behaviour within the context of behavioural dynamics that occur between multiple actors (Lunetto et al., 2022; Parkinson et al., 2025). This novel methodological approach contributes to the field of behavioural sciences and policy-making on carpooling. In total, eight

themes have been identified that capture key behavioural dynamics. This section discusses four themes that are extensively discussed during the workshop, provide rich insights into the behavioural interactions influencing the adoption of carpooling, and substantially advance the understanding of societal carpooling efforts.

4.1.1. Fragmentation of knowledge

Fragmentation of knowledge is a behavioural dynamic that is reflected in many interviews. This behavioural dynamic is reflected in theme 8 *'fragmented roles and absence of shared visions across multiple actors'* and theme 3 *'knowledge sharing, communication, and promotion'*. As multiple regional carpool initiatives are currently being developed, numerous actors are simultaneously engaging in carpooling and gaining practical experience. This results in a substantial body of knowledge emerging across different parties. However, this knowledge is not consistently shared. This lack of exchange is a missed opportunity, as regional organisations could benefit from each other by sharing experiences and insights. Similar dynamics have been identified in behavioural studies in other policy domains, such as climate adaptation (Bellmann et al., 2025; Wink, 2025). However, the underlying mechanisms differ. Climate adaptation initiatives are inherently context-dependent, while carpooling initiatives are more similar across different regions. This highlights the importance of exchanging insights and experiences, as fragmented knowledge leads to unnecessary duplication of efforts and impedes policy-makers from developing effective policy interventions (Bal et al., 2025). The observation that knowledge of carpooling is fragmented is slightly unexpected, as already in 1997, the knowledge platform Verdi was established to facilitate knowledge sharing between regional governments (Bootsma and Schijndel, 2000). Since 2004, this knowledge platform is substituted by the knowledge programme traffic and mobility (in Dutch: KpVV) and operates under the knowledge institute CROW (Goudappel Coffeng and AVV, 2005). Despite the establishment of this knowledge platform, the interviews reveal that, at present, carpooling receives limited attention on a national level. With the lever *'centralise knowledge'*, this study addresses this behavioural dynamic and stresses the importance of knowledge centralisation.

4.1.2. Financial dependency

Another prominent behavioural dynamic that has been found is the financial dependency of ride-matching platforms on governmental subsidies. This behavioural dynamic is reflected in theme 2 *'financial dependencies, subsidies, and incentives'*. Many carpool initiatives are publicly funded and do not yet have a self-sustaining business case. Through the provision of additional financial rewards to drivers, the financial dependency on governmental subsidies increases. The interviews reveal that several governmental organisations intend to withdraw their financial support from the carpool initiatives once the pilot period has ended. However,

some ride-matching platforms envision a model in which continuous public subsidies remain justified, arguing that they provide a mobility service comparable to public transport. The extent to which the allocation of public funds is justified depends on the societal value it creates. While several studies have confirmed the effectiveness of governmental subsidies on the number of shared rides (Wang and Monchambert, 2025; Zhao et al., 2025), the provision of these subsidies is not tenable in the long term. For digital ride-matching platforms to become financially independent, a strong business case is needed. This need is addressed in the third leverage point *'set up a business case'*. Whether financial rewards are needed to persuade people to share rides is disputed. Some studies conclude that financial incentives through subsidies do not lead to the desired effects (Laroche and Schemeleva, 2026), while others confirm their effectiveness (Shi et al., 2024; Xiao et al., 2024). There is no consensus among interview participants on the use of financial rewards to motivate people to share a ride. However, financial rewards do motivate people to register their shared ride on a digital platform, which increases the availability of matches for other users. This addresses the fifth leverage point *'establish a carpool network'*.

4.1.3. Digital platform dependency of carpooling

In addition, theme 1 *'digital platform dependency of carpooling'* has emerged as an important behavioural dynamic in the interviews. All carpool pilots that have been discussed in the interviews facilitate digital ride-matching as these digital platforms create the opportunity to efficiently match people from different professional circles. However, this behavioural dynamic was later challenged during the workshop discussions. As ride-matching platforms are currently not used on a large scale, it is uncertain whether the large-scale adoption of carpooling among commuters is dependent on the availability of digital platforms. This study has shown that ride-matching platforms do play a large role in encouraging commuters to carpool. When looking at long-distance trips, the international ride-matching platform BlaBlaCar has more than 100 million users in 2024 and shows substantial growth (VNV Global, 2024). Moreover, a Belgian study reveals that the facilitation of a digital ride-matching platform leads to an increase from to 2% to 5% of the employees participating in carpooling (Karbaumer and Metz, 2022). This indicates that, despite the current limited use of digital platforms among commuters, they may hold considerable potential for future growth. This potential might be further enlarged, if carpooling is incorporated in the reporting obligation. A precondition of incorporating carpooling in the reporting obligation is the reliable and verifiable registration of shared rides. Digital platforms could ease the registration process and verify the validity of shared rides, which enables the inclusion of carpooling in the reporting obligation. In addition, the structural registration of shared rides increases the availability of potential matches for first-time carpoolers, which contributes to the fifth leverage point *'establish a carpool network'*.

4.1.4. Dynamic versus factor-focused research

Comparing the literature-based behavioural determinants with those emerging from the interviews reveals both notable similarities and meaningful differences. The theoretical domains *'beliefs about consequences'*, *'environmental context and resources'*, and *'emotion'* have all been frequently mentioned in both literature and interview data (Mattia et al., 2021; Shi et al., 2024; T. Zhou et al., 2022). This indicates that these determinants are prominent when it comes to carpooling behaviour. Within the domains *'knowledge'*, *'reinforcement'*, *'intentions'*, and *'behavioural regulation'*, considerable differences have been found. While *'knowledge'* has barely been acknowledged in literature (n=2, 5%), the majority of interview participants mentioned knowledge as a behavioural determinant (n=14, 70%). An explanation for this difference is that this study is focused on the Netherlands, where carpooling is not as common as in other countries (Eurostat, 2021). This makes awareness of carpooling and knowledge on how to participate in carpooling more important for Dutch commuters. In existing literature, *'reinforcement'* has only been mentioned in a few papers (n=7, 17%), while all participants mentioned it as an important determinant (n=20, 100%). This likely stems from the interview questions that invited participants to think about encouragement strategies and the knowledge and accessibility many participants have on policy measures. In contrast, the domain *'intentions'* is not mentioned in the interviews (n=0, 0%), while it is acknowledged as a determinant by numerous studies (n=13, 32%). In the literature, researchers often distinguish between the intention to share a ride and actually sharing a ride (Bachmann et al., 2018; Wang et al., 2018). This distinction is not made by interview participants. At last, the domain *'behavioural regulations'* was hardly mentioned in literature (n=2, 5%), while the majority of interviewees recognise it as a behavioural determinant (n=13, 65%). An explanation for this difference is that interviewees were specifically asked about the distinctive decision-making phases of a commuter. Many interviewees pointed out that travel behaviour is a habit and that it is difficult to change those habits, which psychological research confirms (Verplanken and Orbell, 2021). In addition to the comparison of the frequency of TDF domains, comparing the frequency of the COM-B domains also reveals some notable differences. In literature, the domains *'opportunity'* and *'motivation'* are more prominent than the domain *'capability'*, whereas all domains are acknowledged by the interview participants. This difference could be explained by the high frequency of the domains *'knowledge'* and *'behavioural regulation'* in the interviews. This high frequency could be due to the Dutch scope of this study and the focus on the decision-making process of the commuter, as is discussed earlier in this paragraph.

Behavioural System Map based on literature

Incorporating the perspectives of multiple actors and combining these insights with the behavioural determinants identified in the literature is a novel approach to create a behavioural system map. The literature on its own does not contain sufficient information to map the entire

system. In this study, an attempt was made to map the behavioural dynamics that influence carpool behaviour solely based on literature. This BSM is presented in Appendix J. As existing literature is mainly focused on behaviour on an individual level, assumptions had to be made about the behavioural interactions between commuters and other actors in the system. Moreover, not all behavioural interactions could be mapped as there was not sufficient information on the behavioural interactions between multiple actors. The map presented in figure J.1 shows that the extent in which the decision-making context of commuters can be presented is limited. This limited representation of the system is due to the lack of a multi-actor perspective (Chater and Loewenstein, 2022; Lunetto et al., 2022). Therefore, this study incorporates the behaviours of governmental organisations, knowledge institutes, employer coalitions, app providers and people involved in carpool pilots as well. This multi-actor perspective has provided valuable insights that enriches and complements the insights gained in literature (Neoh et al., 2015; Olsson et al., 2019). The combination of both literature insights and expert views enriches the understanding of the system and the interrelationships, dynamic interactions, and behavioural determinants within. In this way, this study contributes to the behavioural sciences field and answers to calls from researchers to analyse the dynamic interactions within the system as well as the individual determinants of citizen behaviour (Parkinson et al., 2025).

4.1.5. Levers and implications

Analysing the behavioural dynamics within the system has resulted in the identification of six leverage points. These levers can be used by policy-makers to design effective policy measures that encourage the adoption of carpooling among commuters. This section discusses potential policy directions that were suggested during the workshop. The policy suggestions are connected to the Behaviour Change Technique (BCT) taxonomy, which is a consensually agreed taxonomy of techniques used in behaviour change interventions (Michie et al., 2013). Table 4.1 provides an overview of the leverage points, recommended policy measures, and corresponding BCTs.

Table 4.1: Overview of levers and implications.

Leverage points	**Policy measure(s)**	**Behaviour Change Technique***
1. Centralise knowledge	Central knowledge platform	Adding objects to the environment
2. Enhance sustainability perspective	Informing employers on sustainable mobility	Information about environmental consequences
	Set sustainability goals and obligate employers to limit their environmental impact	Goal-setting
3. Set up a business case	Social Cost-Beneft Analysis Analysis effectiveness governmental subsidies	Information about social and environmental consequences
4. Reassure commuters	Rating functionality in app Guaranteed ride home service	Restructuring the physical environment
	Displaying exemplary behaviour	Demonstration of behaviour
5. Establish a carpool network	Financial rewards app users Preferential parking app users	Material incentive
6. Incentivise commuters	Travel cost compensation Preferential parking (incl. non-app users) Provision shared company car	Material incentive

*The behaviour change techniques stem from the Behaviour Change Technique taxonomy and are selected by reviewing the technique descriptions (Michie et al., 2013).

The first leverage point '*centralise knowledge*' is relevant for both professionals who intend to set up a carpool project as for commuters themselves. By creating a central knowledge platform, knowledge about the advantages of carpooling and the available facilities can be made more accessible to commuters. This links to the BCT *'adding objects to the environment'*, as information is provided to commuters. In addition, this could enable regional organisations to exchange ideas and experiences of initiating carpool projects.

The second leverage point '*enhance the sustainability perspective*' is about motivating employers to encourage and facilitate sustainable transport modes for employees. Through policy interventions aimed at education and goal-setting, employers can be informed about the advantages of sustainable transport modes and be obligated to limit the environmental impact of their mobility practices. Education is linked to the BCT *'information about environmental*

consequences' and goal-setting is linked to the BCT *'goal-setting (outcome)'*.

The third leverage point '*set up a business case*' concerns the business case of a digital ride-matching platform. As the need for governmental subsidies and the broad effects of carpooling have been insufficiently researched, this lever can be addressed by completing a Social Cost-Benefit Analysis (SCBA) and assessing the effectiveness of governmental subsidies. Conducting additional research as a measure to obtain knowledge is linked to the BCT *'information about social and environmental consequences'*, as it provides additional knowledge on the broader effects of carpooling.

The fourth leverage point '*reassure commuters*' addresses the level of trust among commuters. Commuters could be reassured through the BCT *'restructuring the physical environment'*. For example, the digital platform could be restructured by incorporating rating functionalities and guaranteed ride home services. In addition, commuters could be reassured through displaying exemplary behaviour, which is captured in the BCT *'demonstration of behaviour'*.

The fifth leverage point '*establish a carpool network*' focuses on achieving a large network of commuters who structurally engage in carpooling. This could be achieved through policy interventions that incentivise commuters to structurally carpool and register those shared rides on a digital ride-matching platform. Recommended policy measures are financial rewards and preferential parking for app users. These measures are linked to the BCT *'material incentive'*.

At last, the sixth leverage point '*incentivise commuters*' addresses the reinforcement mechanisms that can be used to motivate commuters to carpool. In contrast to the fifth leverage point, the sixth leverage point is directed at all forms of carpooling rather than carpooling using a digital platform. Policy measures that could motivate commuters to engage in carpooling are the provision of travel cost compensation, a shared company car, and preferential parking, regardless of the usage of a digital platform. These incentives are captured in the BCT *'material incentive'*.

Section 4.2 elaborates on the policy directions for the following leverage points: '*centralise knowledge*', '*enhance sustainability perspective*', and '*incentivise commuters*'. These leverage points are elaborated on as these levers were discussed more extensively during the workshop. The third leverage point *'set up a business case'* is not included as there is not enough knowledge to develop adequate policy measures. As stated above, more research is needed on the broader effects of carpooling and the effectiveness of governmental subsidies. The fourth leverage point *'reassure commuters'* is not included as there are already policy measures in place to address this lever (e.g. a rating functionality and guaranteed ride home service). Furthermore, this leverage point only applies to a small group of commuters: people who currently engage in carpooling and make use of a digital ride-matching platform. The fifth leverage point

'establish a carpool network' is not included as the suggested policy measures to address this lever are similar to the sixth leverage point *'incentivise commuters'*. The main difference is the focus on digital ride-matching platforms, rather than incentivising carpooling in general.

4.2. Policy recommendations

Based on a comprehensive analysis of the identified behavioural dynamics, several policy suggestions emerge. Building on Section 4.1.5, this section discusses the policy recommendations for leverage points 1, 2, and 6 in more detail. The proposed policy directions can be used by policy-makers to create effective measures that address the levers and achieve behavioural change.

4.2.1. Centralise knowledge

Centralise knowledge has emerged as a lever that could cause ripple effects throughout the system. Clear and accessible information not only motivates employers to facilitate carpooling, it also informs commuters and helps them recognise the advantages of sharing a ride. Limited knowledge on transport alternatives is a common barrier found in policy science (Mesquita et al., 2025; Tönnies et al., 2025). This study adds novel insights on how to address it. By developing a central knowledge platform, employers, regions, and commuters are supported to facilitate or engage in carpooling by enabling them to exchange ideas, experiences, and knowledge. The type of information on this platform could concern the application for governmental subsidies, issuing a tender for an app provider, information on fiscal regulations regarding travel cost compensation, or information on the advantages of carpooling and available facilities. Within the BSM, this central knowledge platform enhances the behaviours *'share knowledge on carpool pilots'* by regional organisations and *'inform people about advantages of carpooling'* by the government, which, in turn, increases the possibility for regions to set up a carpool project and motivates commuters to choose carpooling as their mode of transport.

To ensure the visibility and accessibility of the knowledge platform, it should be developed on a national level. Regional organisations could then use this platform to share practices and experiences or gain insight into the experiences of others. To reach as many regional governments and employers as possible, existing networks should be used. Examples of such networks are the knowledge programme traffic and mobility (in Dutch: KpVV) and the employer coalition travel differently (in Dutch: 'Coalitie Anders Reizen'). The knowledge programme develops, collects, and distributes knowledge within the mobility sector (CROW, 2025). In 2004, this programme has become the replacement of knowledge platform Verdi, which facilitated knowledge sharing on carpooling between regions (Bootsma and Schijndel, 2000; Goudappel Coffeng and AVV, 2005). At the moment, the KpVV programme does not include carpooling

specifically. Nevertheless, it could be used to give carpooling a platform and to reach regional governments. Similarly, the network of the employer coalition could be used to reach employers that aim to encourage sustainable mobility. In addition to the sharing of knowledge and experiences among regional governments and employers, a central knowledge platform could also be beneficial for commuters themselves. Dedicating a part of the platform to informing commuters about the advantages of carpooling and the available facilities (e.g. ride-matching platforms, carpool places) would increase their awareness and practical know-how. In the long term, this centralisation could be expanded beyond information-sharing to include the integration of transport services as well. Denmark, for example, already provides a central system that combines public transport with flex mobility options such as carpooling (CROW, 2025).

4.2.2. Enhance the sustainability perspective

The second lever concerns the enhancement of the sustainability perspective among employers, which could increase their motivation to reduce the environmental impact of work-related mobility. Two potential policy directions are educating employers on the advantages of sustainable mobility and obligating them to limit the environmental impact of their work-related mobility practices. Education of employers could be achieved through the sharing of knowledge and the use of existing employer networks. These policy measures relate to the creation of a central knowledge platform, as discussed in Section 4.2.1. However, to enhance the sustainability perspective among employers, knowledge sharing should be focused on informing employers about the advantages of sustainable mobility and the need for change, rather than the know-how of initiating a carpool project. This could be achieved by monitoring the environmental impact of existing measures on sustainable mobility. The monitoring results on the CO_2 impact of sustainable mobility practices could be shared through a central dashboard integrated in the central knowledge platform. In the BSM, this would influence the behaviour *'share knowledge on sustainable mobility'* by the national government and employer coalition, which, in turn, affects the behaviour *'commit to reduce CO_2 emissions'* by employers.

Another measure that motivates employers to reduce their environmental impact is to set objectives on the maximum amount of CO_2 emissions per kilometre travelled. This measure directly links to the behaviour *'commit to reduce CO_2 emissions'* in the BSM. Existing literature reveals that companies' sustainability plans often lack specific goals (Hiselius et al., 2025). CO_2 emission targets set by the government could guide employers in reducing their environmental impact. The objectives could be achieved by connecting them to the reporting obligation of work-related mobility. As discussed in the first subsection of Section 3.2.2, organisations of 100+ employers are obligated to report on the number of kilometres travelled for work-related purposes. At the moment, a standard correction term is used to compensate for the kilometres travelled through carpooling. This standard correction term is based on the national

average occupancy rate of 1,07 persons per car (RVO, 2025a). The purpose of this obligation is to achieve a reduction of 1,5 Mton CO_2 by 2030 (RVO, 2025a). The CO_2 emissions will be monitored to see if this joint target will be met. If needed, a CO_2 limit per kilometre travelled will be introduced to hold individual employers accountable. However, due to the use of a standard correction term and a joint objective, employers are not directly stimulated to encourage carpooling. Based on the findings of this study, it is recommended to explicitly include carpooling in the reporting obligation and introduce a CO_2 limit per kilometre travelled. These measures create a direct incentive for employers to encourage carpooling, enables assessment of the environmental impact of work-related mobility, and allows enforcement if the targets are not met.

4.2.3. Incentivise commuters

The sixth leverage point, *'incentivise commuters'* asks for policy measures that reinforce commuters to engage in carpooling. A policy intervention that is suggested by various participants is the differentiation in travel cost compensation. It is within employers' discretion to vary travel cost compensation according to the environmental impact associated with different transport modes. This measure has also been proposed by the Netherlands Enterprise Agency to promote sustainable mobility (RVO, 2025b). However, the legal tax-free compensation remains fixed for all transport modes at €0,23 per kilometre and does not apply to the additional kilometres travelled during informal carpooling (RVO, 2025c). This fiscal regulation discourages employers to differentiate in favour of sustainable transport modes, as they must remain competitive in the labour market. Adjusting the fiscal regulations that determine the tax-free travel cost compensation according to the environmental impact of the transport mode could incentivise commuters to carpool. Within the BSM, this adjustment would encourage the employer behaviour *'provide travel cost compensation for carpoolers'*, which motivates commuters to *'repeat sharing a ride'*.

In addition to fiscal regulations regarding the travel cost compensation, employers could implement preferential parking for those who carpool. The effectiveness of this measure has been confirmed by various studies (Ciari, 2012; M. A. Javid et al., 2017; Karbaumer and Metz, 2022) and numerous interview participants mentioned parking benefits as a reinforcement strategy. Some participants stated that preferential parking is the most effective tool to motivate commuters to engage in carpooling. Within the BSM, this measure influences the commuter behaviour *'reserve a parking spot'*, which increases the behaviour *'share a first ride'*. Another measure that employers could take is the provision of shared company cars instead of personal company cars. As reflected in theme 6 *'dependencies on the structural and social environment'*, the options made available to commuters strongly influence the choices they make. Offering a personal company car implicitly steers employees toward driving to work

and reduces the perceived need to share a ride. In contrast, providing a shared company car prompts commuters to engage in carpooling and can reduce overall car use. In the BSM, this measure could increase the perceived benefits of carpooling and motivate commuters to either *'download the app'* or *'search for a carpool match (without an app)'*. Although the adoption of shared company cars is currently limited, the measure holds substantial potential for increasing the overall occupancy rate of cars (CROW, 2026).

4.3. Limitations and future research

While this study has provided valuable insights within the behavioural systems field, several limitations should be acknowledged. In this section, four main limitations of this study are addressed, as these limitations provide the most valuable starting points for future research to deepen the understanding of the behavioural dynamics influencing carpool behaviour and informing the development of effective policy measures.

4.3.1. Commuter validation

The first limitation concerns the type of participants. As commuter behaviour has already been extensively researched in existing literature, this study focuses on incorporating the perspective of other actors in the field, such as governmental organisations, knowledge institutes, employer coalitions, app providers and people involved in carpool pilots. All participants were professionals who were asked about the behaviour of commuters, while no commuters were interviewed directly. The subjective experiences and professional environment of the participants influences their views on commuter behaviour. As the findings of this study reflect the perspective of professionals, there might be a mismatch between the results of this study and actual commuter behaviour. Moreover, participants might have felt pressured to answer in a socially desirable way, even when the interview data remained anonymous (Júnior, 2022). To validate the results of this study, future research could incorporate the perspective of commuters themselves. This would enrich the understanding of the behavioural system and allows comparing the perspective of professionals to the perspective of commuters. In addition, it would be interesting to compare the leverage points found in this study to the levers that result from studying the commuters' perspective. To use the identified levers as a valuable starting point for policy-making, insight needs to be gained into the different types of commuters and their behaviour. Through target audience segmentation, policy-makers can develop policy measures that align with the needs and motivations of specific commuter groups.

4.3.2. Testing of levers and policy interventions

A second limitation of this study is that the effects of the levers and proposed policy measures have not been tested. While the leverage points stem from the behavioural dynamics within the BSM, the actual influence these levers have on the rest of the system is not assessed. To address this limitation, future research could simulate the effects of these levers by using modelling techniques such as System Dynamics (SD) or Agent-Based modelling (ABM) (Schünemann et al., 2024). While ABM allows for a more detailed analysis of the dynamic interactions and decision of individual actors, SD requires less resources to model the system, as it solely focuses on aggregated behaviour. The decision of which modelling technique to use depends on the availability of resources. In addition to simulating the effects of levers, future research could generate and test hypotheses for policy interventions. While the BSM provides an exploratory device to generate hypotheses, this study has not done so due to the limited availability of resources. Both SD and ABM can be used to test intervention hypotheses and simulate the effects of the proposed policy measures on the behaviour of actors.

4.3.3. Longitudinal data

A third limitation of this study concerns the lack of longitudinal data, as the behavioural dynamics within the system are not assessed over time. The lack of longitudinal data stems from the choice to not include commuters directly in this study, as discussed in Section 4.3.1. However, conducting a longitudinal study could be valuable to observe how behaviour and its underlying determinants change over time. In addition, causal relationships between behaviours and factors can be identified. There are different approaches to conducting a longitudinal study, such as cohort studies, panel studies, or follow-up studies (Johnson and Louis, 2026). For future research, it would be interesting to investigate how the behaviour of commuters is shaped by changes that are made to the system. By conducting a follow-up study, longitudinal data can be collected of a group of commuters at two points in time, to assess how the changes made to the system, through policy interventions for example, influence the behaviour of commuters. Ultimately, this would enable policy-makers to design more effective policy measures in the future.

4.3.4. Focus on app users

At last, the focus on app users limits the applicability of the findings of this study. The data gathered through this study mainly reflect the behaviour of commuters who have access to a digital ride-matching platform. In the BSM, the path commuters take who do not make use of an app is less detailed than the path of app users, while in reality, the majority of commuters either lack access to such platforms or have little willingness to engage with them. The focus on app users leads to underrepresentation of the mobility behaviour and underlying motivations

of non-app users. Nevertheless, the focus on app users is intentional, as digital ride-matching is expected to have substantial growth potential in future mobility systems, as discussed in Section 4.1.3. Future research could test this hypothesis by simulating the effect of facilitating a digital ride-matching platform through SD or ABM. To study the behaviour of non-app users, a different approach is needed. Future research could enrich the understanding of the decision-making process of non-app users by conducting a longitudinal study, as discussed in Section 4.3.3. By measuring the behaviour of non-app users at different points in time, factors that influence their behaviour can be identified. Incorporating the behaviour of non-app users, enriches the understanding of the whole system and informs the development of policy measures that target these commuter groups as well.

5

Conclusion

This thesis contributes to existing literature, by adopting a behavioural systems approach, which combines behavioural analysis on a micro level with dynamic interactions between multiple actors on a macro level. This study enriches the understanding of dynamic interactions influencing the adoption of carpooling among commuters. By integrating the insights gained through reviewing existing literature with the expert views gathered through the conduction of interviews, this study provides a comprehensive overview of the system and the interrelationships, behavioural interactions, and underlying factors within. To the best of the author's knowledge, this study is the first to apply this novel lens to understand the behavioural dynamics that influence the adoption of carpooling.

5.1. Behavioural determinants

To gain insight into the psychological and contextual factors that influence the adoption of carpooling among commuters, considering the dynamic interactions between multiple actors in the system, this study addresses three sub-questions. The first sub-question is formulated as follows:

1. *'What psychological and contextual factors influencing carpool behaviour have been identified in peer-reviewed research?'*

To answer this research question, a state-of-the-art literature review has been conducted toward the psychological and contextual factors influencing carpool behaviour. Perceived benefits, such as economic or environmental benefits, appeared to be one of the main behavioural determinants. These perceived benefits can act as either a driver or a barrier, as they are weighed against the benefits of other modes of transport. This duality is clearly observable within the

social dimension, where social interaction functions as a motivator for some commuters, while it discourages others. The influence of these behavioural determinants depends on individuals' personal preferences and the broader context in which decisions are made.

5.2. Behavioural dynamics

The goal of the second sub-question is to incorporate the insights from policy-makers, employers, facilitators, and mobility experts to enhance the understanding of the dynamic interactions within the system. This research question is defined as follows:

2. *'What behavioural determinants and dynamic interactions are perceived by multiple actors that affect carpool behaviour?'*

To answer this research question, semi-structured interviews have been conducted with various experts within the field. The interview data is analysed through a behavioural analysis and thematic analysis, to gain insight in individual behavioural determinants as well as systemic interactions. Similarly to the literature review results, perceived economic benefits is most frequently cited as a behavioural determinant. In contrast, the habitual nature of modal choice is not a prominent factor in literature, while being acknowledged by various interview participants. The insights from this behavioural analysis adds on the understanding of individual determinants in literature.

The thematic analysis has revealed various behavioural dynamics perceived by experts. On a national level, fragmentation of knowledge appears to be an important dynamic that affects the uptake of carpooling. Centralising this knowledge requires the efforts of multiple actors and a guiding role from the national government. On the level of employers and facilitators, the financial dependency of digital ride-matching platforms is seen as a critical factor for the future viability of carpooling. On the level of commuters, the dependency on digital ride-matching platforms to establish carpool matches has been frequently mentioned. As these platforms allow commuters to match with people outside their social circle, they may hold considerable growth potential. These behavioural dynamics all play an important role in the large-scale adoption of carpooling.

5.3. Behavioural insights

The third sub-question focuses on the interpretation of the behavioural dynamics identified through the thematic analysis. The goal of this research question is to identify leverage points that affect the adoption of carpooling among commuters. The third sub-question is formulated as follows:

3. *'What leverage points can be identified that affect the participation of commuters in car-*

pooling services?'

To answer this research question, a behavioural system map (BSM) is constructed based on the behavioural dynamics identified through the thematic analysis and the behavioural determinants identified through the behaviour analysis. The BSM has lead to the construction of the following leverage points: 1. *'centralise knowledge'*, 2. *'enhance sustainability perspective'*, 3. *'set up a business case'*, 4. *'reassure commuters'*, 5. *'establishing a carpool network'*, and 6. *'incentivise commuters'*. While levers 4 - 6 target commuter behaviour, levers 1 - 3 focus on the behaviour of governmental organisations, employers, and facilitators, respectively. Together, these six leverage points guide policy-makers in developing effective policy measures that not only affect individual decision-making, yet also change the system in which these decisions are made.

To conclude, this thesis enriches the understanding of dynamic interactions that influence the adoption of carpooling among commuters. By following a behavioural systems approach consisting of multiple methods, this study has applied a novel lens to understand today's grand societal challenges. The behavioural dynamics this study has revealed and the leverage points that have been identified provide three main policy insights. First, it is recommended to develop a central knowledge platform where multiple actors can obtain information and exchange knowledge and experiences. Second, employers could be informed on the environmental impact of work-related mobility and be required to adhere to CO_2 emissions limits set by the government. Third, commuters could be incentivised by differentiation in travel cost compensation, preferential parking, and the provision of a shared company car. Taken together, these policy insights form a valuable starting point for policy-makers to develop effective interventions that encourage the adoption of carpooling.

References

Abrahamse, W., & Keall, M. (2012). Effectiveness of a web-based intervention to encourage carpooling to work: A case study of wellington, new zealand. *Transport Policy*, *21*, 45–51. https://doi.org/10.1016/j.tranpol.2012.01.005

Aguiléra, A., & Pigalle, E. (2021). The Future and Sustainability of Carpooling Practices. An identification of research challenges. *Sustainability*, *13*(21), 11824. https://doi.org/10.3390/su132111824

Ahmed, S. K. (2024). How to choose a sampling technique and determine sample size for research: A simplified guide for researchers. *Oral Oncology Reports*, *12*, 100662. https://doi.org/10.1016/j.oor.2024.100662

Akbari, M., Moradi, A., SeyyedAmiri, N., Zúñiga, M. Á., Rahmani, Z., & Padash, H. (2020). Consumers' intentions to use ridesharing services in iran. *Research in Transportation Business & Management*, *41*, 100616. https://doi.org/10.1016/j.rtbm.2020.100616

Allemann, S. S., Nieuwlaat, R., Van Den Bemt, B. J. F., Hersberger, K. E., & Arnet, I. (2016). Matching adherence interventions to patient determinants using the Theoretical Domains framework. *Frontiers in Pharmacology*, *7*, 429. https://doi.org/10.3389/fphar.2016.00429

Allison, A. L., Frost, R., & Murtagh, N. (2024). Promoting planting in front gardens: A systematic approach to intervention development. *UCL Open Environment*, *6*(1), e3147. https://doi.org/10.14324/111.444/ucloe.3147

Armoogum, Garcia, Gopal, Borgato, Fiorello, Maffii, Mars, Popovska, Schlemmer, Vincent, Bogaert, & Gayda. (2022, July). *Study on new mobility patterns in european cities: Task a: Eu wide passenger mobility survey*. European Commission. https://doi.org/10.2832/36900

Atkins, L., Francis, J., Islam, R., O'Connor, D., Patey, A., Ivers, N., Foy, R., Duncan, E. M., Colquhoun, H., Grimshaw, J. M., Lawton, R., & Michie, S. (2017). A guide to using the theoretical domains framework of behaviour change to investigate implementation problems. *Implementation Science*, *12*(1), 77. https://doi.org/10.1186/s13012-017-0605-9

Atlas.ti scientific software development gmbh (comp. software; Version ATLAS.ti Windows (version 24.2.1)). (2024). http://refhub.elsevier.com/S0272-4944(25)00149-5/sref5

Bachmann, F., Hanimann, A., Artho, J., & Jonas, K. (2018). What drives people to carpool? explaining carpooling intention from the perspectives of carpooling passengers and drivers. *Transportation Research Part F Traffic Psychology and Behaviour*, *59*, 260–268. https://doi.org/10.1016/j.trf.2018.08.022

Bal, Münzel, & Stoop. (2025, September 9). *In search for insights for policymakers: The impact of shared mobility amid the transition to e-mobility in the netherlands*. Province of Utrecht. https://www.interregnorthsea.eu/sites/default/files/2025-09/SDMH_HU_WP2%203.1%20The%20Impact%20of%20Shared%20Mobility%20Amid%20the%20Transition%20to%20e-Mobility%20in%20the%20Netherlands.pdf

Baldassare, M., Ryan, S., & Katz, C. (1998). Suburban attitudes toward policies aimed at reducing solo driving. *Transportation*, *25*(1), 99–117. https://doi.org/10.1023/a:1004982709482

Bálint, D., & Trócsányi, A. (2017). New ways of mobility: The birth of ridesharing. a case study from hungary. *Hungarian Geographical Bulletin*, *65*(4), 391–405. https://doi.org/10.15201/hungeobull.65.4.7

Barbrook-Johnson, P., & Penn, A. S. (2022). *Participatory systems mapping*. Springer. https://doi.org/10.1007/978-3-031-01919-7_5

Bellmann, K. P. (2025). A stepwise guide to behavioural system mapping. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.5444814

Bellmann, K. P., De Vries, G., & Scholten, L. (2025). Understanding slow progress on urban climate adaptation: An empirical analysis of behavioural dynamics in dutch policymaking. *Journal of Environmental Psychology*, *105*, 102666. https://doi.org/10.1016/j.jenvp.2025.102666

BlaBlaCar. (2019, March). *Study – carpooling saves more than 1.6 million tonnes of co2 a year, whilst doubling the number of people traveling*. https://newsroom.blablacar.com/news/study-carpooling-saves-more-than-1-6-million-tonnes-of-co2-a-year-whilst-doubling-the-number-of-people-traveling

Bootsma & Schijndel. (2000, May 3). *Kansen voor carpoolen*. Ministerie van Verkeer en Waterstaat. https://open.rijkswaterstaat.nl/publish/pages/168612/kansen_voor_carpoolen.pdf

Brainport Bereikbaar. (2025, April 16). *Apps voor samenrijden nu beschikbaar in de brainport - brainport bereikbaar*. https://www.brainportbereikbaar.nl/inspiratie/apps-voor-samenrijden/

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Buliung, R. N., Soltys, K., Bui, R., Habel, C., & Lanyon, R. (2010). Catching a ride on the information super-highway: Toward an understanding of internet-based carpool formation and use. *Transportation*, *37*(6), 849–873. https://doi.org/10.1007/s11116-010-9266-0

Bulteau, J., Feuillet, T., Dantan, S., & Abbes, S. (2021). Encouraging carpooling for commuting in the Paris area (France): which incentives and for whom? *Transportation*, *50*(1), 43–62. https://doi.org/10.1007/s11116-021-10237-w

Bulteau, J., Feuillet, T., & Dantan, S. (2019). Carpooling and carsharing for commuting in the paris region: A comprehensive exploration of the individual and contextual correlates of their uses. *Travel Behaviour and Society*, *16*, 77–87. https://doi.org/10.1016/j.tbs.2019.04.007

Burghard, U., & Scherrer, A. (2022). Sharing vehicles or sharing rides - psychological factors influencing the acceptance of carsharing and ridepooling in germany. *Energy Policy*, *164*, 112874. https://doi.org/10.1016/j.enpol.2022.112874

Cane, J., Richardson, M., Johnston, M., Ladha, R., & Michie, S. (2014). From lists of behaviour change techniques (bct s) to structured hierarchies: Comparison of two methods of developing a hierarchy of bct s. *British Journal of Health Psychology*, *20*(1), 130–150. https://doi.org/10.1111/bjhp.12102

Carlin, Arshad, Martin, Hou, Baker, Naidjate, & Subbiah. (2024, May). *Climate risks in the transportation sector*. https://www.unepfi.org/themes/climate-change/climate-risks-in-the-transportation-sector/

Cascetta, E., Pagliara, F., & Papola, A. (2007). Governance of urban mobility: Complex systems and integrated policies. *Advances in Complex Systems*, *10*(supp02), 339–354. https://doi.org/10.1142/s0219525907001392

CE Delft & Goudappel. (2021, June). *Effecten van het programma duurzame mobiliteit*. https://mrdh.nl/sites/default/files/documents/ce_delft_200350_effecten_van_het_programma_duurzame_mobiliteit_def.pdf

Centraal Bureau voor de Statistiek. (2024). Hoeveel reisden inwoners van Nederland van en naar het werk? https://www.cbs.nl/nl-nl/visualisaties/verkeer-en-vervoer/personen/van-en-naar-werk

Centraal Bureau voor de Statistiek. (2025). Hoeveel broeikasgas stoot de transportsector uit? https://www.cbs.nl/nl-nl/dossier/dossier-broeikasgassen/hoeveel-broeikasgas-stoot-de-transportsector-uit-

Chater, N., & Loewenstein, G. (2022). The i-frame and the s-frame: How focusing on individual-level solutions has led behavioral public policy astray. *Behavioral and Brain Sciences*, *46*, e147. https://doi.org/10.1017/s0140525x22002023

Ciari, F. (2012). Why do people carpool: Results from a swiss survey. *Swiss Transport Research Conference*. https://www.strc.ch/2012/Ciari.pdf

Coalitie Anders Reizen. (2026, January 16). *Home - anders reizen*. https://www.andersreizen.nu/

Cohen, M. C., Fiszer, M., Ratzon, A., & Sasson, R. (2021). Incentivizing Commuters to Carpool: A Large Field Experiment with Waze. *Manufacturing & Service Operations Management*, *25*(4), 1263–1284. https://doi.org/10.1287/msom.2021.1033

Cohen, M. C., Jacquillat, A., Ratzon, A., & Sasson, R. (2022). The impact of high-occupancy vehicle lanes on carpooling. *Transportation Research Part A Policy and Practice*, *165*, 186–206. https://doi.org/10.1016/j.tra.2022.08.021

Correia, G., & Viegas, J. M. (2010). Carpooling and carpool clubs: Clarifying concepts and assessing value enhancement possibilities through a Stated Preference web survey in Lisbon, Portugal. *Transportation Research Part A Policy and Practice*, *45*(2), 81–90. https://doi.org/10.1016/j.tra.2010.11.001

Cowdell, F., & Dyson, J. (2019). How is the theoretical domains framework applied to developing health behaviour interventions? a systematic search and narrative synthesis. *BMC Public Health*, *19*(1), 1180. https://doi.org/10.1186/s12889-019-7442-5

Crotti, D., Myftiu, J., Di Ruocco, I., Cornalba, S. B., & Husic, N. (2026, January 1). *Commuting and sustainability*. https://doi.org/10.1016/b978-0-443-27396-4.00021-x

CROW. (2025, December). *Publieke mobiliteit vraagt om minder experimenten en meer regie*. https://www.kennisnetwerktoegankelijkheid.nl/nieuws/825-publieke-mobiliteit-vraagt-om-minder-experimenten-en-meer-regie

CROW. (2026, January). *Staat van de deelmobiliteit 2025: Ontwikkeling naar een volwassen markt zet door*. https://www.crow.nl/kennisproducten/staat-van-de-deelmobiliteit-2025/

CROW. (n.d.). *Crow | over crow*. https://www.crow.nl/over-crow/

Cunningham, S., & Hermans, L. (2018, January 19). *Actor and strategy models*. https://doi.org/10.1002/9781119284772

Davan Wetton, J., Santilli, M., Gitau, H., Muindi, K., Zimmermann, N., Michie, S., & Davies, M. (2025). Behavioural systems mapping of solid waste management in kisumu, kenya, to understand the role of behaviour in a health and sustainability problem. *Behavioral Sciences*, *15*(2), 133. https://doi.org/10.3390/bs15020133

De Almeida Correia, G. H., De Abreu E Silva, J., & Viegas, J. M. (2013). Using latent attitudinal variables estimated through a structural equations model for understanding carpooling propensity. *Transportation Planning and Technology*, *36*(6), 499–519. https://doi.org/10.1080/03081060.2013.830894

de Haas, Visser, Jonkeren, Moorman, Romijn, & Faber. (2024, November). *Kerncijfers mobiliteit 2024*. Kennisinstituut voor Mobiliteitsbeleid. https://www.kimnet.nl/site/

binaries / site - content / collections / documents / 2024 / 11 / 18 / kerncijfers - mobiliteit - 2024/KiM+Kerncijfers_Mobiliteit_2024_DTdef.pdf

Delhomme, P., & Gheorghiu, A. (2015). Comparing french carpoolers and non-carpoolers: Which factors contribute the most to carpooling? *Transportation Research Part D Transport and Environment*, *42*, 1–15. https://doi.org/10.1016/j.trd.2015.10.014

Dinesh, N. S., Rejikumar, G., & Sisodia, G. S. (2021). An empirical investigation into carpooling behaviour for sustainability. *Transportation Research Part F Traffic Psychology and Behaviour*, *77*, 181–196. https://doi.org/10.1016/j.trf.2021.01.005

DMI. (n.d.). *Thema mobiliteit – dmi-ecosysteem*. https://dmi-ecosysteem.nl/thema-mobiliteit/

Dörrzapf, Tanzer, Kammerhofer, Preißler, Artacker, & Berger. (2023, September 20). *Increase occupancy rate in passenger cars – potentials of awareness raising for carpooling*. https://repository.corp.at/993/1/CORP2023_160.pdf

Enserink, Bots, van Daalen, Hermans, Kortmann, Koppenjan, Kwakkel, Ruijgh-van der Ploeg, Slinger, & Thissen. (2022, August 15). *Policy analysis of multi-actor systems* (2nd ed.). Eleven. https://doi.org/10.5074/t.2022.004

European Commission. (2019, December 11). *The european green deal: Communication from the commission to the european parliament, the european council, the council, the european economic and social committee and the committee of the regions*. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0640

European Court of Auditors. (2020, March). *Sustainable urban mobility in the eu: No substantial improvement is possible without member states' commitment*. https://www.eca.europa.eu/Lists/ECADocuments/SR20_06/SR_Sustainable_Urban_Mobility_EN.pdf

European Environment Agency. (2022a, June). *Decarbonising road transport — the role of vehicles, fuels and transport demand* (ISBN: 978-92-9480-473-0). https://www.eea.europa.eu/en/analysis/publications/transport-and-environment-report-2021

European Environment Agency. (2022b). *Digitalisation in the mobility system: Challenges and opportunities*. https://doi.org/10.2800/47438

European Environment Agency. (2026, February). *Sustainability of europe's mobility systems 2025*. https://www.eea.europa.eu/en/analysis/publications/sustainability-of-europes-mobility-systems-2025

Eurostat. (2021, November). *Passenger mobility statistics*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Passenger_mobility_statistics

Franckx, L. (2023). Increasing the occupancy rates of cars: Carrot, stick or both? *Case Studies on Transport Policy*, *15*, 101132. https://doi.org/10.1016/j.cstp.2023.101132

Gemeente Den Haag. (2021). *Strategie mobiliteitstransitie den haag 2022-2040*. https://denhaag.raadsinformatie.nl/document/10877149/1?connection_type=16&connection_id=710964

Gheorghiu, A., & Delhomme, P. (2018). For which types of trips do french drivers carpool? motivations underlying carpooling for different types of trips. *Transportation Research Part A Policy and Practice*, *113*, 460–475. https://doi.org/10.1016/j.tra.2018.05.002

Gkartzonikas, C., & Dimitriou, L. (2025). Evaluation of young people's perceptions and comfort levels in sharing information via ride-matching apps. *Transportation Research Interdisciplinary Perspectives*, *31*, 101437. https://doi.org/10.1016/j.trip.2025.101437

Goudappel Coffeng & AVV. (2005, September). *Veilig op weg: Monitoring startprogramma duurzaam veilig*. https://www.fietsberaad.nl/CROWFietsberaad/media/Kennis/Bestanden/document000094.pdf?ext=.pdf

Grimmer, M., & Miles, M. P. (2016). With the best of intentions: A large sample test of the intention□behaviour gap in pro□environmental consumer behaviour. *International Journal of Consumer Studies*, *41*(1), 2–10. https://doi.org/10.1111/ijcs.12290

Guariguata, L., Rouwette, E. A., Murphy, M. M., Ville, A. S., Dunn, L. L., Hickey, G. M., Jones, W., Samuels, T. A., & Unwin, N. (2020). Using group model building to describe the system driving unhealthy eating and identify intervention points: A participatory, stakeholder engagement approach in the caribbean. *Nutrients*, *12*(2), 384. https://doi.org/10.3390/nu12020384

Guidotti, R., Nanni, M., Rinzivillo, S., Pedreschi, D., & Giannotti, F. (2016). Never drive alone: Boosting carpooling with network analysis. *Information Systems*, *64*, 237–257. https://doi.org/10.1016/j.is.2016.03.006

Hale, Jofeh, & Chadwick. (2022). Decarbonising existing homes in wales: A participatory behavioural systems mapping approach. *UCL Open Environment*. https://doi.org/10.14324/111.444/ucloe.000047

Heersink, E., & Slagboom, B. (2023, November). Steeds meer auto's, maar weinig plek: grote gemeenten kampen met parkeerdruk. https://nos.nl/artikel/2498765-steeds-meer-autos-maar-weinig-plek-grote-gemeenten-kampen-met-parkeerdruk

Hiselius, L. W., Johansson, M., & Arnfalk, P. (2025). Establishing action plans for sustainable mobility within companies. *Transportation research procedia*, *86*, 429–434. https://doi.org/10.1016/j.trpro.2025.04.054

Hoerler, R., Baumann, M., Schubert, I., & Del Duce, A. (2025). Factors influencing the adoption of carpooling in switzerland: A differentiation between platforms, family and friends and colleagues. *Transportation Research Interdisciplinary Perspectives*, *34*, 101674. https://doi.org/10.1016/j.trip.2025.101674

Horowitz & Sheth. (1977). Ride sharing to work: An attitudinal analysis. *Transp. Res.*, 1–8. http://onlinepubs.trb.org/Onlinepubs/trr/1977/637/637-001.pdf

Hu, X., Chiu, Y., & Zhu, L. (2015). Behavior insights for an incentive-based active demand management platform. *International Journal of Transportation Science and Technology*, *4*(2), 119–133. https://doi.org/10.1260/2046-0430.4.2.119

Hunecke, M., Richter, N., & Heppner, H. (2021). Autonomy loss, privacy invasion and data misuse as psychological barriers to peer-to-peer collaborative car use. *Transportation Research Interdisciplinary Perspectives*, *10*, 100403. https://doi.org/10.1016/j.trip.2021.100403

Javid, M. A., Mehmood, T., Asif, H. M., Vaince, A. U., & Raza, M. (2017). Travelers' attitudes toward carpooling in lahore: Motives and constraints. *Journal of Modern Transportation*, *25*(4), 268–278. https://doi.org/10.1007/s40534-017-0135-9

Javid, R. J., Nejat, A., & Hayhoe, K. (2017). Quantifying the environmental impacts of increasing high occupancy vehicle lanes in the united states. *Transportation Research Part D Transport and Environment*, *56*, 155–174. https://doi.org/10.1016/j.trd.2017.07.031

Jiang, Y., & Lau, A. K. (2021). Roles of consumer trust and risks on continuance intention in the sharing economy: An empirical investigation. *Electronic Commerce Research and Applications*, *47*, 101050. https://doi.org/10.1016/j.elerap.2021.101050

Johnson & Louis. (2026). *Chapter 37 - longitudinal study: Design and measures*. https://doi.org/10.1016/B978-0-323-90532-9.00060-1

Júnior, J. P. B. (2022). Viés de desejabilidade social na pesquisa qualitativa em saúde. *Revista de Saúde Pública*, *56*, 101. https://doi.org/10.11606/s1518-8787.2022056004164

Karbaumer & Metz. (2022). *Gids voor het universum van de deelmobiliteit*. Share-North project. https://share-north.eu/wp-content/uploads/2022/05/Shared-Mobility-Guide_DUTCH.pdf

Kesternich. (2015, April). *What factors explain carpoolers' decision to use carpooling matching platforms? A survey-based observation of carpooling matching platforms in europe*. University of Twente. https://purl.utwente.nl/essays/66952

KiM. (2026, January). *Kim-programma 2026*. https://www.kimnet.nl/site/binaries/site-content/collections/documents/2026/01/15/kim-programma-2026/kim-programma-2026-def.pdf

Knoope. (2023, June). *Verkenning van de gevolgen van betalen naar gebruik voor autoreizen naar het buitenland*. Kennisinstituut voor Mobiliteitsbeleid. https://www.kimnet.nl/site/binaries/site-content/collections/documents/2023/06/22/verkenning-van-de-gevolgen-van-betalen-naar-gebruik-voor-autoreizen-naar-het-buitenland/KiM.+Verkenning+van+de+gevolgen+van+betalen+naar+gebruik+voor+autoreizen+naar+het+buitenland_def2.pdf

Koenig, H. G. (2018, January 1). *Mechanisms*. https://doi.org/10.1016/b978-0-12-811282-3.00007-0

Laroche, F., & Schemeleva, K. (2026). Exploratory study of long-distance carpooling supply and public financial incentives: The case of france. *Research in Transportation Economics*, *116*, 101734. https://doi.org/10.1016/j.retrec.2026.101734

Leavy, P. (2020, November). *The oxford handbook of qualitative research*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190847388.001.0001

Lee, B. H., Aultman-Hall, L., Coogan, M., & Adler, T. (2015). Rideshare mode potential in non-metropolitan areas of the northeastern united states. *Journal of Transport and Land Use*. https://doi.org/10.5198/jtlu.2015.669

Levin, I. P. (1982). Measuring tradeoffs in carpool driving arrangement preferences. *Transportation*, *11*(1), 71–85. https://doi.org/10.1007/bf00165595

Li, J., Embry, P., Mattingly, S. P., Sadabadi, K. F., Rasmidatta, I., & Burris, M. W. (2007). Who chooses to carpool and why? *Transportation Research Record Journal of the Transportation Research Board*, *2021*(1), 110–117. https://doi.org/10.3141/2021-13

Liu, X., Titheridge, H., Yan, X., Wang, R., Tan, W., Chen, D., & Zhang, J. (2020). A passenger-to-driver matching model for commuter carpooling: Case study and sensitivity analysis. *Transportation Research Part C Emerging Technologies*, *117*, 102702. https://doi.org/10.1016/j.trc.2020.102702

Lunetto, M., Hale, J., & Michie, S. (2022). Achieving effective climate action in cities by understanding behavioral systems. *One Earth*, *5*(7), 745–748. https://doi.org/10.1016/j.oneear.2022.06.009

Margolin, J. B., Misch, M. R., & Stahr, M. (1978). Incentives and disincentives of ride-sharing. *Transportation Research Record Journal of the Transportation Research Board*, (673). https://trid.trb.org/view/87712

Mattia, G., Di Pietro, L., Principato, L., & Toni, M. (2021). Shared car for traveling? uncovering the intention of non-users to adopt p2p ride-sharing. *Research in Transportation Business & Management*, *43*, 100737. https://doi.org/10.1016/j.rtbm.2021.100737

McLeod, S. (2024). Open coding in qualitative research. *Simply Psychology*. https://doi.org/10.13140/rg.2.2.32424.89608

Meloni, I., Giubergia, D., Piras, F., & Sottile, E. (2025). Can maas encourage travel behavior change? the role of cognitive, motivational factors in sustainable and pro-environmental choices. *Transportation research procedia*, *82*, 1896–1912. https://doi.org/10.1016/j.trpro.2024.12.162

Mesquita, A. R., De Abreu, V. H. S., Poyares, C. N., & Santos, A. S. (2025). Barriers to electric vehicle adoption: A framework to accelerate the transition to sustainable mobility. *Sustainability*, *17*(18), 8318. https://doi.org/10.3390/su17188318

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J., & Wood, C. E. (2013). The behavior change technique taxonomy (v1)

of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine*, *46*(1), 81–95. https://doi.org/10.1007/s12160-013-9486-6

Michie, S., Van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. https://doi.org/10.1186/1748-5908-6-42

Milieu Centraal. (2025, November). *Monitor duurzaam leven*. https://www.milieucentraal.nl/media/gfcpxgon/milieu-centraal-monitor-duurzaam-leven-2025.pdf

Ministerie van Infrastructuur en Waterstaat. (2023, March). *Mobiliteitsvisie 2050*. https://open.overheid.nl/documenten/ronl-d954c7efb64c60233b4000dbc2efe949e84bb7f9/pdf

Ministerie van Infrastructuur en Waterstaat. (2025, June). *Organogram ministerie van infrastructuur en waterstaat*. https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/publicaties/2018/02/01/organogram-ministerie-van-infrastructuur-en-waterstaat/ienw-organogram-nederlands-06-2025.pdf

Mobiliteitsalliantie. (2023). *Deltaplan 2035: Samen de transitie door*. https://mobiliteitsalliantie.nl/wp-content/uploads/2023/11/23-0240-Deltaplan-2035_DIGI_LK_DEF.pdf

Mohammadi-Mavi, H., Ranjbari, A., Guler, S. I., & Gayah, V. V. (2024). What does it take for rural-urban commuters to switch from driving to carpooling? *Transportation Research Part F Traffic Psychology and Behaviour*, *107*, 803–819. https://doi.org/10.1016/j.trf.2024.10.007

Moore, Khan, & Gastaldo. (2023). Capability, Opportunity, Motivation - Behavior & Theoretical Domains Framework. Adapted from Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(42). https://thecenterforimplementation.com/toolbox/com-b-tdf

Muconsult. (2025, October 21). *Vervoersveranderingen bij jongvolwassenen: Een onderzoek naar de invloed van verhuizing, een nieuwe baan en gezinsuitbreiding op reisgedrag*. https://natuurenmilieu.nl/app/uploads/Rapport-Vervoersveranderingen-bij-jongvolwassenen-Natuur-Milieu.pdf

Nabogo. (2025, August 5). *Met nabogo kun je doordeweeks eenvoudig samenrijden*. https://nabogo.com/nl/

Natuur & Milieu. (2023, May). *Impactverslag 2023*. https://natuurenmilieu.nl/app/uploads/2023_Jaarverslag-Natuur-Milieu-gecomprimeerd.pdf

Neoh, J. G., Chipulu, M., & Marshall, A. (2015). What encourages people to carpool? An evaluation of factors with meta-analysis. *Transportation*, *44*(2), 423–447. https://doi.org/10.1007/s11116-015-9661-7

Newberry, P., & Carhart, N. (2023). Constructing causal loop diagrams from large interview data sets. *System Dynamics Review*, *40*(1). https://doi.org/10.1002/sdr.1745

Nielsen, J. R., Hovmøller, H., Blyth, P., & Sovacool, B. K. (2015). Of "white crows" and "cash savers:" a qualitative study of travel behavior and perceptions of ridesharing in denmark. *Transportation Research Part A Policy and Practice*, *78*, 113–123. https://doi.org/10.1016/j.tra.2015.04.033

Nilsen, P. (2026). Rethinking barriers and facilitators in implementation science: Conceptual, methodological, and practical challenges, and ways forward. *Implementation Science Communications*, *7*(1). https://doi.org/10.1186/s43058-026-00901-6

NRC. (1989). 'Behalve reiskosten ook lekker zelf eens achterin te zitten' Carpooling rijp voor tweede kans. https://www.nrc.nl/nieuws/1989/04/19/behalve-reiskosten-ook-lekker-zelf-eens-achterin-te-zitten-carpooling-rijp-voor-tweede-kans-kb_000031291-a3569045

Olsson, L. E., Maier, R., & Friman, M. (2019). Why do they ride with others? meta-analysis of factors influencing travelers to carpool. *Sustainability*, *11*(8), 2414. https://doi.org/10.3390/su11082414

Oranga, J., & Matere, A. (2023). Qualitative research: Essence, types and advantages. *Open Access Library Journal*, *10*(12), 1–9. https://doi.org/10.4236/oalib.1111001

Park, Y., Chen, N., & Akar, G. (2018). Who is interested in carpooling and why: The importance of individual characteristics, role preferences and carpool markets. *Transportation Research Record Journal of the Transportation Research Board*, *2672*(8), 708–718. https://doi.org/10.1177/0361198118756883

Parkinson, J. A., Gould, A., Knowles, N., West, J., & Goodman, A. M. (2025). Integrating systems thinking and behavioural science. *Behavioral Sciences*, *15*(4), 403. https://doi.org/10.3390/bs15040403

Provincie Zuid-Holland. (n.d.). *Deelmobiliteit*. https://www.zuid-holland.nl/onderwerpen/verkeer-vervoer/deelmobiliteit-0/

Richmond, B. (1994). Systems thinking/system dynamics: Let's just get on with it. *System Dynamics Review*, *10*(2-3), 135–157. https://doi.org/10.1002/sdr.4260100204

Rijkswaterstaat. (2016, September 28). *Wat en waarom verlenging wisselbaan*. https://bezoekerscentrum.rijkswaterstaat.nl/SchipholAmsterdamAlmere/waarom-verlenging-wisselbaan/

Rijkswaterstaat. (2025a, October 20). *Duurzame mobiliteit*. https://www.rijkswaterstaat.nl/leefomgeving/duurzame-mobiliteit

Rijkswaterstaat. (2025b, March). *Rapportage rijkswegennet*. https://open.overheid.nl/documenten/329416ea-90f7-43d1-b966-f61751df0afc/file

RVO. (2025a, December). *Gegevensverzameling werkgebonden personenmobiliteit: Handreiking voor werkgevers*. https://www.rvo.nl/sites/default/files/2025-12/Handreiking-werkgebonden-personenmobiliteit-december-2025.pdf

RVO. (2025b, October). *Reiskostenvergoeding - werkgebonden personenmobiliteit*. https://www.rvo.nl/onderwerpen/start-met-verduurzamen-werkgebonden-personenmobiliteit/reiskostenvergoeding

RVO. (2025c, May). *Samen reizen - carpoolen en vanpoolen - werkgebonden personenmobiliteit*. https://www.rvo.nl/onderwerpen/start-met-verduurzamen-werkgebonden-personenmobiliteit/carpoolen

Rye, Tully, Godin, Schmalholz, & Hertel. (2022, August). *Parking and sump: Using parking management to achieve sump objectives effectively and sustainably*. European Commission. https://urban-mobility-observatory.transport.ec.europa.eu/system/files/2023-11/parking_and_sump.pdf

Saldana, J. (2025). *The coding manual for qualitative researchers* (5th ed.). https://doi.org/10.4135/9781036235611

Schünemann, C., Johanning, S., Reger, E., Herold, H., & Bruckner, T. (2024). Complex system policy modelling approaches for policy advice – comparing systems thinking, system dynamics and agent-based modelling. *Political Research Exchange*, *6*(1). https://doi.org/10.1080/2474736x.2024.2387438

Shaheen, S., Chan, N. D., & Gaynor, T. (2016). Casual carpooling in the san francisco bay area: Understanding user characteristics, behaviors, and motivations. *Transport Policy*, *51*, 165–173. https://doi.org/10.1016/j.tranpol.2016.01.003

Shaheen, S., & Cohen, A. (2018). Shared ride services in north america: Definitions, impacts, and the future of pooling. *Transport Reviews*, *39*(4), 427–442. https://doi.org/10.1080/01441647.2018.1497728

Shaheen, S., Cohen, A., & Bayen, A. (2018, October). *The Benefits of Carpooling*. UC Berkeley. https://doi.org/10.7922/G2DZ06GF

Shi, J., Hua, W., Si, H., & Cheng, L. (2024). How to stimulate users' ridesharing intention and behavior? evidence from structural and multi-group analyses. *Travel Behaviour and Society*, *37*, 100858. https://doi.org/10.1016/j.tbs.2024.100858

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Tahmasseby, S., Kattan, L., & Barbour, B. (2015). Propensity to participate in a peer□to□peer social□network□based carpooling system. *Journal of Advanced Transportation*, *50*(2), 240–254. https://doi.org/10.1002/atr.1326

Tischer, M. L., & Dobson, R. (1979). An empirical analysis of behavioral intentions of single-occupant auto drivers to shift to high occupancy vehicles. *Transportation Research Part A General*, *13*(3), 143–158. https://doi.org/10.1016/0191-2607(79)90066-9

Tönnies, J., Ahrens, J., Hasselder, P., Van Houten, P., Van Eerten, J., White, M., Weber, M., & Bolte, G. (2025). Tackling transport poverty with offers for shared mobility – a qualitative analysis on mobility needs and barriers in the context of a new mobility hub in a deprived neighbourhood. *Cities & Health*, 1–15. https://doi.org/10.1080/23748834.2025.2539608

Trouw. (1994). Het einde van de carpoolstrook. https://www.trouw.nl/voorpagina/het-einde-van-de-carpoolstrook~bc785ca2/

Tsai, Y., Yu, C., & Boonprakob, R. (2021). Assessing carpooling drivers and barriers: Evidence from bangkok, thailand. *Transportation Research Part F Traffic Psychology and Behaviour*, *82*, 84–95. https://doi.org/10.1016/j.trf.2021.07.017

Urquhart, J., Goodenough, A., Staddon, P., Mills, J., Powell, J., Vigani, M., & Simmonds, P. (2025). Afforestation on agricultural land in england: Applying the theoretical domains framework and behaviour change wheel to identify the enablers of change within farmer behaviour. *Journal of Rural Studies*, *120*, 103848. https://doi.org/10.1016/j.jrurstud.2025.103848

van Essen, Stemerding, Litjens, van Lent, Groenhuis, & Wolf. (2026, February). *Landelijk reizigersonderzoek 2025*. https://open.overheid.nl/documenten/c52594a7-9d7f-4d45-8d1f-0ba4ff19bd68/file

Vanoutrive, T., van de Vijver, E., Van Malderen, L., Jourquin, B., Thomas, I., Verhetsel, A., & Witlox, F. (2012). What determines carpooling to workplaces in Belgium: location, organisation, or promotion? *Journal of Transport Geography*, *22*, 77–86. https://doi.org/10.1016/j.jtrangeo.2011.11.006

Veldhuis, G., Smits-Clijsen, E., Van Waas, R., Hof, T., Maccatrozzo, V., Rouwette, E., & Kerstholt, J. (2025). The influence of causal loop diagrams on systems thinking and information utilization in complex problem-solving. *Computers in Human Behavior Reports*, *17*, 100613. https://doi.org/10.1016/j.chbr.2025.100613

Verhul, van der Voet, & van der Pas. (2019, June 3). *Gezamenlijke ambities en samenwerkingsprincipes voor smart mobility, dutch reality*.

Verplanken, B., & Orbell, S. (2021). Attitudes, habits, and behavior change. *Annual Review of Psychology*, *73*(1), 327–352. https://doi.org/10.1146/annurev-psych-020821-011744

VNG. (2023, December). *Vng-perspectief op mobiliteit in 2050*. https://vng.nl/sites/default/files/2024-01/vng-perspectief-op-mobiliteit-in-2050.pdf

VNV Global. (2024). *Annual report 2024*. https://www.vnv.global/netcat_files/12/13/vnv_ar24_eng.pdf

Wang, Y., & Monchambert, G. (2025). Does subsidy increase the use of carpooling via platforms? the case of short-distance carpooling in france. *Transportation Research Part A Policy and Practice*, *203*, 104767. https://doi.org/10.1016/j.tra.2025.104767

Wang, Y., Gu, J., Wang, S., & Wang, J. (2019). Understanding consumers' willingness to use ride-sharing services: The roles of perceived value and perceived risk. *Transportation Research Part C Emerging Technologies*, *105*, 504–519. https://doi.org/10.1016/j.trc.2019.05.044

Wang, Y., Wang, S., Wang, J., Wei, J., & Wang, C. (2018). An empirical study of consumers' intention to use ride-sharing services: Using an extended technology acceptance model. *Transportation*, *47*(1), 397–415. https://doi.org/10.1007/s11116-018-9893-4

Wang, Y., Wu, J., Gu, J., & Wang, F. (2024). An elaboration likelihood model of perceived safety risk in ride-sharing continuance: Platform quality cues as antecedents and gender as moderator. *Transportation Research Part F Traffic Psychology and Behaviour*, *109*, 367–382. https://doi.org/10.1016/j.trf.2024.12.025

West, Michie, Chadwick, Atkins, & Lorencatto. (2020, November). *Achieving behaviour change: A guide for national government*.

Wink. (2025, July). *Analysis of the decision-making processes of municipal policy-makers on urban climate change adaptation for extreme precipitation*. Delft University of Technology. https://resolver.tudelft.nl/uuid:de9b0fa8-08af-4b65-8aac-97c450b32e9a

Wutich, A., Beresford, M., & Bernard, H. R. (2024). Sample sizes for 10 types of qualitative data analysis: An integrative review, empirical guidance, and next steps. *International Journal of Qualitative Methods*, *23*. https://doi.org/10.1177/16094069241296206

Xiao, L., Wu, J., Sun, J., & Tian, Y. (2024). Money is power: Carpooling stimulus with evidence from an interactive long-term laboratory experiment. *Transport Policy*, *152*, 55–70. https://doi.org/10.1016/j.tranpol.2024.04.013

Yi, X., Lian, F., & Yang, Z. (2022). Research on commuters' carpooling behavior in the mobile internet context. *Transport Policy*, *126*, 14–25. https://doi.org/10.1016/j.tranpol.2022.06.016

Zhang, X., Zhong, S., Ling, S., Jia, N., Qi, H., & He, Z. (2022). How to promote the transition from solo driving to mobility services delivery? an empirical study focusing on ridesharing. *Transport Policy*, *129*, 176–187. https://doi.org/10.1016/j.tranpol.2022.10.009

Zhang, Y., & Zhang, Y. (2018). Examining the relationship between household vehicle ownership and ridesharing behaviors in the united states. *Sustainability*, *10*(8), 2720. https://doi.org/10.3390/su10082720

Zhao, C., Sun, Y., Ding, J., & Wang, K. (2025). The optimal government policy towards carpooling market: A differential game analysis considering carbon emission reduction.

Transportation Research Part A Policy and Practice, *204*, 104816. https://doi.org/10.1016/j.tra.2025.104816

Zhou, T., Zhang, J., Peng, L., & Zhang, S. (2022). Exploring the determinants of public transport usage and shared mobilities: A case study from nanchang, china. *Sustainable Cities and Society*, *87*, 104146. https://doi.org/10.1016/j.scs.2022.104146

Zhou, Y., Huang, Y., Wang, Y., Xu, X., Yu, Z., & Gu, Y. (2024). Theoretical domains framework: A bibliometric and visualization analysis from 2005-2023. *Journal of Multidisciplinary Healthcare*, *Volume 17*, 4055–4069. https://doi.org/10.2147/jmdh.s470223

Zuid-Holland Bereikbaar. (2024, October). *Zuid-holland bereikbaar*. https://www.zuidhollandbereikbaar.nl/media/site/3bccd25e66-1734607211/jaarplan-zhb-2025.pdf

A

Screening process literature

Table A.1: Reasons for excluding articles from the literature review regarding psychological factors.

Reasons for exclusion	**Frequency (n=30)**
Research on ride-hailing (professional driver)	7
Research on carpooling with autonomous vehicles	5
Research on carpooling during Covid-19	3
Meta-analyses without specific references	2
Research on ride-sharing algorithms	1
Research on trip-planning tools	1
Research on managed lane use	1
Research on experience of professional drivers	1
Research on drivers' fatigue	1
Research on mood during travel	1
Research on paratransit services	1
Research on public bike-and-ride	1
Research on high-speed railway hubs	1
Research on rollercoaster experience	1
Research on the use of Virtual Reality	1
Research paper inaccessible	1

Table A.2: Reasons for excluding articles from the literature review regarding contextual factors.

Reasons for exclusion	**Frequency (n=22)**
Research on ride-sourcing	4
Research on carpooling among older adults	2
Research on trip-planning tools	2
Research on traffic prediction	2
Research on MaaS (Mobility as a Service)	1
Research on car-sharing	1
Research on carpooling for childhood immunization	1
Research on carpooling among high school students	1
Research on park and ride	1
Research on bike and ride	1
Research on intelligent transport systems	1
Research on the sharing economy, specifically Airbnb	1
Research on sustainable mobility (too broad)	1
Research on impaired driving	1
Research on coaches' leadership in youth sport	1
Research on irrigation experiments	1

B

Theoretical Domains Framework

Table B.1: Description of Domains TDF – table reproduced from Cane et al. (2014).

Domain	**Definition**
1. Knowledge	An awareness of the existence of something.
2. Skills	An ability or proficiency acquired through practice.
3. Social/Professional Role and Identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting.
4. Beliefs about Capabilities	Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use.
5. Optimism	The confidence that things will happen for the best or that desired goals will be attained.
6. Beliefs about Consequences	Acceptance of the truth, reality, or validity about outcomes of a behaviour in a given situation.
7. Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus.
8. Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way.

Continued on next page

Domain	Definition
9. Goals	Mental representations of outcomes or end states that an individual wants to achieve.
10. Memory, Attention and Decision Processes	The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives.
11. Environmental Context and Resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behaviour.
12. Social Influences	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours.
13. Emotion	A complex reaction pattern - experiential, behavioural, and physiological - by which the individual attempts to deal with a personally significant matter or event.
14. Behavioural Regulation	Anything aimed at managing or changing objectively observed or measured actions.

C

Actor scan

Table C.1: Overview of actors based on actor scan.

Sector	Actor	Description	Reference
	Ministry of Infrastructure & Water Management	National governmental organization with a broad view on improving the Dutch mobility system	(Ministerie van Infrastructuur en Waterstaat, 2023))
Governmental organisations	Directorate-General Mobility	Falls under the Ministry of I&W and works on Dutch mobility	(Ministerie van Infrastructuur en Waterstaat, 2025)
	Rijkswaterstaat	Plays an important role in the transition toward sustainable mobility	(Rijkswaterstaat, 2025a)
	IPO (Inter Provinciaal Overleg)	Collaboration of Dutch provinces aiming for high accessibility	(Verhul et al., 2019)

Continued on next page

Sector	Actor	Description	Reference
	VNG (Vereniging Nederlandse Gemeenten)	Collaboration of all Dutch municipalities working on just mobility transitions	(VNG, 2023)
	Province of Zuid-Holland	Aims for a sustainable and accessible province	(Provincie Zuid-Holland, n.d.)
	ZHB (Zuid-Holland Bereikbaar)	Collaboration of public organisations striving for an accessible province	(Zuid-Holland Bereikbaar, 2024)
	Metropoolregio Rotterdam Den Haag	Collaboration of municipalities aiming for sustainable mobility	(CE Delft and Goudappel, 2021)
	Municipality of The Hague	Aims for a sustainable and accessible municipality	(Gemeente Den Haag, 2021)
Facilitators	BlaBlaCar	Ride-matching app that matches carpoolers based on travel behaviour	(BlaBlaCar, 2019)
	Karos	Ride-matching app that matches carpoolers based on travel behaviour	(Brainport Bereikbaar, 2025)
	Nabogo	Ride-matching app that matches carpoolers based on travel behaviour	(Nabogo, 2025)
	Swidg	Ride-matching app that matches carpoolers based on travel behaviour	(Brainport Bereikbaar, 2025)
Businesses	Employers	Can support, facilitate, or encourage carpooling among commuters	-

Continued on next page

Sector	Actor	Description	Reference
	Coalitie Anders Reizen	Collaboration of 70 organisations striving for sustainable mobility	(Coalitie Anders Reizen, 2026)
Citizens	Commuters	People who travel to or from work	-
Knowledge institutes	KiM (Kennisinstituut voor Mobiliteit)	Provides knowledge and advice to the Ministry of I&W	(KiM, 2026)
	CROW	Strives for a safe, sustainable, and accessible environment	(CROW, n.d.)
	Milieu Centraal	Informs citizens on sustainability in daily life	(Milieu Centraal, 2025)
Overarching organisations	Mobiliteitsalliantie	Consists of 24 parties with broad mobility goals	(Mobiliteitsalliantie, 2023)
	DMI (Dutch Metropolitan Innovations)	Collaboration of public and private parties working on future mobility	(DMI, n.d.)
	Stichting Gedeeld Autogebruik / Vereniging Deelauto	Facilitates shared use of cars	(Bootsma and Schijndel, 2000)
Interest groups	Stichting Natuur en Milieu	Strives for sustainable mobility	(Natuur & Milieu, 2023)
	ANWB	Represents the interests of drivers	(Bootsma and Schijndel, 2000)
Other	VVN (Veilig Verkeer Nederland)	Works on a safe mobility system	(Bootsma and Schijndel, 2000)

D

Interview Guideline

D.1. Interview guideline in Dutch

Opening

Bedankt voor het deelnemen aan dit onderzoek. Ik waardeer het enorm dat je hier tijd voor wilt vrijmaken. Ik zal eerst kort het doel van het onderzoek uitleggen en daarna heb 7 vragen voorbereid over de rol van <organisatie>, de verschillende actoren die betrokken zijn, het proces dat een forens doormaakt als hij/zij besluit om te carpoolen en de effectiviteit van beleidsinterventies. Je mag mij onderbreken als je een pauze wilt of als je wil dat ik een vraag verduidelijk.

Heb ik je toestemming om de opname te starten en te beginnen met het interview?

Aanleiding

Het doel van dit onderzoek is om het besluitvormingsproces van forenzen te begrijpen. Hierbij ga ik kijken naar het reisgedrag van forenzen en hoe dit wordt beïnvloed door het gedrag van andere actoren. In dit interview wil ik graag inzicht krijgen in jouw professionele perspectief op het gedrag van forenzen met betrekking tot carpoolen. Er zijn geen goede of foute antwoorden.

Introductie

Allereerst, wil ik graag meer weten over jouw werk bij <organisatie> en de rol van <organisatie> in het algemeen.

1. Wat houdt jouw werk bij <organisatie> in?
    - Hoe bent/was jij betrokken bij het stimuleren van carpoolen onder forenzen?
2. Wat is/was de rol van <organisatie> als het gaat over carpoolen?

- Wat is/was het doel van <pogingen die zijn genoemd>?

Actoren

Dan wil ik nu graag met je praten over de verschillende actoren die betrokken zijn.

1. Welke actoren beïnvloeden het besluitvormingsproces van forenzen (dus of zij wel of niet gaan carpoolen)?
    - Je noemde <actor>; wat is het doel van deze actor?
    - Wat doet deze <actor> om dat doel te behalen?
    - Hoe interacteert deze actor met andere actoren die je hebt genoemd?

Proces en factoren

Nu we het hebben gehad over de actoren die betrokken zijn bij het reisgedrag van forenzen, wil ik graag overgaan op het proces dat een forens doormaakt als hij/zij wel of niet besluit om te carpoolen.

1. Hoe ziet het besluitvormingsproces van een forens eruit?
    - Wat zijn de verschillende stappen binnen dit proces?
    - Hoe verschilt het proces van een carpooler van andere forenzen?
    - Hoe verschilt het proces van iemand die zich aanbiedt als automobilist van iemand die mee zou willen rijden?
2. Welke factoren zijn volgens jou van invloed op het gedrag van forenzen in de verschillende processtappen die je hebt genoemd?
    - Waarom denk je dat <factor> van invloed is?
    - Is <factor> van invloed op andere factoren die van invloed zijn?

Beleidsinterventies

Als laatst wil ik het graag nog met je hebben over het effect van beleidsinterventies.

1. Welke interventies of incentives zouden volgens jou effectief kunnen zijn in het stimuleren van carpoolen onder forenzen?
    - Welke niet?

Open vraag

1. Is er iets dat we niet hebben besproken, maar u wel graag zou willen delen met betrekking tot dit onderzoek?

Afsluiting

We zijn aangekomen bij het eind van het interview. Nogmaals bedankt voor uw deelname. Ik heb nog een paar vragen met betrekking tot het verwerken van de resultaten van het interview en het verdere onderzoek.

- Binnen 2 weken zal ik een anonieme samenvatting van het interview met u delen. Als u aanvullingen of correcties heeft op deze samenvatting, ontvang ik deze graag binnen 4 weken na ontvangst van de samenvatting.
- De anonieme samenvatting zal als bijlage aan het onderzoeksrapport worden gevoegd.
- Kent u verder nog mensen die interessant zouden zijn voor mij om te interviewen?

Als onderdeel van dit onderzoek zal ik ook een behavioural system map construeren. In deze map, breng ik de verschillende actoren en hun gedraging in kaart om zo inzicht te krijgen in de verschillende factoren en interacties die van invloed zijn op het gedrag van forenzen.

- Om deze behavioural system map te evalueren en valideren en mogelijke beleidsinterventies te identificeren, organiseer ik een 2-uur durende workshop eind april. Zou u interesse hebben om deel te nemen aan zo'n workshop?

D.2. Interview guideline in English

Opening statement

Thank you for participating in this study. I really appreciate you taking the time for this. I have prepared 7 questions on the role of <organisation>, the different actors that are involved, the decision process of a commuter and the effectiveness of interventions. Please feel free to interrupt me at any time if you would like to take a break or if you would like me to clarify a question.

Do I have your permission to start the recording and transition to the start of the interview?

Motivation

The goal of this study is to understand commuter decision-making. I am going to analyse the travel behaviour of commuters and how this is influenced by the behaviour of other actors. In this interview I would like to gain insights into your professional perspective on the behaviour of commuters regarding carpooling.

Introduction

First, I would like to know more about your work at <organisation> and the role of <organisation> in general.

1. What did your work at <organisation> entail?

- How were you involved in encouraging carpooling among commuters?

2. What is/was the role of <organisation> when it comes to carpooling?
    - What is/was the goal of <mentioned efforts>?

Actors

Then, I would like to move on to the different actors that are involved.

1. Which actors influence the decision-making process of a commuter?
    - You mentioned <actor>; what are the objectives of this actor?
    - What does this actor do to reach these objectives?
    - How does this actor interact with the other actors you mentioned?

Process and factors

Now we have discussed the different actors, I would like to ask you about the decision-making process a commuter goes through when deciding to carpool.

1. What does the decision-making process of a commuter look like?
    - What are distinctive decision steps in this process?
    - How does the process of a carpooler differ from other commuters?
    - How does the decision making process differ between a driver and a passenger?
2. Which factors influence the behaviour of commuters in the different process steps you mentioned?
    - Why do you think that <factor> is of influence?
    - Is <factor> connected to other factors or behaviours that are of influence?

Interventions

At last, I would like to talk with you about the effect of policy interventions.

1. Which interventions or incentives would be effective in encouraging carpooling among commuters?
    - Which not?

Open question

1. Is there anything that we haven't discussed that you would like to share regarding this study?

Closing

We are at the end of our interview. Thank you very much for your participation. I have a few more questions about the processing of the interview results and the study itself.

- Within 2 weeks I will share an anonymous summary of the interview. If you would like to make any additions or corrections, please let me know within 4 weeks after you received the summary.
- The anonymous summary will be attached to the research report as an appendix.
- Are there any other people that you think should be interviewed for this study on car-pooling among commuters?

As part of this study, I will construct a behavioural system map. This map will provide an overview of the different factors and interactions that are of influence on the behaviour of commuters.

- To review and validate this map and identify potential policy interventions, I we organise a 2-hour workshop in the end of April. Would you be willing to participate in such a workshop?

E

Human Research Ethics Committee documents

This appendix contains all documents for the process of obtaining approval from the Human Research Ethics Committee for conducting interviews and organising an expert workshop. The approval number is 6406.

E.1. Human Research Ethics Checklist for human research

Delft University of Technology
HUMAN RESEARCH ETHICS
CHECKLIST FOR HUMAN RESEARCH
(Version January 2022)

IMPORTANT NOTES ON PREPARING THIS CHECKLIST

1. An HREC application should be submitted for every research study that involves human participants (as Research Subjects) carried out by TU Delft researchers
2. Your HREC application should be submitted and approved **before** potential participants are approached to take part in your study
3. All submissions from Master's Students for their research thesis need approval from the relevant Responsible Researcher
4. The Responsible Researcher must indicate their approval of the completeness and quality of the submission by signing and dating this form OR by providing approval to the corresponding researcher via email (included as a PDF with the full HREC submission)
5. There are various aspects of human research compliance which fall outside of the remit of the HREC, but which must be in place to obtain HREC approval. These often require input from internal or external experts such as Faculty Data Stewards, Faculty HSE advisors, the TU Delft Privacy Team or external Medical research partners.
6. You can find detailed guidance on completing your HREC application here
7. Please note that incomplete submissions (whether in terms of documentation or the information provided therein) will be returned for completion **prior to any assessment**
8. If you have any feedback on any aspect of the HREC approval tools and/or process you can leave your comments here

I. Applicant Information

PROJECT TITLE:	Adoption of Carpooling
Research period: *Over what period of time will this specific part of the research take place*	02-02-2026 – 26-06-2026
Faculty:	Technology, Policy & Management
Department:	Multi-actor systems
Type of the research project: *(Bachelor's, Master's, DreamTeam, PhD, PostDoc, Senior Researcher, Organisational etc.)*	Master thesis
Funder of research: *(EU, NWO, TUD, other – in which case please elaborate)*	N/A
Name of Corresponding Researcher: *(If different from the Responsible Researcher)*	Simone Hoogendijk
Position of Corresponding Researcher: *(Masters, DreamTeam, PhD, PostDoc, Assistant/ Associate/ Full Professor)*	Master student
Name of Responsible Researcher: ***Note:*** *all student work must have a named Responsible Researcher to approve, sign and submit this application*	Gerdien de Vries
Position of Responsible Researcher : *(PhD, PostDoc, Associate/ Assistant/ Full Professor)*	Full Professor

II. Research Overview

NOTE: *You can find more guidance on completing this checklist here*

a) Please summarise your research very briefly (100-200 words)

What are you looking into, who is involved, how many participants there will be, how they will be recruited and what are they expected to do?

Add your text here – (please avoid jargon and abbrevations)
This research focuses on the adoption of carpooling among commuters, using a system-level approach. By adopting a multi-actor perspective, this study aims to gain insights into the behavioural interactions between various stakeholders. The goal is to guide policy-makers in designing measures that encourage the adoption of carpooling among commuters. To this end, a behavioural system map will be constructed, providing insights in carpool behaviour on a system level. This will be done by reviewing literature, conducting semi-structured interviews and organizing an expert workshop. The recruitment of participants will be done through my own network. The interviews will be held either physical or online. The expert workshop will be held in person. For all meetings Microsoft Teams will be used for recording and transcribing.

b) **If your application is an additional project** related to an existing approved HREC submission, please provide a brief explanation including the existing relevant HREC submission number/s.

Add your text here – (please avoid jargon and abbrevations)

N/A

c) **If your application is a simple extension of, or amendment to,** an existing approved HREC submission, you can simply submit an HREC Amendment Form as a submission through LabServant.

III. Risk Assessment and Mitigation Plan

NOTE: *You can find more guidance on completing this checklist here*

Please complete the following table in full for all points to which your answer is "yes". Bear in mind that the vast majority of projects involving human participants as Research Subjects also involve the collection of **Personally Identifiable Information (PII)** and/or **Personally Identifiable Research Data (PIRD)** which may pose potential risks to participants as detailed in Section G: Data Processing and Privacy below.

To ensure alighment between your risk assessment, data management and what you agree with your Research Subjects you can use the last two columns in the table below to refer to specific points in your Data Management Plan (DMP) and Informed Consent Form (ICF) – **but this is not compulsory**.

It's worth noting that **you're much more likely to need to resubmit your application if you neglect to identify potential risks**, than if you identify a potential risk and demonstrate how you will mitigate it. If necessary, the HREC will always work with you and colleagues in the Privacy Team and Data Management Services to see how, if at all possible, your research can be conducted.

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
A: Partners and collaboration						
1. Will the research be carried out in collaboration with additional organisational partners such as: • One or more collaborating research and/or commercial organisations • Either a research, or a work experience internship provider[1] [1] *If yes, please include the graduation agreement in this application*	**X**		The personal data of participants could be leaked or accessed by unauthoirsed parties.	The data will be stored on the TU Delft One Drive. All data will be password-protected. The data will not be shared outside of the research team of TU Delft. Only aggregated and anonymous results will be presented.	p.2-3, p. 6	
2. Is this research dependent on a Data Transfer or Processing Agreement with a collaborating partner or third party supplier? *If yes please provide a copy of the signed DTA/DPA*		**X**				
3. Has this research been approved by another (external) research ethics committee (e.g.: HREC and/or MREC/METC)? *If yes, please provide a copy of the approval (if possible) and summarise any key points in your Risk Management section below*		**X**				
B: Location						

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
4. Will the research take place in a country or countries, other than the Netherlands, within the EU?		**X**				
5. Will the research take place in a country or countries outside the EU?		**X**				
6. Will the research take place in a place/region or of higher risk – including known dangerous locations (in any country) or locations with non-democratic regimes?		**X**				
C: Participants						
7. Will the study involve participants who **may** be vulnerable and possibly (legally) unable to give informed consent? (e.g., children below the legal age for giving consent, people with learning difficulties, people living in care or nursing homes,).		**X**				
8. Will the study involve participants who **may** be vulnerable under specific circumstances and in specific contexts, such as victims and witnesses of violence, including domestic violence; sex workers; members of minority groups, refugees, irregular migrants or dissidents?		**X**				
9. Are the participants, outside the context of the research, in a dependent or subordinate position to the investigator (such as own children, own students or employees of either TU Delft and/or a collaborating partner organisation)? *It is essential that you safeguard against possible adverse consequences of this situation (such as allowing a student's failure to participate to your satisfaction to affect your evaluation of their coursework).*		**X**				
10. Is there a high possibility of re-identification for your participants? (e.g., do they have a very specialist job of which there are only a small number in a given country, are they members of a small community, or employees from a partner company collaborating in the research? Or are they one of only a handful of (expert) participants in the study?		**X**				
D: Recruiting Participants						
11. Will your participants be recruited through your own, professional, channels such as conference attendance lists, or through specific network/s such as self-help groups	**X**		The personal data of participants could be leaked or accessed by unauthoirsed parties.	The data will be stored on the TU Delft OneDrive. All data will be password-protected. All personal data will be preserved until the end date of the overarching research project in May 2028. The data will not be shared outside of the research team. Only aggregated results will be presented.	p. 7	
12. Will the participants be recruited or accessed in the longer term by a (legal or customary) gatekeeper? (e.g., an adult professional working with children; a		**X**				

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
community leader or family member who has this customary role – within or outside the EU; the data producer of a long-term cohort study)						
13. Will you be recruiting your participants through a crowd-sourcing service and/or involve a third party data-gathering service, such as a survey platform?		**X**				
14. Will you be offering any financial, or other, remuneration to participants, and might this induce or bias participation?		**X**				
E: Subject Matter *Research related to medical questions/health may require special attention. See also the website of the CCMO before contacting the HREC.*						
15. Will your research involve any of the following: • Medical research and/or clinical trials • Invasive sampling and/or medical imaging • Medical and *In Vitro Diagnostic Medical* Devices Research		**X**				
16. Will drugs, placebos, or other substances (e.g., drinks, foods, food or drink constituents, dietary supplements) be administered to the study participants? *If yes see here to determine whether medical ethical approval is required*		**X**				
17. Will blood or tissue samples be obtained from participants? *If yes see here to determine whether medical ethical approval is required*		**X**				
18. Does the study risk causing psychological stress or anxiety beyond that normally encountered by the participants in their life outside research?		**X**				
19. Will the study involve discussion of personal sensitive data which could put participants at increased legal, financial, reputational, security or other risk? (e.g., financial data, location data, data relating to children or other vulnerable groups) *Definitions of sensitive personal data, and special cases are provided on the TUD Privacy Team website.*		**X**				
20. Will the study involve disclosing commercially or professionally sensitive, or confidential information? (e.g., relating to decision-making processes or business strategies which might, for example, be of interest to competitors)	**X**		The information collected can pose reputational risks to the participants and their organisation.	Informed consent is required and will be collected. Participants will be informed about collection, processing and storage of data. Data will be de-identified and anonymized. All data stored on password-protected storage with access limited to researchers on the project.	p. 5-6	
21. Has your study been identified by the TU Delft Privacy Team as requiring a Data Processing Impact Assessment (DPIA)? *If yes please attach the advice/ approval from the Privacy Team to this application*		**X**				

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
22. Does your research investigate causes or areas of conflict? *If yes please confirm that your fieldwork has been discussed with the appropriate safety/security advisors and approved by your Department/Faculty.*		**X**				
23. Does your research involve observing illegal activities or data processed or provided by authorities responsible for preventing, investigating, detecting or prosecuting criminal offences *If so please confirm that your work has been discussed with the appropriate legal advisors and approved by your Department/Faculty.*		**X**				
F: Research Methods						
24. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g., covert observation of people in non-public places).		**X**				
25. Will the study involve actively deceiving the participants? (For example, will participants be deliberately falsely informed, will information be withheld from them or will they be misled in such a way that they are likely to object or show unease when debriefed about the study).		**X**				
26. Is pain or more than mild discomfort likely to result from the study? And/or could your research activity cause an accident involving (non-) participants?		**X**				
27. Will the experiment involve the use of devices that are not 'CE' certified? *Only, if 'yes': continue with the following questions:*		**X**				
• Was the device built in-house?						
• Was it inspected by a safety expert at TU Delft? *If yes, please provide a signed device report*						
• If it was not built in-house and not CE-certified, was it inspected by some other, qualified authority in safety and approved? *If yes, please provide records of the inspection*						
28. Will your research involve face-to-face encounters with your participants and if so how will you assess and address Covid considerations?	**X**		The Covid virus can be passed on between the researcher and the participant, which could lead to illness.	When someone has Covid-related symptoms, the interview or workshop will be rescheduled to another moment or moved online.		
29. Will your research involve **either:** a) "big data", combined datasets, new data-gathering or new data-merging techniques which might lead to re-identification of your participants **and/or** b) artificial intelligence or algorithm training where, for example biased datasets could lead to biased outcomes?		**X**				

			If YES please complete the Risk Assessment and Mitigation Plan columns below.		*Please provide the relevant reference #*	
ISSUE	**Yes**	**No**	**RISK ASSESSMENT – what risks could arise?** *Please ensure that you list ALL of the actual risks that could potentially arise – do not simply state whether you consider any such risks are important!*	**MITIGATION PLAN – what mitigating steps will you take?** *Please ensure that you summarise what actual mitigation measures you will take for each potential risk identified – do not simply state that you will e.g. comply with regulations.*	**DMP**	**ICF**
G: Data Processing and Privacy						
30. Will the research involve collecting, processing and/or storing any directly identifiable PII (Personally Identifiable Information) including name or email address that will be used for administrative purposes only? (eg: obtaining Informed Consent or disbursing remuneration)	**X**		There are risks of participant identification and data loss or leakage.	The data will only be accessed by TU Delft researchers involved in the project and stored on the password-protected TU Delft OneDrive.	p. 5-7	
31. Will the research involve collecting, processing and/or storing any directly or indirectly identifiable PIRD (Personally Identifiable Research Data) including videos, pictures, IP address, gender, age etc and **what other Personal Research Data** (including personal or professional views) will you be collecting?	**X**		The research will collect the name, email address, phone number and job description of the participants. There are risks of participant identification and data loss or leakage.	The data will only be accessed by TU Delft researchers involved in the project and stored on the password-protected TU Delft OneDrive.	p. 5-7	
32. Will this research involve collecting data from the internet, social media and/or publicly available datasets which have been originally contributed by human participants		**X**				
33. Will your research findings be published in one or more forms in the public domain, as e.g., Masters thesis, journal publication, conference presentation or wider public dissemination?	**X**		There are identification risks due to information in the publication.	Only aggregated data and anonmised quotes will be included in the publication. Otherwise, informed consent will be collected from the participant before publication.	p. 5-7	
34. Will your research data be archived for re-use and/or teaching in an open, private or semi-open archive?	**X**		Accidentally revealing the ID participants in the supplementary material.	The supplementary material only contains protocol related information.	p. 5-7	

H: More on Informed Consent and Data Management

NOTE: *You can find guidance and templates for preparing your Informed Consent materials) here*

Your research involves human participants as Research Subjects if you are recruiting them or actively involving or influencing, manipulating or directing them in any way in your research activities. This means you must seek informed consent and agree/ implement appropriate safeguards regardless of whether you are collecting any PIRD.

Where you are also collecting PIRD, and using Informed Consent as the legal basis for your research, you need to also make sure that your IC materials are clear on any related risks and the mitigating measures you will take – including through responsible data management.

Got a comment on this checklist or the HREC process? You can leave your comments here

IV. Signature/s

Please note that by signing this checklist list as the sole, or Responsible, researcher you are providing approval of the completeness and quality of the submission, as well as confirming alignment between GDPR, Data Management and Informed Consent requirements.

Name of Corresponding Researcher (if different from the Responsible Researcher) (print)

Simone Hoogendijk

Signature of Corresponding Researcher: 

Date: 12-01-2026

Name of Responsible Researcher (print)

Gerdien de Vries

Signature (or upload consent by mail) Responsible Researcher: 

Date: 13.01.2026

V. Completing your HREC application

Please use the following list to check that you have provided all relevant documentation

Required:

- **Always:** This completed HREC checklist
- **Always:** A data management plan (reviewed, where necessary, by a data-steward)
- **Usually:** A complete Informed Consent form (including Participant Information) and/or Opening Statement (for online consent)

E.2. Data Management plan

Plan Overview

A Data Management Plan created using DMPonline

Title: Adoption of Carpooling

Creator: Simone Hoogendijk

Principal Investigator: Simone Hoogendijk

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2025)

Project abstract:

This research focuses on the adoption of carpooling among commuters, using a system-level approach. By adopting a multi-actor perspective, this study aims to gain insights into the behavioural interactions between various stakeholders. The goal is to guide policy-makers in designing measures that encourage the adoption of carpooling among commuters. To this end, a behavioural system map will be constructed, providing insights in carpool behaviour on a system level. This will be done by reviewing literature, conducting semi-structured interviews and organizing an expert workshop. The recruitment of participants will be done through my own network. The interviews will be held either physical or online. The expert workshop will be held in person. For all meetings Microsoft Teams will be used for recording and transcribing.

ID: 194711

Start date: 02-02-2026

End date: 26-06-2026

Last modified: 13-01-2026

Adoption of Carpooling

0. Administrative questions

1. Provide the name of the data management support staff consulted during the preparation of this plan and the date of consultation. Please also mention if you consulted any other support staff.

Nicolas Dintzner, Data Steward at the Faculty of Technology, Policy & Management, has reviewed this DMP on 12-01-2026.

2. Is TU Delft the lead institution for this project?

- Yes, leading the collaboration – please provide details of the type of collaboration and the involved parties below

TU Delft is the lead institution of this project. The Ministry of Infrastructure & Water Management is an external party that contributes to this research by providing advise, existing data on carpool behaviour and potential experts and policy-makers to interview.

I. Data/code description and collection or re-use

3. Provide a general description of the types of data/code you will be working with, including any re-used data/code.

Type of data/code	**File format(s)**	**How will data/code be collected/generated?** *For re-used data/code: what are the sources and terms of use?*	**Purpose of processing**	**Storage location**	**Who will have access to the data/code?**
Interview/workshop recordings	.mp4	Microsoft Teams recording	Gain insights from policy-makers and experts in the field and to capture their opinion.	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.

Interview/workshop transcriptions	.docx	Microsoft Teams recording and transcription notes	Process research data for analysis.	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.
Workshop notes	.docx	Self-written notes	Process opinions from experts on the behavioural system map.	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.
Summary of interviews	.docx	Self-written summary of interview data	Translate interview results in key takeaways	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.
Summary of workshop results	.docx	Self-written summary of workshop results	Translate workshop results in key points of refinement of the behavioural system map	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.

Personally Identifiable Information (PII) of participants: name, email	.xlsx	Contact information for participants taking part in interviews or workshop received through the recruitment process	For administrative purposes: obtaining consent and communicating with participants.	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.
Informed consent forms	.pdf	Informed consent forms signed digitally	To obtain and document informed consent.	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.
Code book of Atlas.TI. This will include data on participants' opinion on carpool behaviour among commuters.	.altas.project	Created by the research team	Analyse interview results	TU Delft Onedrive - Microsoft Teams	The TU Delft project team (researcher, supervisors, external advisor) consisting of Simone Hoogendijk, Gerdien de Vries, Lisa Scholten, Kai Bellmann.

II. Storage and backup during the research process

4. How much data/code storage will you require during the project lifetime?

- < 250 GB

5. Where will the data/code be stored and backed-up during the project lifetime? (Select all that apply.)

- TU Delft OneDrive

III. Data/code documentation

6. What documentation will accompany data/code? (Select all that apply.)

- Procedure – A description of data processing procedure(s) (such as laboratory setup, simulation workflows).
- Data – Methodology of data collection

IV. Legal and ethical requirements, code of conducts

7. Does your research involve human subjects or third-party datasets collected from human participants?

If you are working with a human subject(s), you will need to obtain the HREC approval for your research project.

- Yes – please provide details in the additional information box below

Both the semi-structured interviews and the expert workshop will include human participants.

8. Will you work with personal data? (This is information about an identified or identifiable natural person, either for research or project administration purposes.)

- Yes

9. Will you work with any other types of confidential or classified data or code as listed below? (Select all that apply and provide additional details below.)

If you are not sure which option to select, ask your Faculty Data Steward for advice.

- Yes, politically-sensitive data (such as research commissioned by public authorities, research in social issues)

10. How will ownership of the data and intellectual property rights to the data be managed?

For projects involving commercially-sensitive research or research involving third parties, seek advice of your Faculty Contract Manager when answering this question.

The intellectual property rights are framed by a graduation agreement between Delft University of Technology, myself and the Ministry of Infrastructure & Water management.

11. Which personal data or data from human participants do you work with? (Select all that apply.)

- Proof of consent (such as signed consent materials which contain name and signature)
- Audio recordings
- Video materials
- Job title and/or employer
- Telephone number, email addresses and/or other addresses as contact details for administrative purposes
- Names as contact details for administrative purposes

12. Please list the categories of data subjects and their geographical location.

The participants of the interviews and workshop will be policy-makers and transport behaviour experts located in the Netherlands.

13. Will you be receiving personal data from or transferring personal data to third parties (groups of individuals or organisations)?

- No

16. What are the legal grounds for personal data processing?

- Informed consent

17. Please describe the informed consent procedure you will follow below.

The researcher will inform the potential participants about the goals and procedures of the research project. The researcher will also inform them about the personal data that are being processed and for what purpose. This information will be provided to the potential participants as follows: a digital copy of the information will be emailed to participants before the interview or expert workshop. All

participants will be asked for their consent for taking part in the study and for data processing by signing a digital informed consent form before the start of the interview or expert workshop.

18. Where will you store the physical/digital signed consent forms or other types of proof of consent (such as recording of verbal consent)?

The digital signed consent forms will be stored on the TU Delft One Drive.

19. Does the processing of the personal data result in a high risk to the data subjects? (Select all that apply.)

If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data in your research project.

If any category applies, please provide additional information in the box below. Likewise, if you collect other type of potentially sensitive data, or if you have any additional comments, include these in the box below.

If one or more options listed below apply, your project might need a DPIA. Please get in touch with the Privacy team (privacy-tud@tudelft.nl) to get advice as to whether DPIA is necessary.

- None of the above apply

23. What will happen with the personal data used in the research after the end of the research project?

- Anonymised or aggregated data will be shared with others

24. For how long will personal research data (including pseudonymised data) be stored?

- Other – please state the duration and explain the rationale below

Personal data will be preserved until the end date of the overarching research project in May 2028.

25. How will your study participants be asked for their consent for data sharing?

- In the informed consent form: participants are informed that their personal data will be

anonymised and that the anonymised dataset is shared publicly

V. Data sharing and long term preservation

27. Apart from personal data mentioned in question 23, will any other data be publicly shared?

Please provide a list of data/code you are going to share under 'Additional Information'.

- All other non-personal data/code underlying published articles/reports/theses

29. How will you share research data/code, including those mentioned in question 23?
Select all that apply and provide additional details below.

- All anonymised or aggregated data, and/or all other non-personal data/code will be uploaded to 4TU.ResearchData with public access

30. How much of your data/code will be shared in a research data repository?

- < 100 GB

31. When will the data/code be shared?

- As soon as corresponding results (papers, theses, reports) are published

32. Under what licence(s) will the data/code be released?

- CC BY-SA

VI. Data management responsibilities and resources

33. If you leave TU Delft (or are unavailable), who is going to be responsible for the data/code resulting from this project?

My external advisor Kai Bellmann, PhD student at the faculty of Technology, Policy & Management,

34. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

Not applicable.

35. Which faculty do you belong to?

- Faculty of Technology, Policy and Management (TPM)

E.3. Informed consent form interviews

Dear participant,

You are being invited to participate in a research study titled The Adoption of Carpooling. This study is being done by Simone Hoogendijk from the TU Delft. The Ministry of Infrastructure & Water management is a collaborating partner that has a an advisory role. The purpose of this research study is to gain insights in the behavioural interactions of various actors within the carpooling system. We will be asking you to talk about your view on carpooling behaviour among commuters and how this behaviour is affected by the behaviour of other actors or external influences.

The interview will be recorded and transcribed through Microsoft Teams for processing purposes. The recording and transcription will be stored on an institutional TU Delft storage, accessible only to the research team of the TU Delft. The information you provide will be aggregated with input from other participants and will be presented in an anonymous manner in a scientific publication and/or education material. This might include the use of anonymised quotes, in which only a general job description or field of expertise is mentioned. The interview will take approximately 60 minutes to complete.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by storing all personal data in an institutional TU Delft storage, accessible only to the research team. The data collected will be preserved until the end date of the overarching research project in May 2028. The data will be used for scientific research and publication, as well as educational activities. You will be anonymous in all outputs.

After the interview, we will produce an anonymous summary of the conversation. The summary will be sent to you within 2 weeks of the interview, and you will be welcome to suggest modifications to it. Be aware that this summary will be included in the MSc thesis, which will be public.

Your participation in this study is entirely voluntary and you can withdraw at any time. If you decide to withdraw, we will make every reasonable effort to remove your data. You are free to omit any questions.

If you have any questions regarding data handling or information provided, feel free to contact the research team:

Please tick the approprite boxed below to provide explicit consent

Participation and Study Characteristics	**Yes**	**No**
I have read and understood the study information or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐

I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions and I can withdraw from the study at any time, without having to give a reason.	☐	☐
Research publication	**Yes**	**No**
I understand that personal information collected about me that can identify me will not be shared beyond the research team of the TU Delft.	☐	☐
I understand that after the research study the de-identified information I provide will be used for academic research publications.	☐	☐
I agree that my responses, views or other input can be quoted anonymously in research outputs, by only using a general job description or field of expertise.	☐	☐

I have read and understood the study information and I consent to participate and agree to the personal data processing described above.

_____ _____ _____

Name of participant Signature Date

E.4. Informed consent form workshop

Dear participant,

You are being invited to participate in a research study titled The Adoption of Carpooling. This study is being done by Simone Hoogendijk from the TU Delft. The Ministry of Infrastructure & Water management is a collaborating partner that has a an advisory role. The purpose of this research study is to gain insights in the behavioural interactions of various actors within the carpooling system. We will be asking you to revise a behavioural system map that is constructed during this project and talk about your view on carpooling behaviour among commuters.

The workshop will be recorded and transcribed through Microsoft Teams for processing purposes. The recording and transcription will be stored on an institutional TU Delft storage, accessible only to the research team of the TU Delft. The information you provide will be aggregated with input from other participants and will be presented in an anonymous manner in a scientific publication and/or education material. This might include the use of anonymised quotes, in which only a general job description or field of expertise is mentioned. The workshop will take approximately 120 minutes to complete.

As with any online activity the risk of a breach is always possible. To the best of our ability your answers in this study will remain confidential. We will minimize any risks by storing all personal data in an institutional TU Delft storage, accessible only to the research team. The data collected will be preserved until the end date of the overarching research project in May 2028. The data will be used for scientific research and publication, as well as educational activities. You will be anonymous in all outputs.

After the workshop, we will produce an anonymous summary of the conversation. The summary will be sent to you within 2 weeks of the workshop, and you will be welcome to suggest modifications to it. Be aware that this summary will be included in the MSc thesis, which will be public.

Your participation in this study is entirely voluntary and you can withdraw at any time. If you decide to withdraw, we will make every reasonable effort to remove your data.

If you have any questions regarding data handling or information provided, feel free to contact the research team:

Please tick the appropriate boxed below to provide explicit consent

Participation and Study Characteristics	**Yes**	**No**
I have read and understood the study information or it has been read to me. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	☐	☐
I consent voluntarily to be a participant in this study and understand that I can withdraw from the study at any time, without having to give a reason.	☐	☐
Research publication	**Yes**	**No**

I understand that personal information collected about me that can identify me will not be shared beyond the research team of the TU Delft.	☐	☐
I understand that after the research study the de-identified information I provide will be used for academic research publications.	☐	☐
I agree that my responses, views or other input can be quoted anonymously in research outputs, by only using a general job description or field of expertise.	☐	☐

I have read and understood the study information and I consent to participate and agree to the personal data processing described above.

_____ _____ _____

Name of participant Signature Date

E.5. Letter of approval from Human Research Ethics Committee

Date 05-Feb-2026
Correspondence hrec@tudelft.nl

Human Research Ethics Committee TU Delft
(http://hrec.tudelft.nl)

Visiting address
Jaffalaan 5 (building 31)
2628 BX Delft

Postal address
P.O. Box 5015 2600 GA Delft
The Netherlands

Ethics Approval Application: Adoption of Carpooling
Applicant: Hoogendijk, Simone

Dear Simone Hoogendijk,

It is a pleasure to inform you that your application mentioned above has been approved.

Thanks very much for your submission to the HREC which has been approved. We do additionally note/advise the following:

To further mitigate the risk of including sensitive information, consider offering transcript review to participants (in reference to concern raised in HREC Checklist, item E20).

In addition to any specific conditions or notes, the HREC provides the following standard advice to all applicants:

• In light of recent tax changes, we advise that you confirm any proposed remuneration of research subjects with your faculty contract manager before going ahead.

• Please make sure when you carry out your research that you confirm contemporary covid protocols with your faculty HSE advisor, and that ongoing covid risks and precautions are flagged in the informed consent - with particular attention to this where there are physically vulnerable (eg: elderly or with underlying conditions) participants involved.

• Our default advice is not to publish transcripts or transcript summaries, but to retain these privately for specific purposes/checking; and if they are to be made public then only if fully anonymised and the

transcript/summary itself approved by participants for specific purpose.

• Where there are collaborating (including funding) partners, appropriate formal agreements including clarity on responsibilities, including data ownership, responsibilities and access, should be in place and that relevant aspects of such agreements (such as access to raw or other data) are clear in the Informed Consent.

Good luck with your research!

Sincerely,

Dr. C. Shelley-Egan
Chair HREC
Faculty of Technology, Policy and Management

F

Workshop timetable

Table F.1: Timetable workshop.

Timestamp	Duration	Subject	Description
10:00–10:10	10 mins	Introduction round	Everyone introduces themselves. Question: "Have you ever car-pooled before and if so how was your experience?"
10:10–10:55	45 mins	Presentation and discussion	Presentation and discussion of the themes. Each theme is presented and directly discussed in the group.
10:55–11:05	10 mins	Open question	Question: "Do you think any behavioural dynamics are missing?"
11:05–11:20	15 mins	*Break*	*Break*
11:20–11:30	10 mins	Presentation leverage points	Presentation of leverage points and feedback loops.

Continued on next page

Timestamp	Duration	Subject	Description
11:30–12:15	45 mins	Identification of policy interventions	Each participant receives a leverage point and the corresponding feedback loop(s) in the BSM. Participants write down potential policy interventions. After a few minutes the leverage points rotate. This is done three times.
12:15–12:25	10 mins	Discussion policy interventions	Each participant discusses the main policy insights of their first leverage point.
12:25–12:30	5 mins	Closing word	Thanking participants and explaining the next steps of the study.
12:30–13:00	30 mins	*Lunch*	*Lunch*

G

Overview behavioural determinants literature

G.1. Behavioural determinants in Theoretical Domains Framework

Table G.1: Behavioural determinants found in literature categorised using the Theoretical Domains Framework.

Domain	Freq. (n=41)	Factors	Ref.
Knowledge	2	Awareness of carpooling	(21)
		Environmental awareness	(36)
Skills	2	Driver's licence availability	(2, 13)
Social/professional role and identity	9	Dispositional trust	(1, 11)
		Social status	(15, 30, 37)
		Personal norm	(1)
		Sense of belonging	(7)
		Environmental identity	(10)

Continued on next page

Domain	Freq. (n=41)	Factors	Ref.
		Responsibility	(15)
		Egoism	(17)
		Helping others	(17, 24)
Beliefs about capabilities	4	Perceived behavioural control	(1, 7)
		Self-efficacy	(8)
		Trialability	(10)
Optimism	0		
Beliefs about consequences	30	Attitude	(1, 7, 8, 9, 10, 18, 23)
		Perceived economic benefits	(7, 9, 11, 19, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 35, 39, 41)
		Perceived environmental benefits	(9, 11, 33, 39)
		Perceived socialisation benefits	(9, 24, 30)
		Perceived ease of use	(4, 10, 36)
		Perceived usefulness	(4, 15, 36)
		Perceived compatibility	(10)
		Perceived safety risk	(3, 5, 8, 20, 25, 30, 31, 33, 35, 36, 41)
		Perceived security risk	(7, 11, 37)
		Perceived privacy risk	(11, 19, 37)

Continued on next page

Domain	Freq. (n=41)	Factors	Ref.
		Perceived physical risk	(6)
		Perceived performance risk	(37)
		Perceived conflict risk	(37)
		Trust	(11, 15, 19)
		Platform-based trust	(6, 9, 19)
		Trust of structural assurance	(6)
		Driver-based trust	(6)
		Time savings	(15, 23, 27, 29, 30, 32, 33, 34)
		Perceived waiting time	(12, 25)
		Perceived reliability	(5, 23, 27, 29, 30, 35)
		Perceived flexibility	(5, 14, 25, 27, 29, 30, 31, 33, 41)
		Perceived convenience	(3, 15, 23, 24, 25, 26, 30, 33)
		Perceived comfort	(3, 23, 26, 27, 30, 32, 33)
		Platform service quality	(8, 20)
		Platform system quality	(8, 20)
		Platform information quality	(20)
		Acceptance	(10)
		Confirmation	(6)
		Utilitarianism	(37)

Continued on next page

Domain	Freq. (n=41)	Factors	Ref.
		Achievement	(8)
		Psychological empowerment	(8)
Reinforcement	7	Financial incentives	(2, 7, 13)
		Parking benefits	(24, 41)
		Guaranteed ride home	(13, 18, 33, 41)
		Non-monetary rewards	(7)
Intentions	13	Intention to use	(1, 4, 7, 8, 11, 15, 23, 25, 36, 37)
		Continuance intention	(6, 20)
Goals	10	Environmental protection	(7, 16, 17, 27, 32, 34, 35)
		Universalism	(8)
		Personal innovativeness	(36)
Memory, attention, and decision processes	5	Previous experience	(2, 15, 16, 34)
		Cognitive complexity	(8)
		Self-direction	(8)
Environmental context and resources	26	Household vehicle ownership	(2, 13, 15, 17, 21, 22, 28, 38)
		Travel time	(3, 5, 13, 16, 18, 21, 23, 35, 38, 40)

Continued on next page

Domain	Freq. (n=41)	Factors	Ref.
		Commute distance	(3, 5, 12, 15, 23, 34)
		Commute costs	(2, 4, 5, 13, 18, 38, 41)
		Departure time	(3, 14, 34)
		Regularity of working hours	(27, 41)
		Transport budget	(13, 21)
		Other responsibilities	(13)
		Attractiveness alternatives	(6)
		Platform reputation	(20)
		Access to HOV lane	(24, 27, 38)
		Carpool size	(26)
		Arrangements about costs	(29)
		Availability of matches	(30)
Social influences	11	Descriptive norm	(1)
		Subjective norm	(4, 7)
		Carpoolers among acquaintances	(13, 21, 39)
		Socialisation benefits	(7, 9, 32)
		Relationship with ride-sharer	(18, 24, 41)
		Perceived peers and family pressure	(35)
Emotion	20	Enjoyment	(7, 11, 15, 23, 24, 27)
		Pro-privacy	(15, 16, 17, 19)
		Satisfaction	(4, 5, 6, 25)
		Hedonism	(8, 17, 37)

Continued on next page

Domain	Freq. (n=41)	Factors	Ref.
		Independence	(15, 29, 30, 32, 41)
		Personal norm	(1)
		Perceived psychological risk	(6)
		Feeling of autonomy	(19)
		Willingness to share personal data	(5)
		Stimulation	(8)
		Enjoyment of driving (alone)	(16)
		Awkwardness	(30)
Behavioural regulation	2	Habit	(15)
		Routine-seeking	(10)

G.2. References

Table G.2: Studies included in the literature review.

Number	Research title	Reference
(1)	What drives people to carpool? Explaining carpooling intention from the perspectives of carpooling passengers and drivers	(Bachmann et al., 2018)
(2)	Money is power: Carpooling stimulus with evidence from an interactive long-term laboratory experiment	(Xiao et al., 2024)
(3)	Exploring the determinants of public transport usage and shared mobilities: A case study from Nanchang, China	(T. Zhou et al., 2022)
(4)	Consumers' intentions to use ridesharing services in Iran	(Akbari et al., 2020)
(5)	Evaluation of young people's perceptions and comfort levels in sharing information via ride-matching apps	(Gkartzonikas and Dimitriou, 2025)
(6)	Roles of consumer trust and risks on continuance intention in the sharing economy: An empirical investigation	(Jiang and Lau, 2021)
(7)	How to stimulate users' ridesharing intention and behavior? Evidence from structural and multi-group analyses	(Shi et al., 2024)
(8)	An empirical investigation into carpooling behaviour for sustainability	(Dinesh et al., 2021)
(9)	Shared car for traveling? Uncovering the intention of non-users to adopt P2P ride-sharing	(Mattia et al., 2021)
(10)	Sharing vehicles or sharing rides - Psychological factors influencing the acceptance of carsharing and ride-pooling in Germany	(Burghard and Scherrer, 2022)
(11)	Assessing carpooling drivers and barriers: Evidence from Bangkok, Thailand	(Tsai et al., 2021)

Continued on next page

Table G.2 (continued from previous page)

Number	Research title	Reference
(12)	Research on commuters' carpooling behavior in the mobile internet context	(Yi et al., 2022)
(13)	Carpooling and carpool clubs: Clarifying concepts and assessing value enhancement possibilities through a Stated Preference web survey in Lisbon, Portugal	(Correia and Viegas, 2010)
(14)	A passenger-to-driver matching model for commuter carpooling: Case study and sensitivity analysis	(Liu et al., 2020)
(15)	How to promote the transition from solo driving to mobility services delivery? An empirical study focusing on ridesharing	(X. Zhang et al., 2022)
(16)	What does it take for rural-urban commuters to switch from driving to carpooling?	(Mohammadi-Mavi et al., 2024)
(17)	Factors influencing the adoption of carpooling in Switzerland: a differentiation between platforms, family and friends and colleagues	(Hoerler et al., 2025)
(18)	Using latent attitudinal variables estimated through a structural equations model for understanding carpooling propensity	(De Almeida Correia et al., 2013)
(19)	Autonomy loss, privacy invasion and data misuse as psychological barriers to peer-to-peer collaborative car use	(Hunecke et al., 2021)
(20)	An elaboration likelihood model of perceived safety risk in ride-sharing continuance: Platform quality cues as antecedents and gender as moderator	(Wang et al., 2024)
(21)	Carpooling and carsharing for commuting in the Paris region: A comprehensive exploration of the individual and contextual correlates of their uses	(Bulteau et al., 2019)
(22)	Examining the Relationship between Household Vehicle Ownership and Ridesharing Behaviors in the United States	(Y. Zhang and Zhang, 2018)

Continued on next page

Table G.2 (continued from previous page)

Number	Research title	Reference
(23)	Ride Sharing to Work: An Attitudinal Analysis	(Horowitz and Sheth, 1977)
(24)	Incentives and Disincentives of Ride Sharing	(Margolin et al., 1978)
(25)	An empirical analysis of behavioral intentions of single-occupant auto drivers to shift to high occupancy vehicles	(Tischer and Dobson, 1979)
(26)	Measuring tradeoffs in carpool driving arrangement preferences	(Levin, 1982)
(27)	Who chooses to Carpool and why?	(Li et al., 2007)
(28)	Catching a ride on the information super-highway: toward an understanding of internet-based carpool formation and use	(Buliung et al., 2010)
(29)	Effectiveness of a web-based intervention to encourage carpooling to work: A case study of Wellington, New Zealand	(Abrahamse and Keall, 2012)
(30)	Of "white crows" and "cash savers:" A qualitative study of travel behavior and perceptions of ridesharing in Denmark	(Nielsen et al., 2015)
(31)	New ways of mobility: the birth of ridesharing. A case study from Hungary	(Bálint and Trócsányi, 2017)
(32)	Comparing French carpoolers and non-carpoolers: Which factors contribute the most to carpooling?	(Delhomme and Gheorghiu, 2015)
(33)	Casual carpooling in the San Francisco Bay Area: Understanding user characteristics, behaviors, and motivations	(Shaheen et al., 2016)
(34)	Propensity to participate in a peer-to-peer social-network-based carpooling system	(Tahmasseby et al., 2015)
(35)	For which types of trips do French drivers carpool? Motivations underlying carpooling for different types of trips	(Gheorghiu and Delhomme, 2018)

Continued on next page

Table G.2 (continued from previous page)

Number	Research title	Reference
(36)	An empirical study of consumers' intention to use ride-sharing services: using an extended technology acceptance model	(Wang et al., 2018)
(37)	Understanding consumers' willingness to use ride-sharing services: The roles of perceived value and perceived risk	(Wang et al., 2019)
(38)	Quantifying the environmental impacts of increasing high occupancy vehicle lanes in the United States	(R. J. Javid et al., 2017)
(39)	What factors explain carpoolers' decision to use carpooling matching platforms?: A survey-based observation of carpooling matching platforms in Europe	(Kesternich, 2015)
(40)	Rideshare mode potential in non-metropolitan areas of the northeastern United States	(Lee et al., 2015)
(41)	Who is Interested in Carpooling and Why: The Importance of Individual Characteristics, Role Preferences and Carpool Markets	(Park et al., 2018)

H

Overview of quotes

Table H.1: Overview of quotes per theme.

Digital platform dependency of carpooling
"There are still some typical barriers. They would like to do it, but they don't know who they could carpool with. That's of course where our matching algorithm can help." (I-02)
"From a policy standpoint, this instrument [carpooling] *seems to be interesting as there is a lot of technology that makes it all easier."* (I-03)
"There need to be facilities, like those apps for example, so that you can easily set up a carpool date." (I-03)
"I'm also curious, you know? In earlier research, things were pretty improvised. If you wanted to carpool, you had to call people or scribble names on a list. These days you'd expect apps to make that much easier, so maybe that opens up new possibilities." (I-04)
"And the third thing is, I think, maybe an app. But you know, if it's a colleague you already know, then you don't even need a carpool app anymore. A carpool app is really only there to bring together the supply and demand of people who don't know each other." (I-11)
"If, as an employer, you consider it as a very serious option, then you can of course purchase a carpool app and make it available to everyone." (I-11)

Continued on next page

"What we have seen with [company] *is that a lot of people do not register their shared rides in the app. So, if you find someone via the app and you know you can now carpool with that person, then you don't need to use the app anymore."* (I-12)

"It is not only about carpooling, but also about registering your shared ride. And so what I've noticed is that the €2 might not actually help to keep people carpooling, because once they've found someone, they'll probably keep doing it anyway. But it does make them keep registering the ride, which keeps it in the app, and that helps build the network for others." (I-12)

Financial dependencies, subsidies, and incentives

"Look, the government can cover the costs for such a party. That is, in my view, an active way to ensure that employers don't see any barriers to participate." (I-01)

"I could challenge you to share a ride, but there needs to be a reward in return, otherwise people simply won't do it." (I-03)

"The wallet is a strong determinant for what people do. The wallet [financial benefits] *is always a good way to influence people."* (I-03)

"I think it also depends on what kind of fiscal measures your employer applies here. Look if your employer says (I don't know if this is allowed, it's just an example) you share a ride with someone and yet you both receive travel cost compensation, then that does matter to people." (I-07)

"There is a carpool arrangement, and then as an employer you can give extra money to an employee who acts as a carpool driver, so they can take a detour and drive extra kilometres to pick up colleagues. But that carpool scheme is so complicated, because you have to record everything precisely. And as an employer you're not allowed to give anything to the passengers. If someone asked me about it, I would say: just don't do it, don't use it. It's nothing but hassle. What works much better, and doesn't involve the tax authorities, is simply going with two or three people in one car, and one person pays one day, the other pays the next day. Then you each pay half of your travel costs. You can arrange that among yourselves. No employer involved, no tax office involved." (I-08)

Continued on next page

"We think those current apps are too complicated. They're apps that charge a fee per ride, which the government, or the bus company, or someone has to pay. Not one of the two people who are making the deal. And if you scale that up, the costs for the government will skyrocket." (I-10)

"At the same time, it's more something they explore as part of their social responsibility, because the volumes are so small right now that it isn't a real business case yet. It's more from the perspective of: if this would work, it could save us money on our thin, expensive routes. And then people might also be brought more easily to the thicker, profitable bus lines." (I-10)

"The tricky part is that if the passenger has to pay that fee, it still is a tight business case. Probably, because I think you'd need to get a decent amount of money to make it worthwhile, the passenger might quickly decide to do something else instead." (I-10)

"Well, I'm wondering whether financial measures would even be effective at all. And honestly, I don't see any other possibilities." (I-11)

"I think we have a bit of a malleability mindset, in which we assume that if we just provide a strong enough financial incentive, people will automatically make that choice. But I think it actually quite depends on what the system of a person looks like on such a day." (I-15)

"I would like for us, as a municipality, to eventually withdraw. Currently we pay for people to share a ride, while more ideally, I would want for us as a municipality to not pay at all and for people to share a ride voluntary. That would be the dream scenario." (I-16)

"In the ideal scenario, of course, you want such a system to eventually stand on its own, so that as a province you can step out of it." (I-19)

Knowledge sharing, communication, and promotion

"A third factor will certainly be how strongly the employer communicates the benefits of doing it [sharing a ride]. If that is made very clear…" (I-02)

"People almost don't read the mobility page of intranet. […] *People don't go there. Sending e-mails… people are already busy enough, so that also doesn't reach them. Flyers might help."* (I-02)

Continued on next page

"To make people aware that there is a solution, you need to search for moments when people have the time to register. To me, the best moment would be to put a sticker at the inside of the toilet door. […] *That would be a good way to still reach them."* (I-02)

"The employers in the coalition, they share a lot of knowledge with each other, pilots, best practices, and then others can start doing that as well." (I-05)

"We're not going to run a behaviour campaign telling people to carpool more. It's been done a few times in the past, and those were pretty much fiascos." (I-08)

"People tend to overlook what they don't know, and that lack of awareness can be explained by the fact that it's small and serves a niche market. It's not something that gets put in the spotlight, and of course it doesn't have the budget to do that itself. A marketing campaign won't solve everything, there also needs to be a really good product in place." (I-09)

"If you do it [launch a ride-matching platform] *at a business park or at a campus and you don't approach employers directly or employees via the employer, it is simply very difficult."* (I-12)

"For example, at [company]*, we stood in the cafeteria to promote the app and explain how it works. And they also have their own app, so they immediately put out a news message saying that everyone could use the app, and things like that. Well, then you suddenly see that you reach a lot of people, and you can use a very trusted channel, which really makes people consider using the app."* (I-12)

"If you want people to carpool, you need to have multiple touch points. So you need to stand there. You need to send an e-mail, maybe there needs to be a flyer somewhere, maybe they need to see it online another time. So that they see multiple times that this is something new and is also a travel option." (I-12)

"We have the Intranet. […] *It should be on there. Add a fun catchy twist to it or let someone explain it once. Yeah, so the internal* [communication]*. I think that works very well."* (I-13)

Continued on next page

"But I don't believe that we, as the government, should devote a campaign to this. I don't think so. And that's because the previous one simply didn't go well, and that could really bounce back on us. Like: 'Oh, there they are again with their carpooling… something that will fail for the second or third time.' You really need to think carefully about that." (I-13)

"I don't believe that if we, for example as the government, were to run a campaign about carpooling… yeah, I don't think that would work. It has to go through employers, using the app, with managers encouraging it and with something built around it." (I-13)

"What you see now, is that pretty often external parties are hired to deliver behavioural knowledge, but they also keep lots of that knowledge to themselves. […] *And the thing we strive for within our department is to standardise it* [knowledge on behaviour] *more, make it more open and transparent."* (I-15)

"In France if you say carpooling app everybody will get it. […] *This is like something that everybody already know in France. In the Netherlands carpooling app: huh? What is it?"* (I-18)

"Mainly with production workers we need to rely on the managers, team leaders but with office workers an e mails can work fine, but with hospitals they don't have time. So maybe the best thing to do is to put stickers on the hand sanitizer things. So we really learn from each project What works? What works not?" (I-18)

"I hope that somehow we'll find a way to bring all that knowledge together, so that something useful can come out of it and that it doesn't just end up being a bunch of experiments that eventually get evaluated and that that evaluation then disappears in some drawer." (I-19)

Multi-level trust as a key driver to carpooling

"Everything that gives certainty in that start up phase is crucial." (I-01)

"We're not so kind to each other anymore, I'd say. And I think that's also why people say, you know, I'll just stick to my own environment where it feels safe. Yes, so the unknown… fear of the unknown is, I think, a very big factor. That applies both to the concept itself and to the idea that you then have to get into a car with a complete stranger." (I-03)

Continued on next page

"It is also important that… 'Is it real', you know, 'am I not getting into trouble?', 'is it not a way of draining me completely or something'." (I-06)

"People try to get that €2 for free." (I-06)

"Maybe you don't know the other person as they work at a different department, but it is nice that you know you're sharing a ride with a colleague. That can also play a role in the level of trust of users." (I-16)

"Yeah so for the return warranty, this is something we provide to every user. We try to not over communicate about because we use it to answer this fear but if we over communicate about it there is this risk that it could be misuse." (I-18)

"It's always a bit of a question 'what kind of person will I end up with?', 'Will the ride actually happen?', 'And if it doesn't happen, then what am I supposed to do?" (I-19)

"They offered an app in which you need to register and find others in that way. And well, there are also needs to be some sort of payment behind it and you noticed that the [organisation] *find it quite scary, because it is out of their control."* (I-19)

"It is important that that [information] *is sent on behalf of the* [organisation]*, as the people then truly know, because it is a reliable sender, that the information is true. And well, that creates then a sense of peace and trust again."* (I-19)

"There are also people who say 'I am willing to carpool, but only with people from my own department, or people from my own village'. In any case, a safer more trusted environment." (I-19)

"One bad experience with someone can already lead to you not wanting to do it again. So trust, is hard to gain, but easy to lose." (I-20)

Resistance based on lack of control and the pressure to socialise

"And that is also apparent in carpooling. You need to make clear agreements. […] *You need to have commitment, so it limits your flexibility and freedom."* (I-01)

"When there is someone next to you, you get the feeling of needing to entertain that person." (I-04)

Continued on next page

”There [within car ownership]*, a car is associated with autonomy and the idea of ‘I determine when I want to travel. I don’t have to ask permission from anyone. I’m totally free.’.”* (I-04)

”People want to stay in control and you sacrifice a part of your autonomy of your journey.” (I-05)

”We are all getting more individualistic, unfortunately. Maybe that also plays a role.” (I-05)

”I think some studies have shown that people really don’t want that at all. In the morning, that time is still really yours, so you probably don’t want to talk to your colleagues already, or anyone at all” (I-07)

“People are just way less willing to share things. Whether we’ve become too wealthy, I don’t know, but I think it has something to do with it.” (I-09)

”If you would rather be behind the wheel, than that is a reason not to carpool. You need to be able to ride along.” (I-11)

”People who travel a lot by car, like to travel by car, because it is convenient, because you are independent, and because you can leave whenever you want. You have much more freedom.” (I-14)

”Maybe the social barrier is that you of course need to share something with someone you know very well.” (I-15)

”For the driver, sacrificing their freedom could be a barrier.” (I-16)

Dependencies on the structural and social environment

“And especially when you’re new at a company, or anywhere really, you’re usually quite open to adjusting your behaviour. You’re entering a new situation, and you have to figure out: how am I going to get around here? If, at that moment, colleagues quickly encourage you to start carpooling as well, that can definitely be an interesting influence.” (I-02)

”At the same time, there are employees who often fall into the lower income groups, where it’s sometimes simply not possible to own a car, or to have two cars in a household, while both people still need to get to places that aren’t easily reachable by public transport.” (I-04)

Continued on next page

"If you ask people, it [their commute trip] *is more of a chain movement.* […] *If you start carpooling, than you need to coordinate everything. And that might be annoying for the other person if you need to do all sorts of things during the trip.* […] *Those kind of factors could be a barrier."* (I-04)

"If people have no alternative, then they might be more likely to do it, right? But if people are given an alternative like 'here is your company car,' then they won't do it." (I-05)

"At the end, there are also people who don't own a car and are not able to move, so it [carpooling] *is an opportunity to move yourself."* (I-06)

"I also think about the physical environment. I think such a carpool location should be easily accessible, whatever that may mean for you. So maybe there should be good parking facilities, or that it's well lit so you feel safe in that place." (I-07)

"I think as a municipality or province you have of course quite some influence on whether there are carpool places and where they are, I think that really matters. I think that yes, the location of a carpool place simply plays a role. P+R locations that make it possible for people to get on and join." (I-07)

"If you have a car parked outside your house, […] *whether you have a parking space at your destination, even more important whether you have a car or what your situation is at home and at your destination, if there's no parking space, then you're already forced, or at least very limited by the available parking, to start thinking: okay, then I need to get there in another way."* (I-08)

"Those carpool places, they are used for many different purposes and we think only a small part of that is carpooling. But, as a province, we are already happy if people park their car and take the bus. Then, it doesn't matter." (I-10)

"I think the household you live in is an important predictor. How do you coordinate things within the household? For example, if there is only one car, who gets to use it? How do you decide that together? The family composition is an important explanatory factor." (I-14)

"I think the most important decision making processes actually happen at those key moments in life: when you change jobs, start working, move, or when children come into the picture and you suddenly have to bring them to school." (I-14)

Continued on next page

”But I think it really depends on what that person’s daily activities look like and how these activities are combined. For example, taking a child to school in the morning can already be a reason to use a car, simply because it works better time wise. Whereas if that child went to school on their own, you might have a bit more flexibility to use public transport instead.” (I-15)

“If no bus line stops at your company, well, you can say ‘Everyone should take public transport,’ but then everyone is standing at the station waiting for a bus that doesn’t… Or you can get on a bus, but it never arrives at your workplace, so to speak. So as an employer, you’re of course also dependent on what’s available.” (I-17)

“But of course, there are also many companies that are located close to a train station, so for those employees it would actually be very logical to come by train or other public transport. The extent to which there is parking available at a company is also important, of course. Also in terms of carpooling.” (I-17)

“How you were raised also plays a role in the choices you eventually make. For example, if you grew up in a spacious neighbourhood, where there’s always a car in front of the house, parking is easy, and you’re always driven to school, or it’s never a problem to take the car, then it’s more logical that later on you’ll make your choices in a similar way.” (I-19)

”Sometimes, it just isn’t possible. Sometimes you have no one to carpool with or you don’t have a public transport station that gives you a realistic journey. So you have objective choices and subjective choices.” (I-20)

Integration of carpooling in the mobility system

“If you have a small part of the route that overlaps, then you can at least bring them along for that part, and after that everyone continues on their own. So you can also have a partial carpool.” (I-04)

“It is always the personal car or public transport. It is never about the mode in between. And that makes that a lot of people don’t know what shared mobility is. And I think people also don’t really know what carpooling is.” (I-09)

Continued on next page

"If a company currently has 100 lease cars, they are used on average three or four days a week, so you could reduce that to 70 or even 50 cars. When things get tight, people might need to send a request in an app, or they get matched automatically, and then you pick up your colleagues." (I-09)

"We're now preparing to launch a long□term tender for a carpool app. It should start running from Q3 this year through 2030, so that we can really offer a good alternative, or rather a strong addition, to public transport." (I-12)

"That is the goal on the long term for every project that is to be really a part of public transport and that's just being a stand alone and I think this is really important, we are not competing with public transport, not at all, we are complementing it." (I-18)

"You see that the public transport system in the Netherlands is quite good, but it doesn't get everywhere." (I-19)

"There have already been successful examples in Denmark of a carpooling platform that could complement such a system [public transport system]. *They ran a large pilot project there and designed it so that people could carpool with each other to a public transport hub, for instance. So the focus wasn't on sharing the entire journey together, but rather on getting people to public transport hubs."* (I-19)

"And an employer can also do something with the company car arrangement, that people who qualify for a company car can get one if they start carpooling." (I-20)

Fragmented roles & absence of shared visions

"One of the most important reasons why I am here. I think it's important. I think the general government, the central government, does way too little to motivate this [carpooling]." (I-06)

"Only, I do feel that sometimes the distance between the national government and the market is quite large, especially with smaller companies. What I don't have to go through to make agreements, and we end up having to take on a lot of financial risk as well." (I-06)

"Of course, there are also provinces that pursue their own plans and want something quite different." (I-06)

Continued on next page

"We [the government] *just want the real actors in this field, a hospital or an amusement park to understand that carpooling might actually be something worthwhile. And then I can seriously do something with it, because then I'll know: OK, I need to do this and that. But we're not going to do it ourselves. We can only advise them and say: this is how you should do it, this is the way."* (I-08)

"What I find difficult at times is that, in this country, we have all these separate little pilot projects and there isn't really one vision for them. We're all experimenting on our own and then something is supposed to come out of that." (I-19)

"I think on a national level, more guidance could be given or a broader context could be sketched on where we want to go with this, so you get less blanks and more collaboration to move in the right direction." (I-19)

"I think there's little enthusiasm among the regions to start working on this again, unless the national government really stimulates it. And then I would actually…. then you get another problem. I would make it something national with regional involvement, so regional sub-platforms. But then you also get competition again. And why should the government do this? Because BlaBlaCar already exists, right?" (I-20)

I

Behavioural System Map

This Appendix contains the different versions of the Behavioural System Map (BSM) that is constructed. In each version, a different part of the map is highlighted. These highlighted parts could either correspond to the commuter journey, a theme, or a feedback loop.

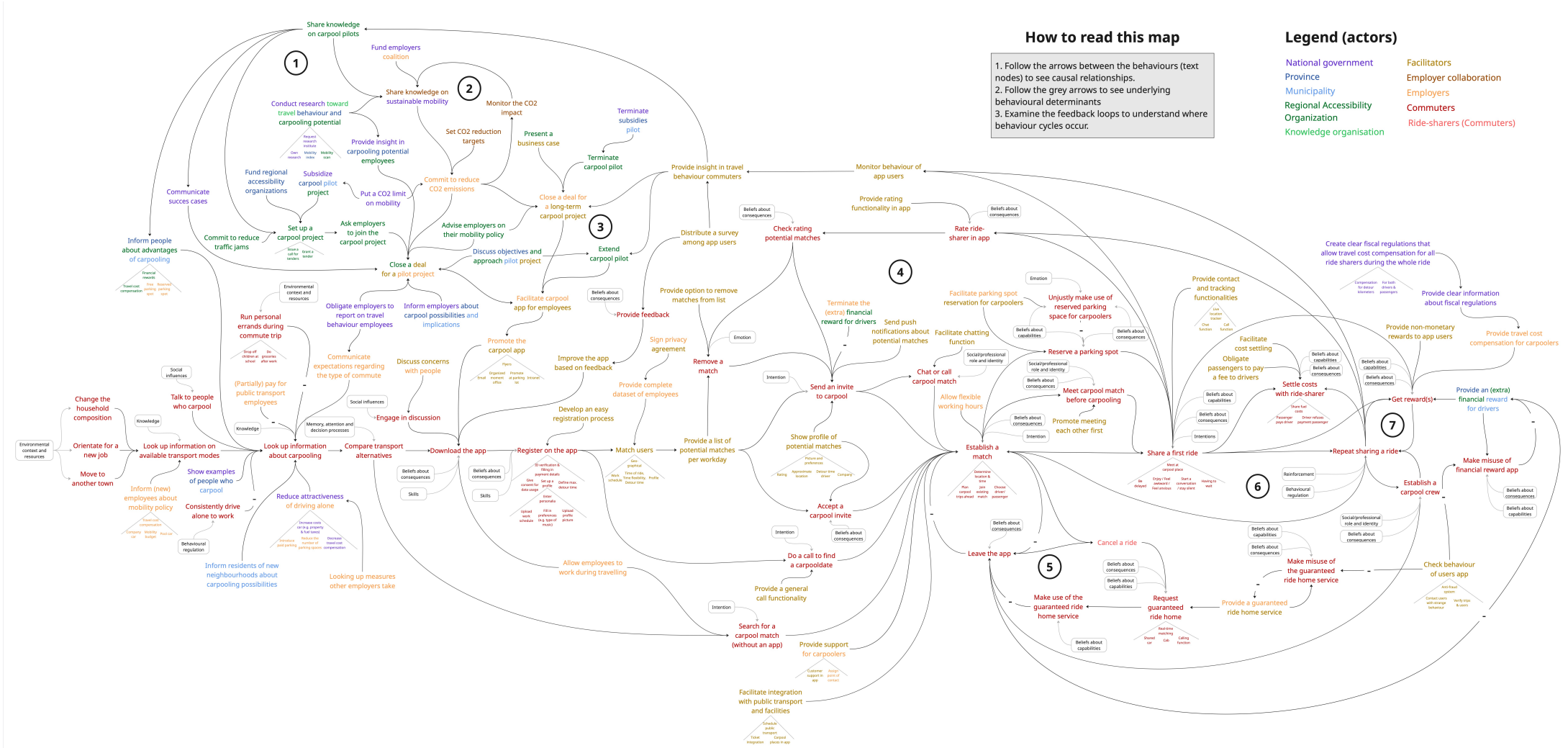


Figure I.1: Behavioural System Map of commuters' decision-making when considering carpooling.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. This BSM is also presented in Figure 3.1 in the main text. The map can be viewed digitally via https://miro.com/app/board/uXjVHAO2_QM=/?share_link_id=553557726951.

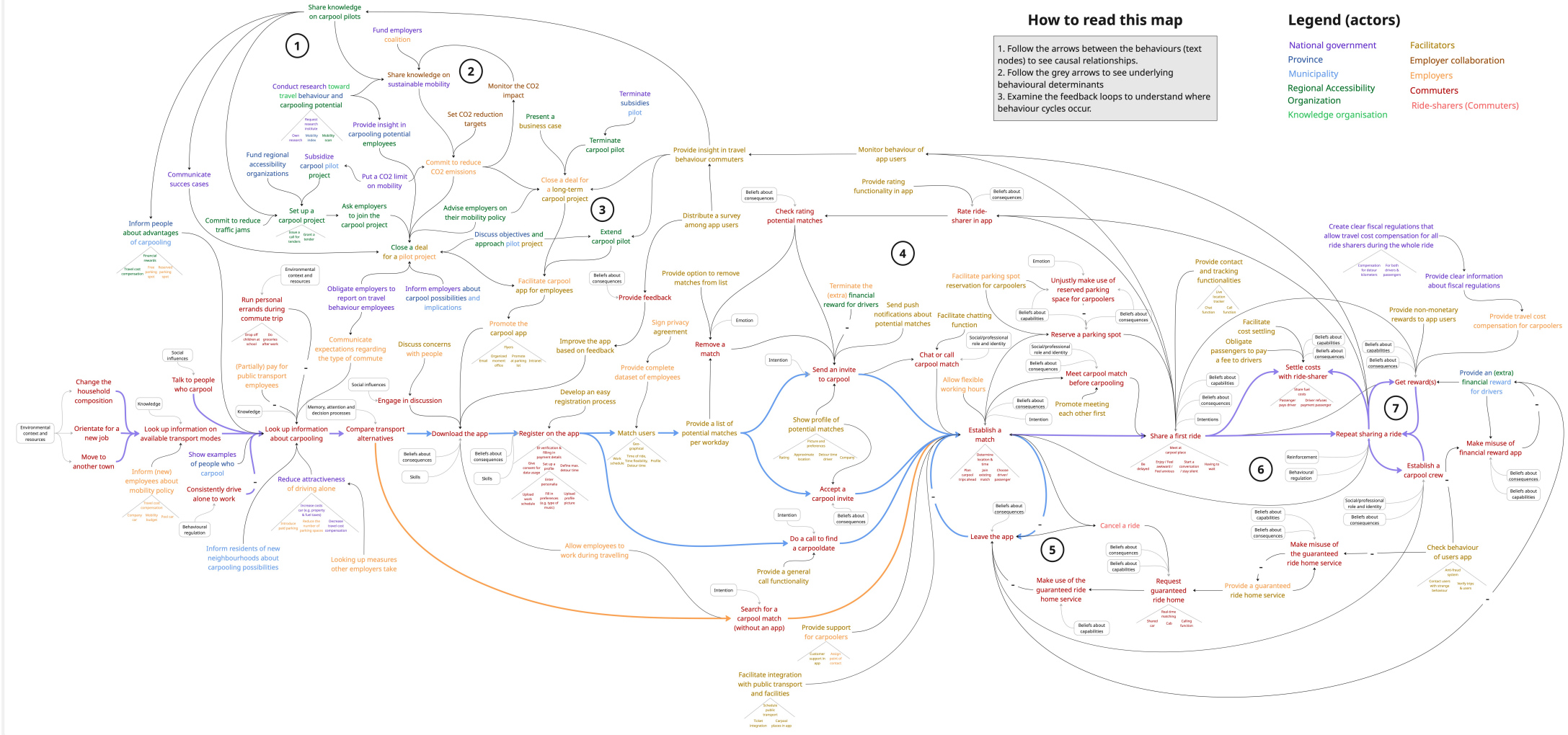


Figure I.2: Behavioural System Map of commuters' journey when considering carpooling.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The coloured arrows show the commuter journey. In Figure 3.2, the BSM is presented in the main text.

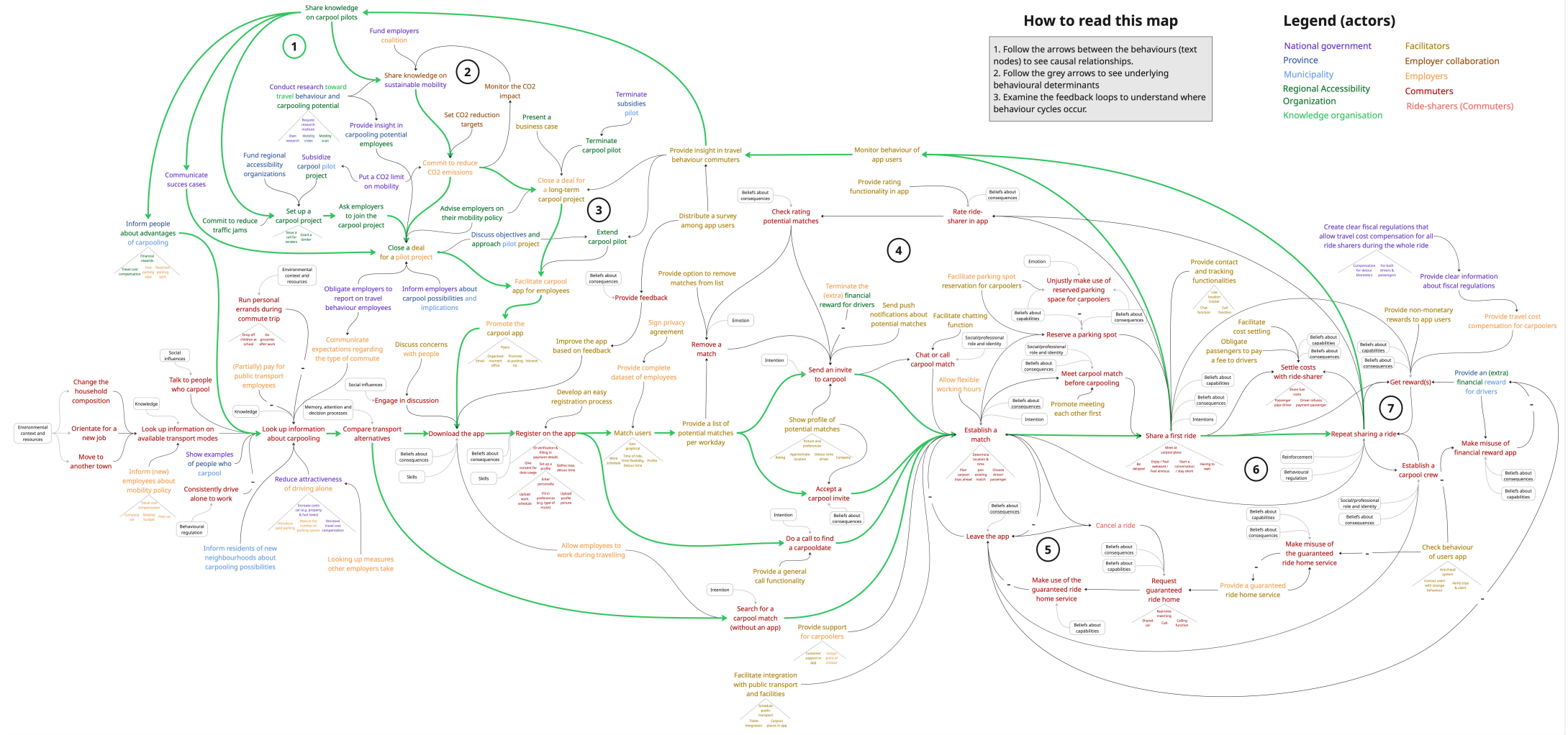


Figure I.3: Behavioural System Map highlighting feedback loop 1 *'sharing knowledge and experiences'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. In Figure 3.3, the BSM is presented in the main text.

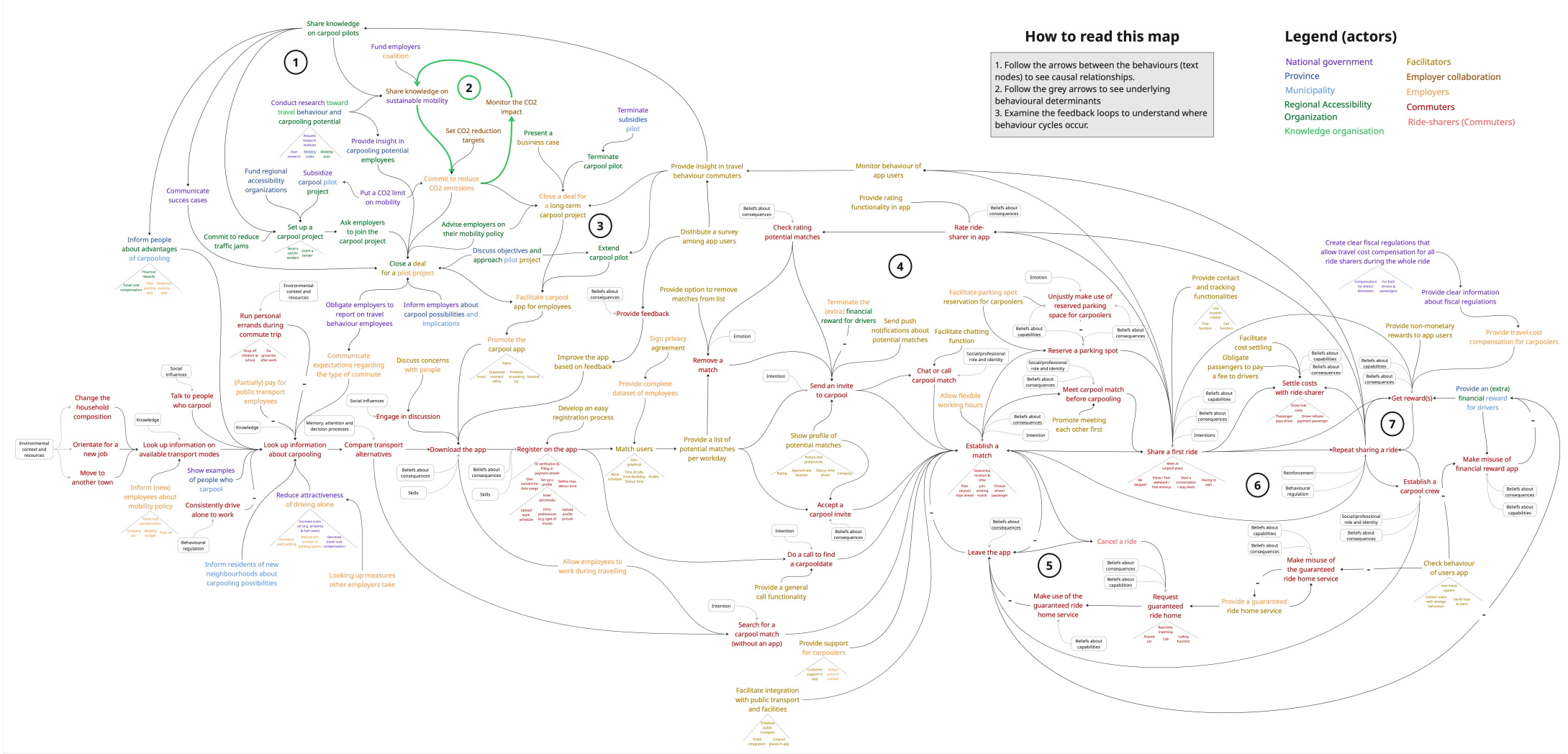


Figure I.4: Behavioural System Map highlighting feedback loop 2 *'committing to sustainable mobility'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. Figure 3.4 shows the BSM in the main text.

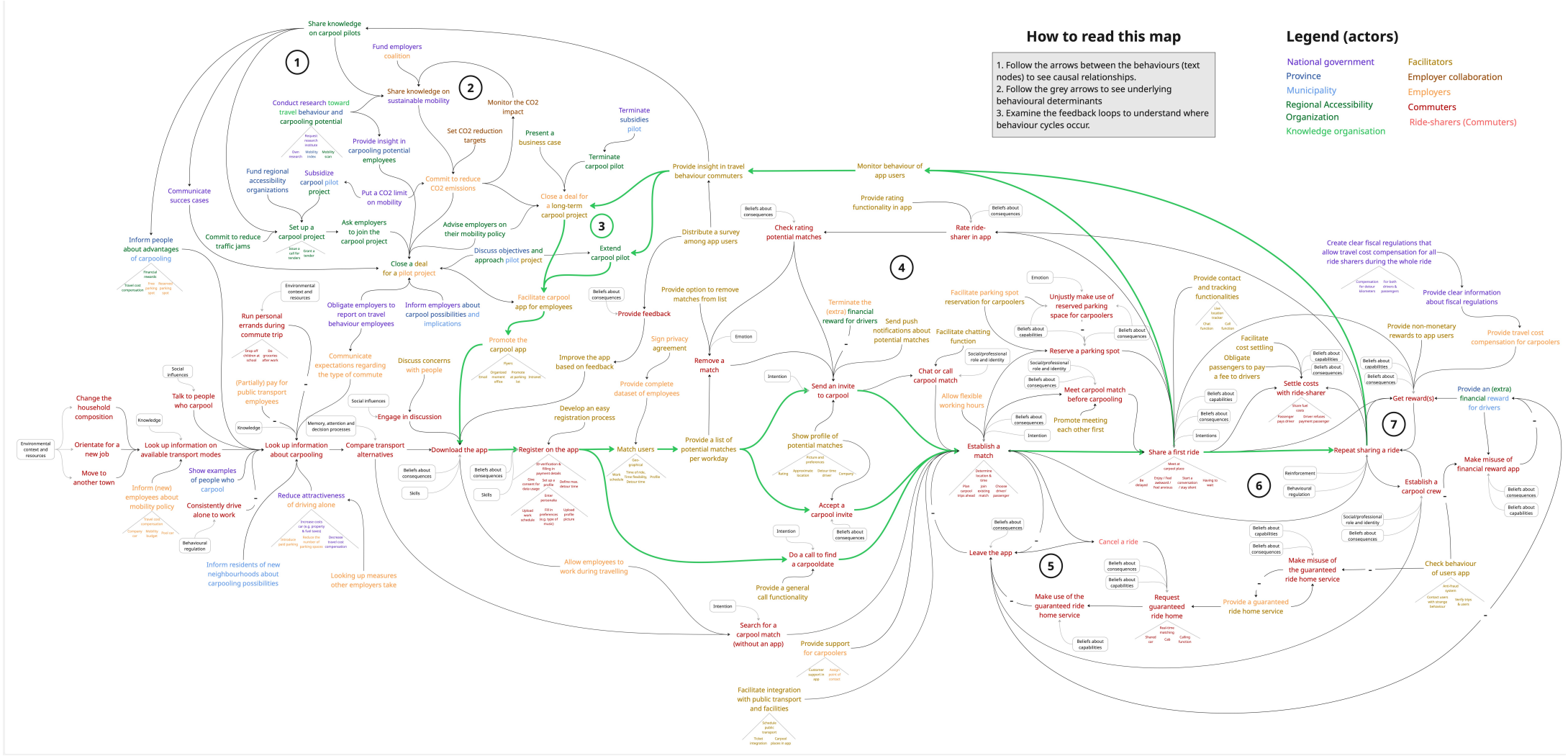


Figure I.5: Behavioural System Map highlighting feedback loop 3 *'continuance of facilitating carpool services'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. Figure 3.5 shows the BSM in the main text.

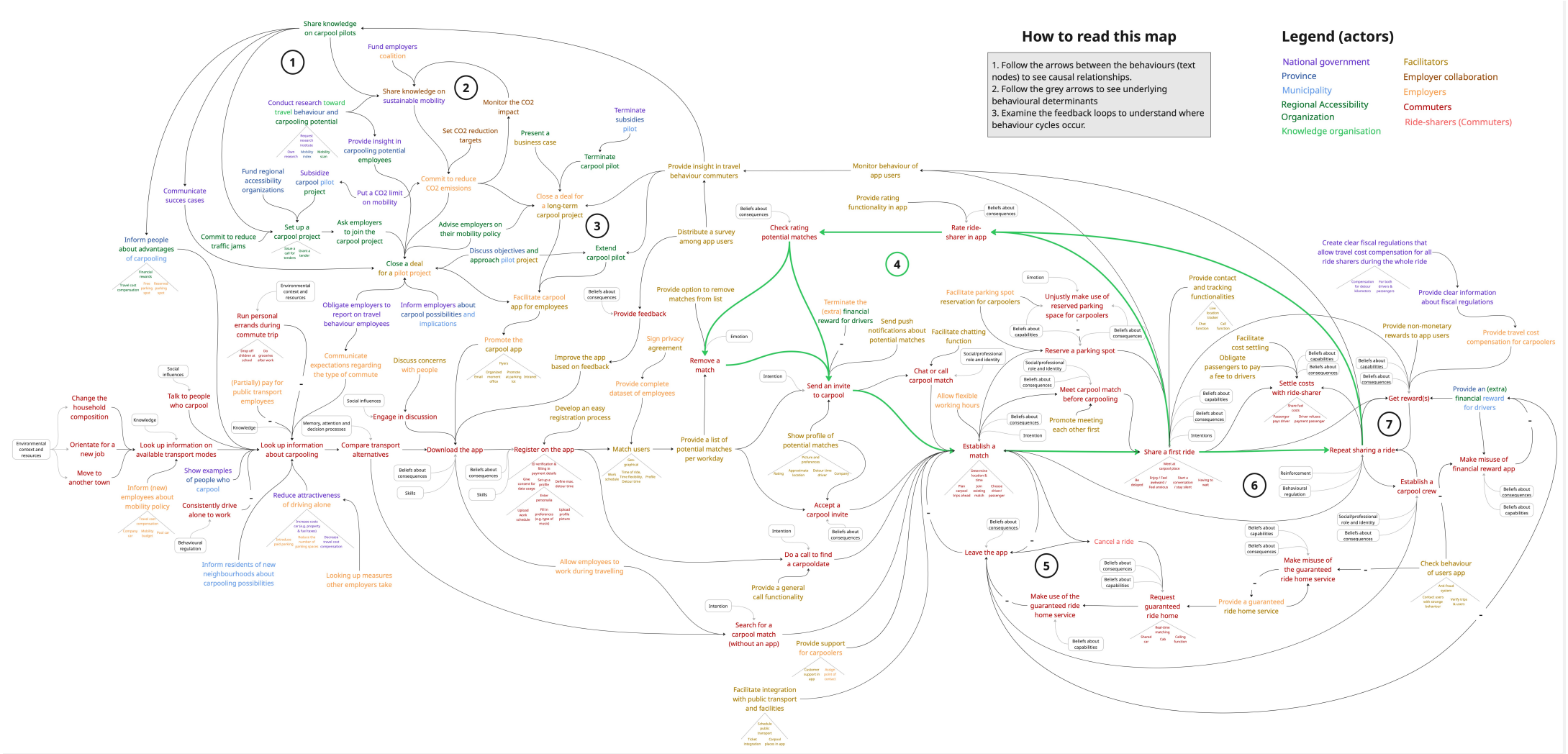


Figure I.6: Behavioural System Map highlighting feedback loop 4 *'level of trust among commuters'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. Figure 3.6 shows the BSM in the main text.

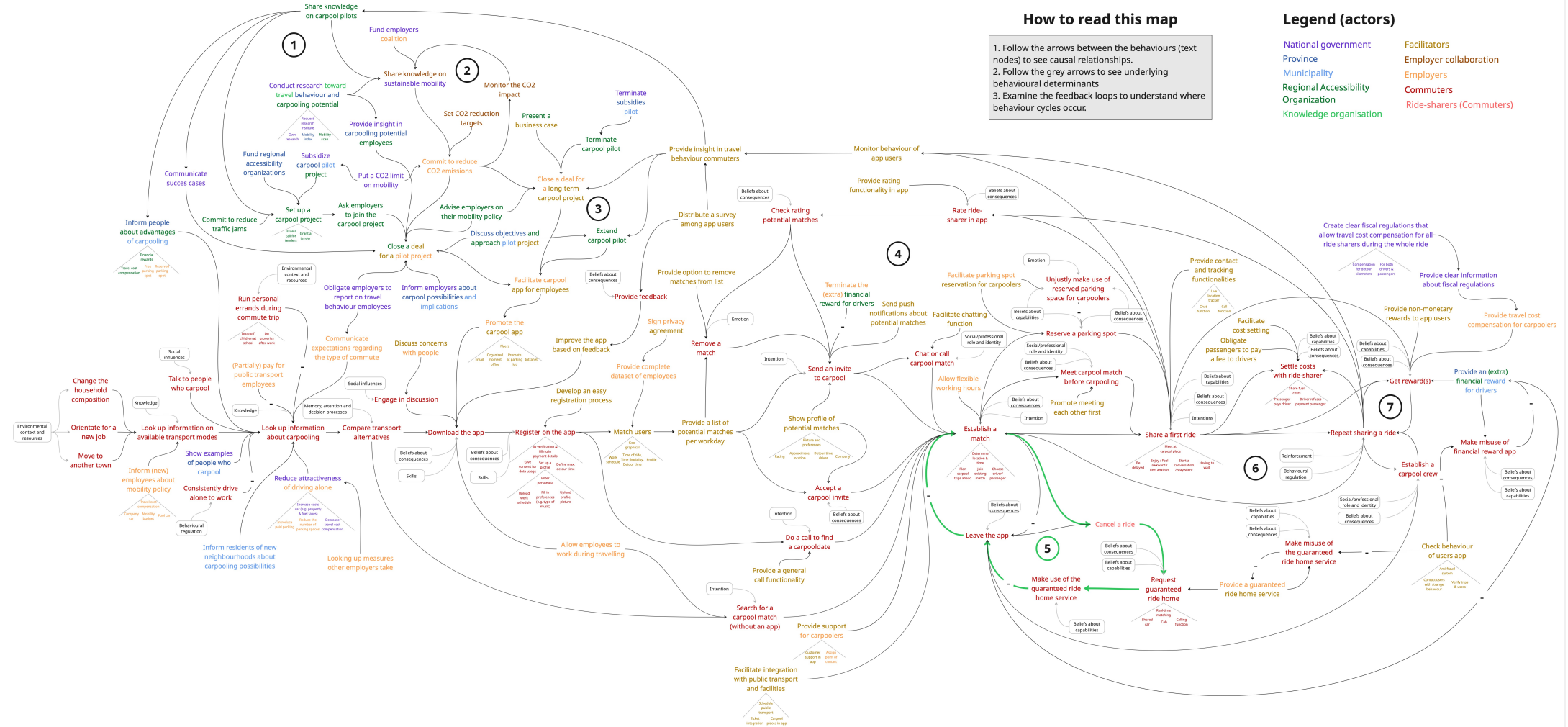


Figure I.7: Behavioural System Map highlighting feedback loop 5 *'guaranteed ride home service'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. Figure 3.7 shows the BSM in the main text.

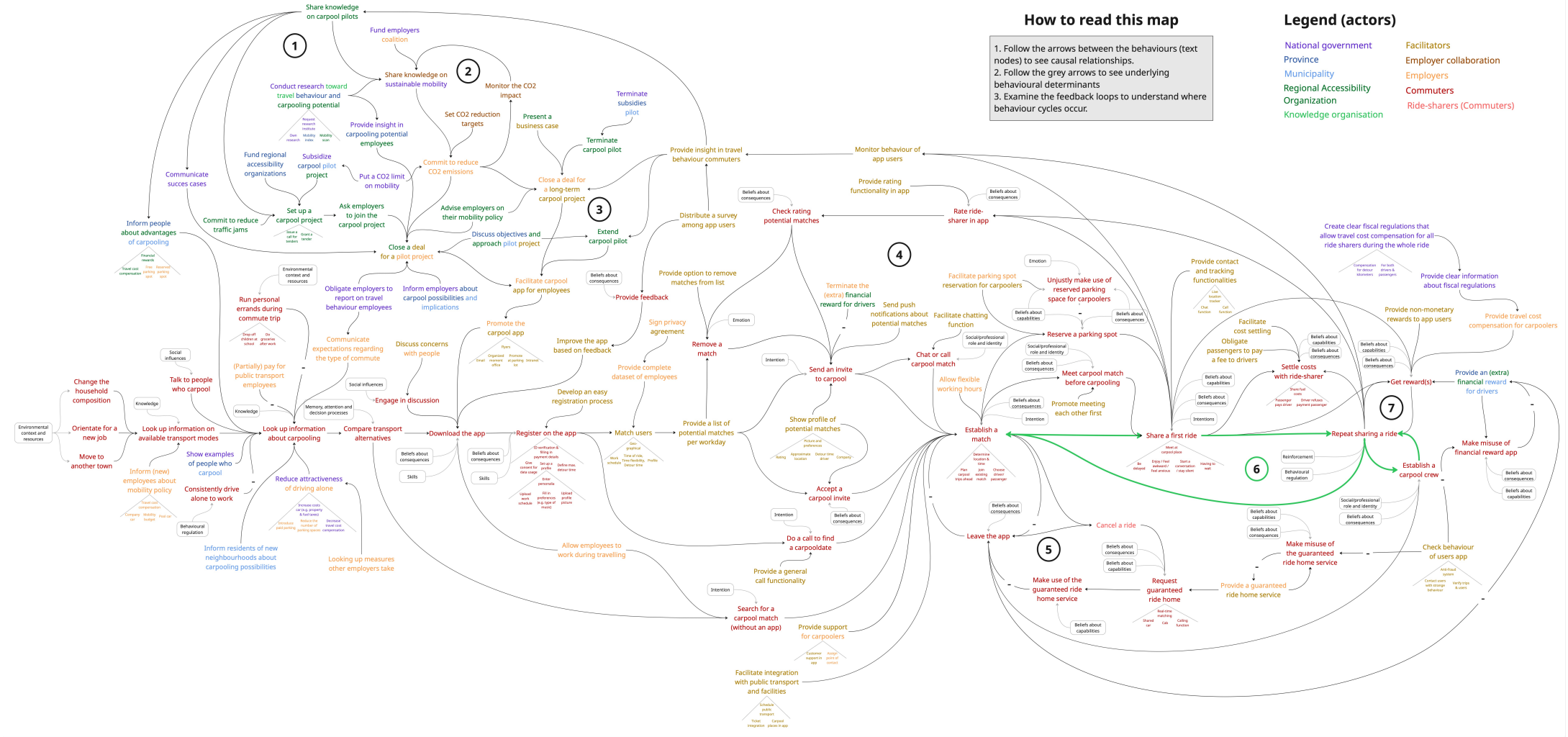


Figure I.8: Behavioural System Map highlighting feedback loop 6 *'importance of a carpool network'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. Figure 3.8 shows the BSM in main text.

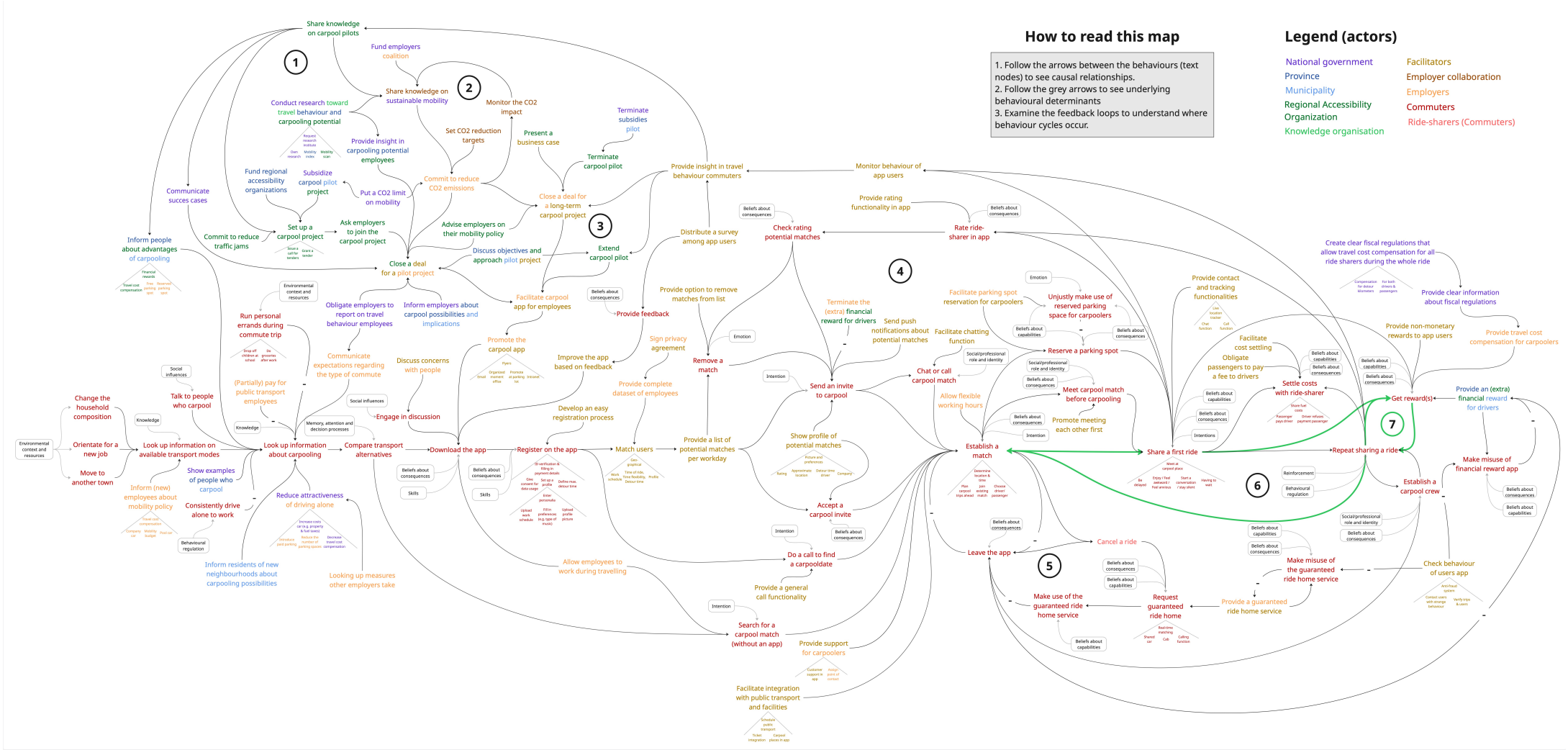


Figure I.9: Behavioural System Map highlighting feedback loop 7 *'reinforcement through incentives'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The green arrows show the feedback loop. Figure 3.9 shows the BSM in the main text.

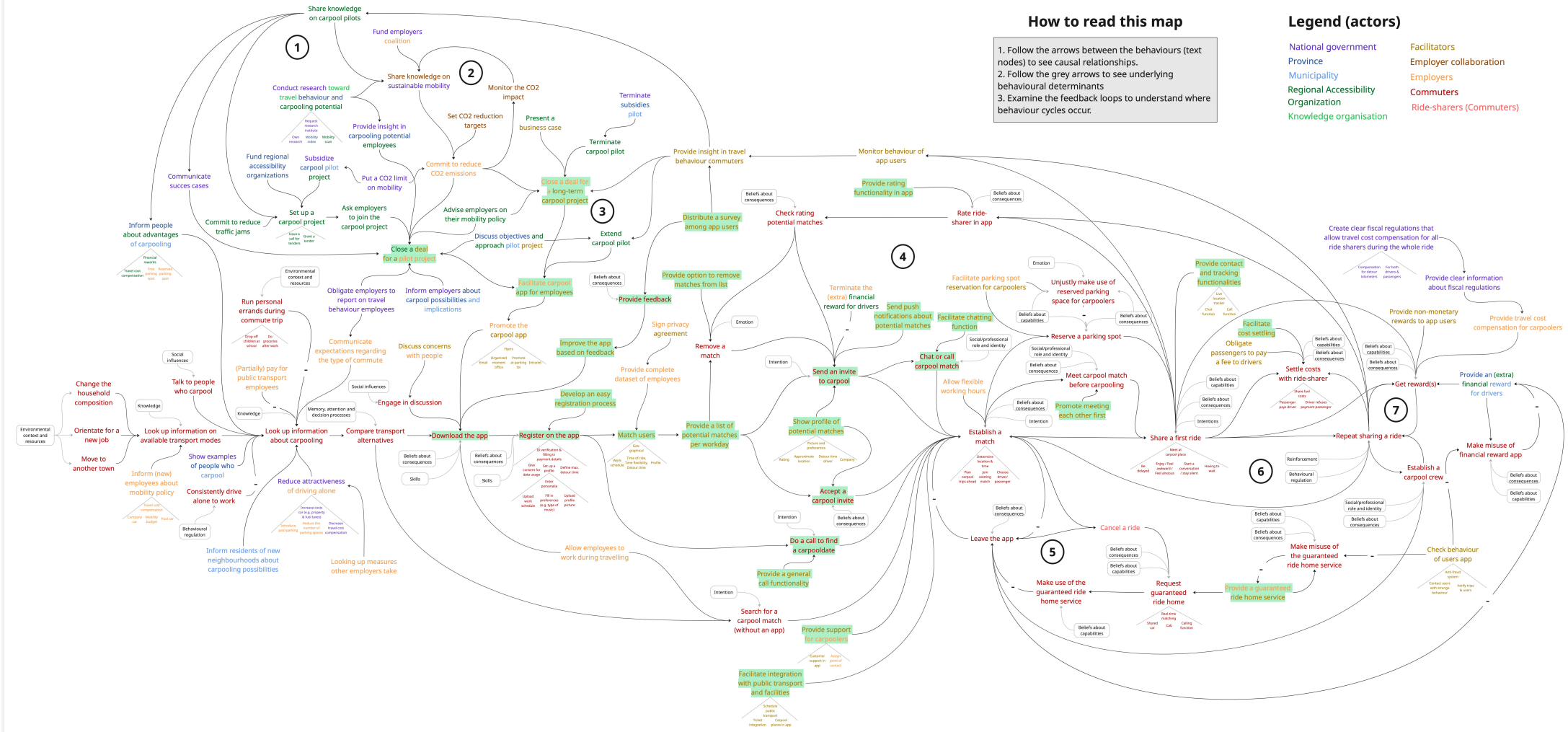


Figure I.10: Behavioural System Map highlighting theme 1 *'digital platform dependency of carpooling'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to theme 1 are highlighted in green.

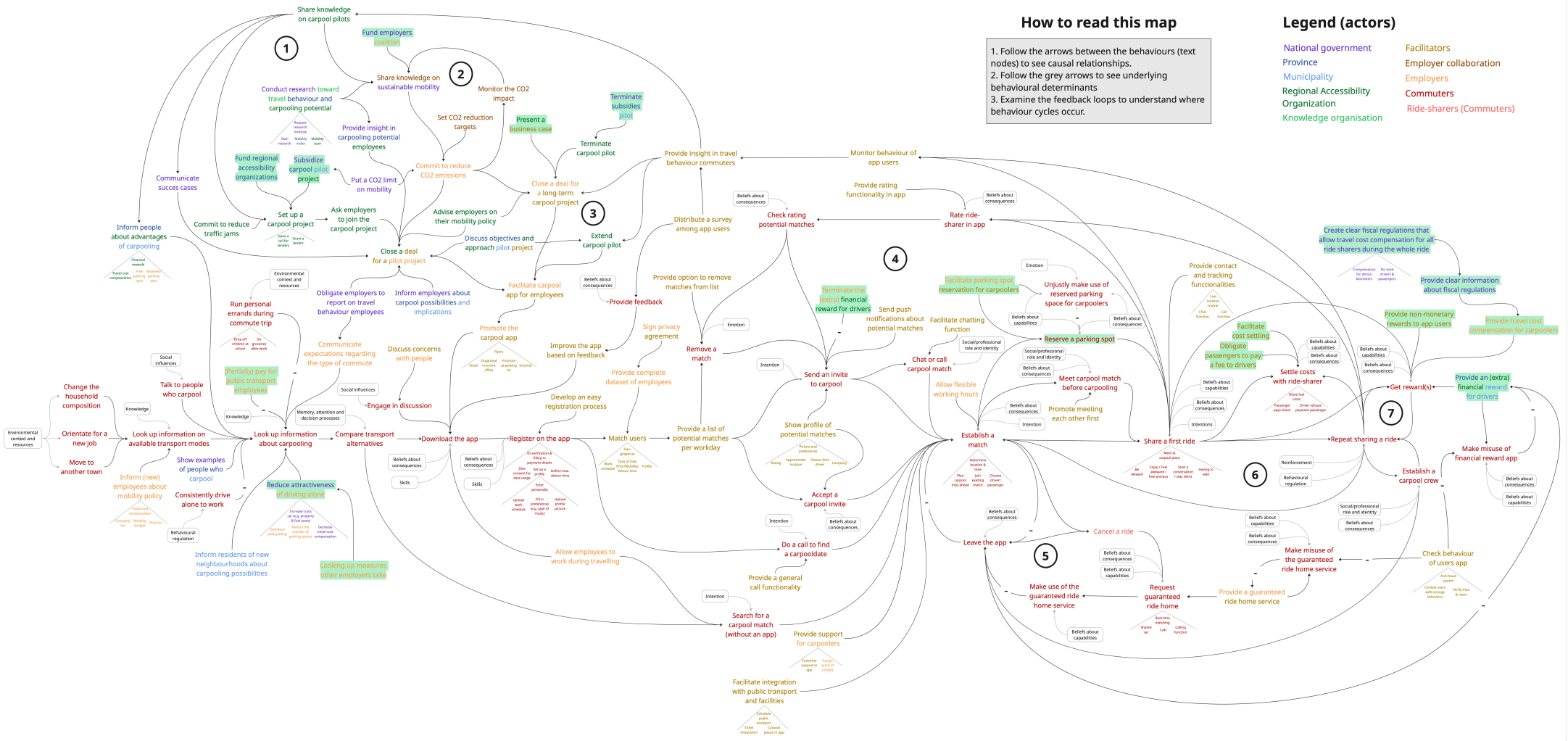


Figure I.11: Behavioural System Map highlighting theme 2 *'financial dependencies, subsidies, and incentives'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to theme 2 are highlighted in green.

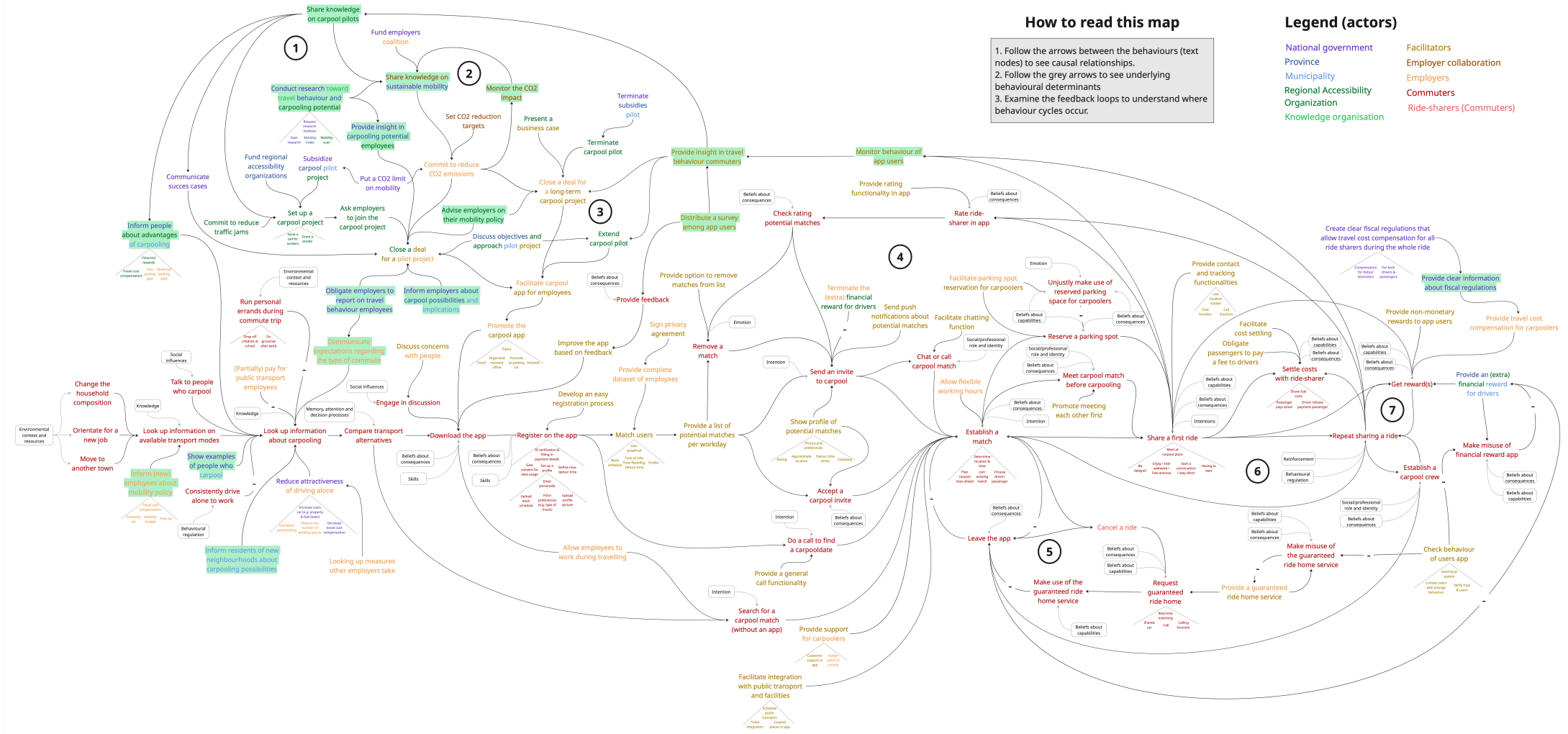


Figure I.12: Behavioural System Map highlighting theme 3 *'knowledge sharing, communication, and promotion'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to theme 3 are highlighted in green.

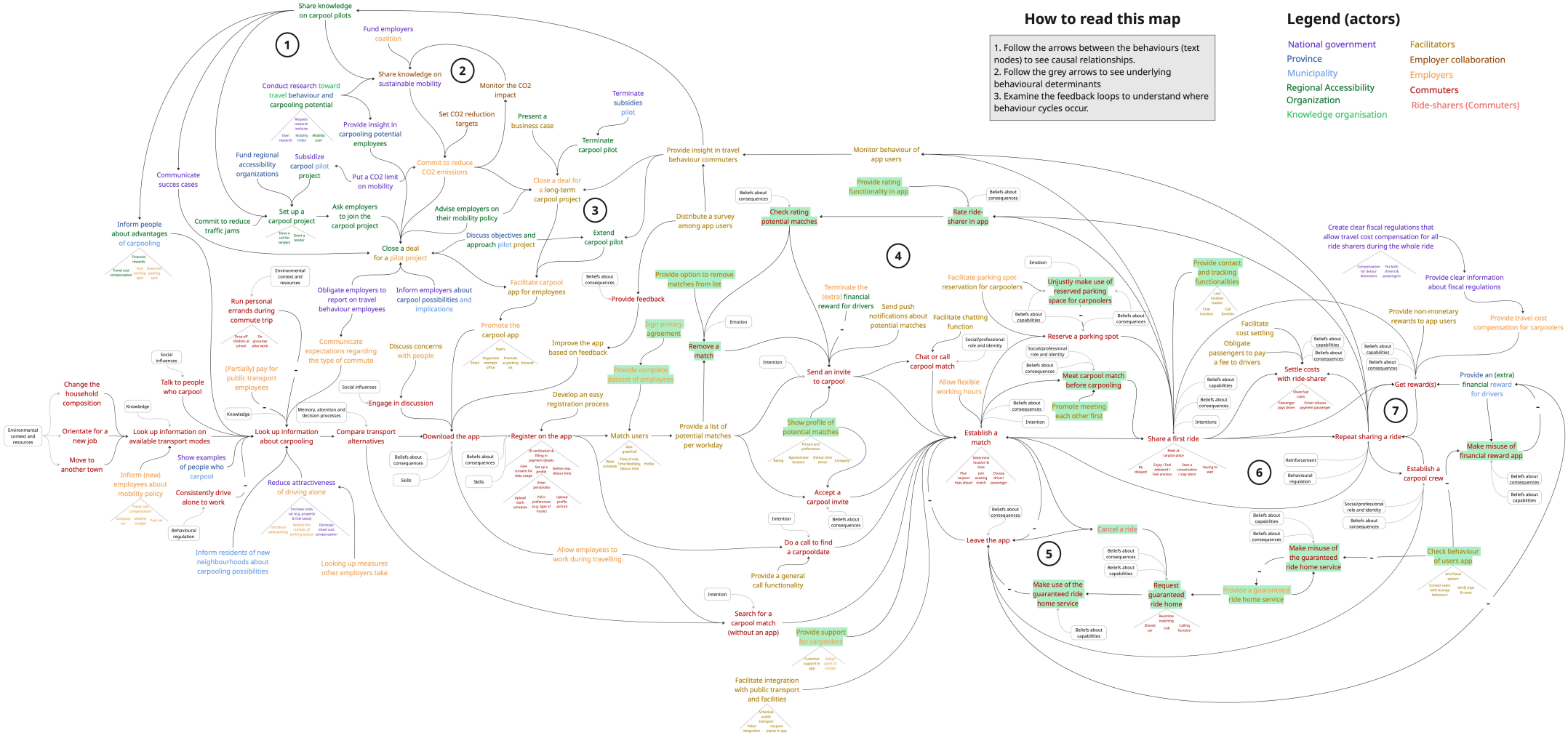


Figure I.13: Behavioural System Map highlighting theme 4 *'multi-level trust a key driver to carpool adoption'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to theme 4 are highlighted in green.

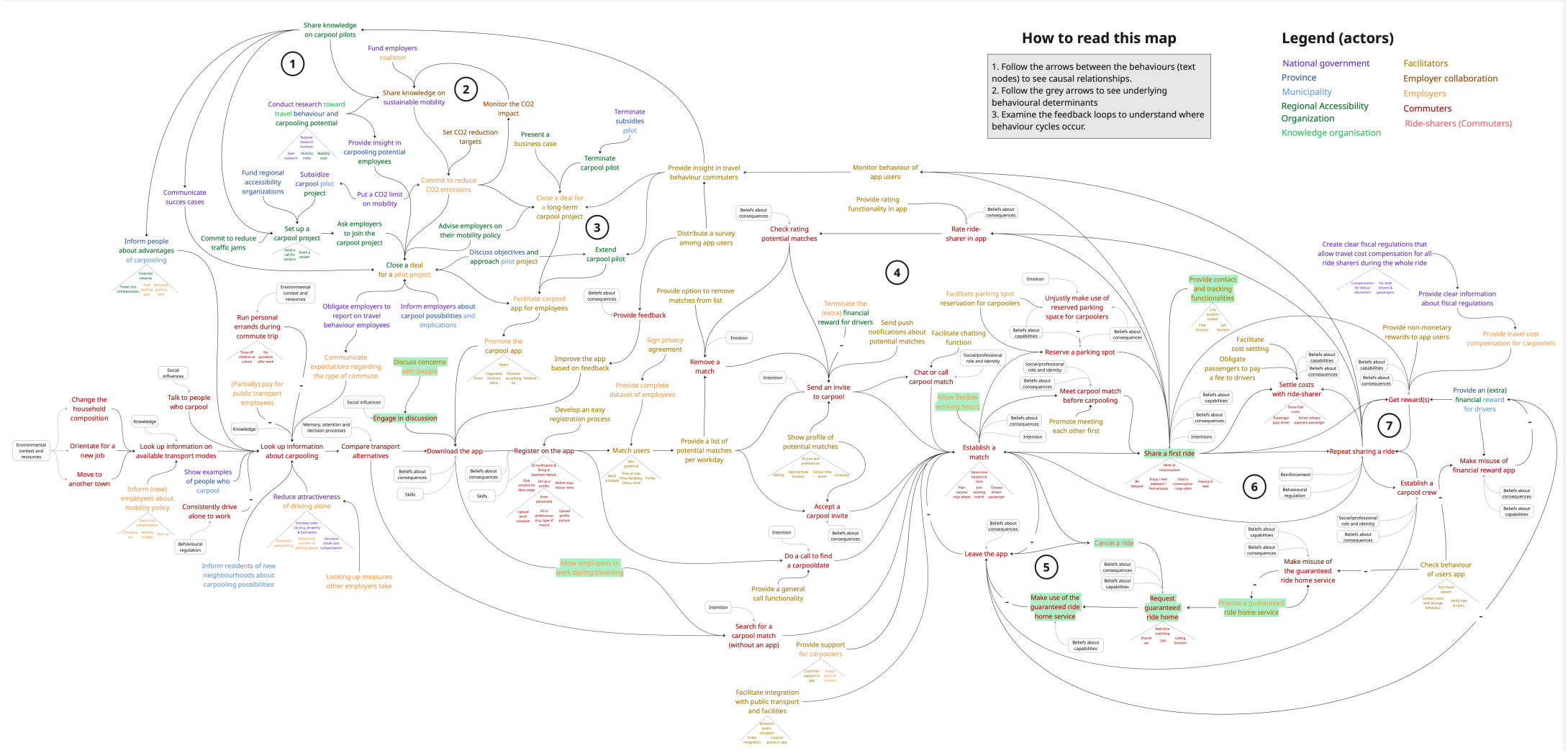


Figure I.14: Behavioural System Map highlighting theme 5 *'resistance based on lack of control and the pressure to socialise'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to theme 5 are highlighted in green.

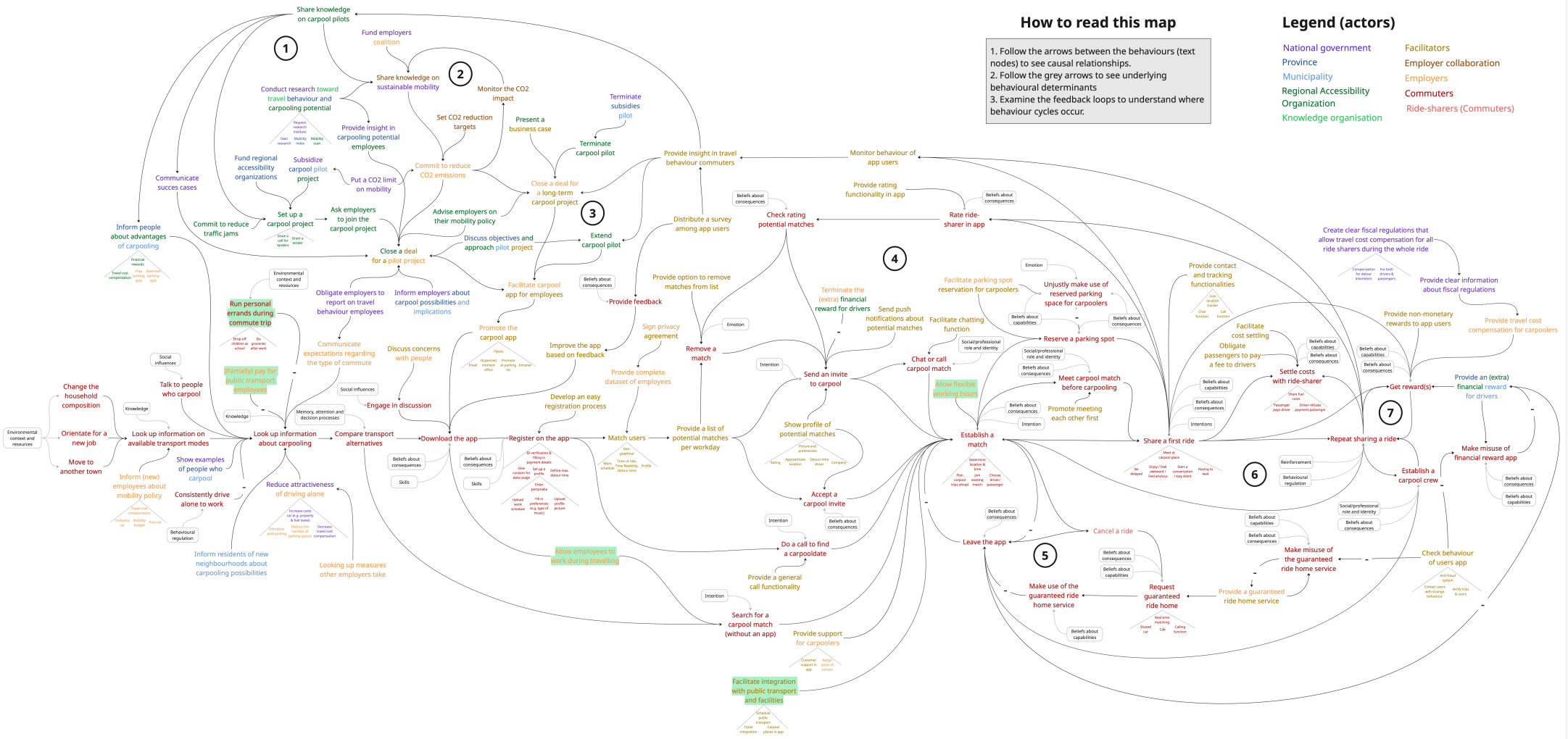


Figure I.15: Behavioural System Map highlighting theme 6 *'dependencies on the structural and social environment'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to theme 6 are highlighted in green.

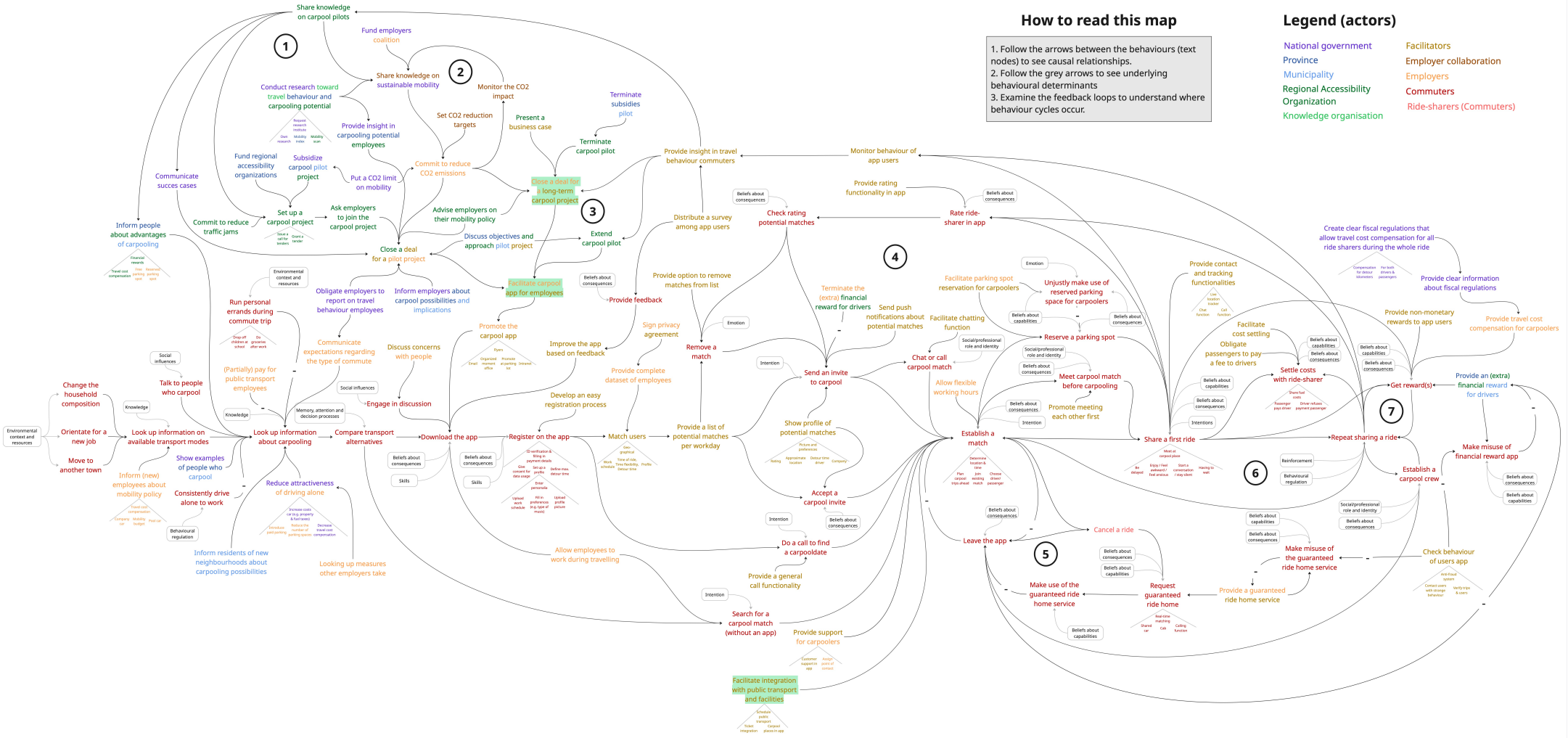


Figure I.16: Behavioural System Map highlighting theme 7 *'integration of carpooling the mobility system'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to this theme are highlighted in green.

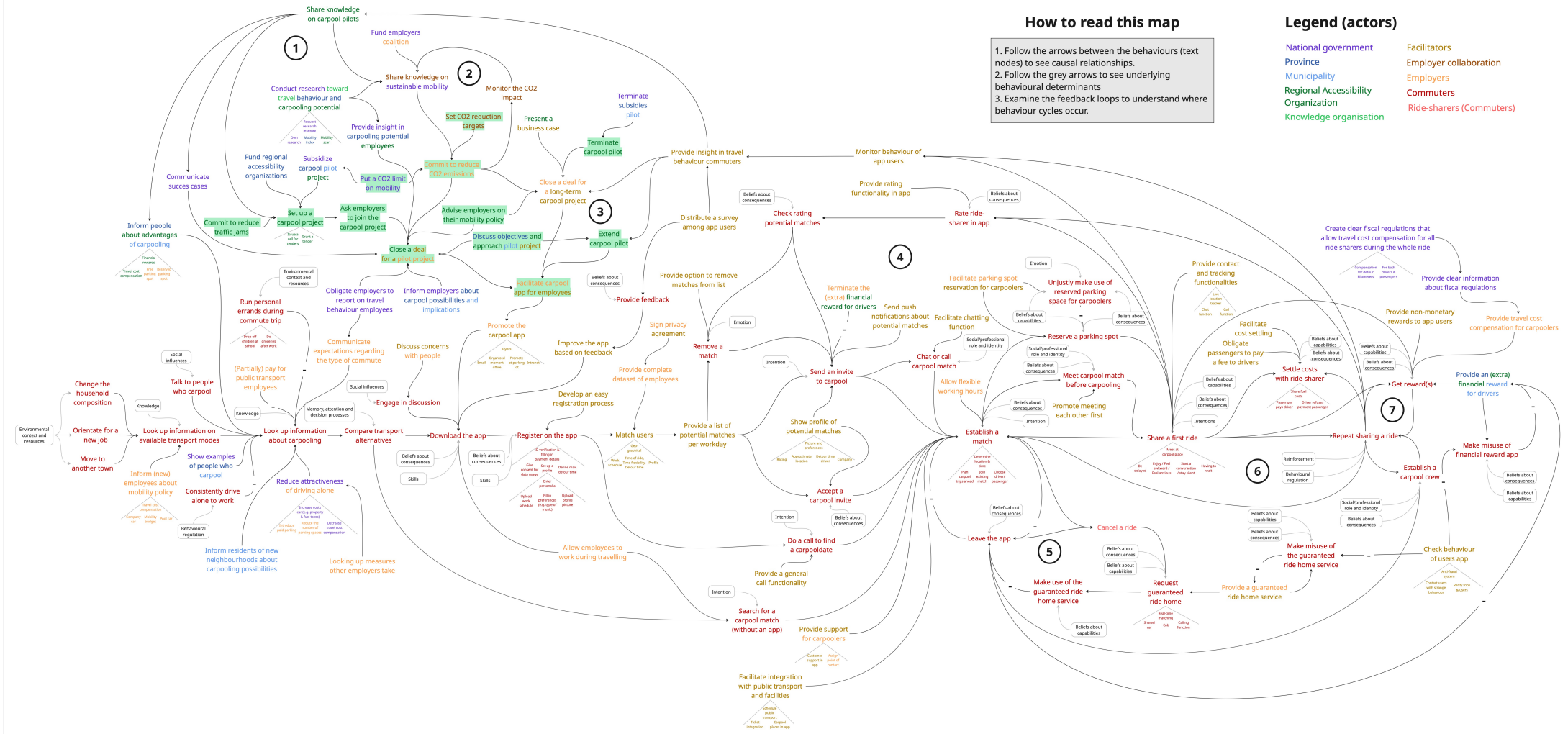


Figure I.17: Behavioural System Map highlighting theme 8 *'fragmented roles and absence of shared visions across multiple actors'*.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. The behaviours related to theme 8 are highlighted in green.

J

Behavioural System Map based on literature

This appendix contains the behavioural system map that is constructed based on literature.

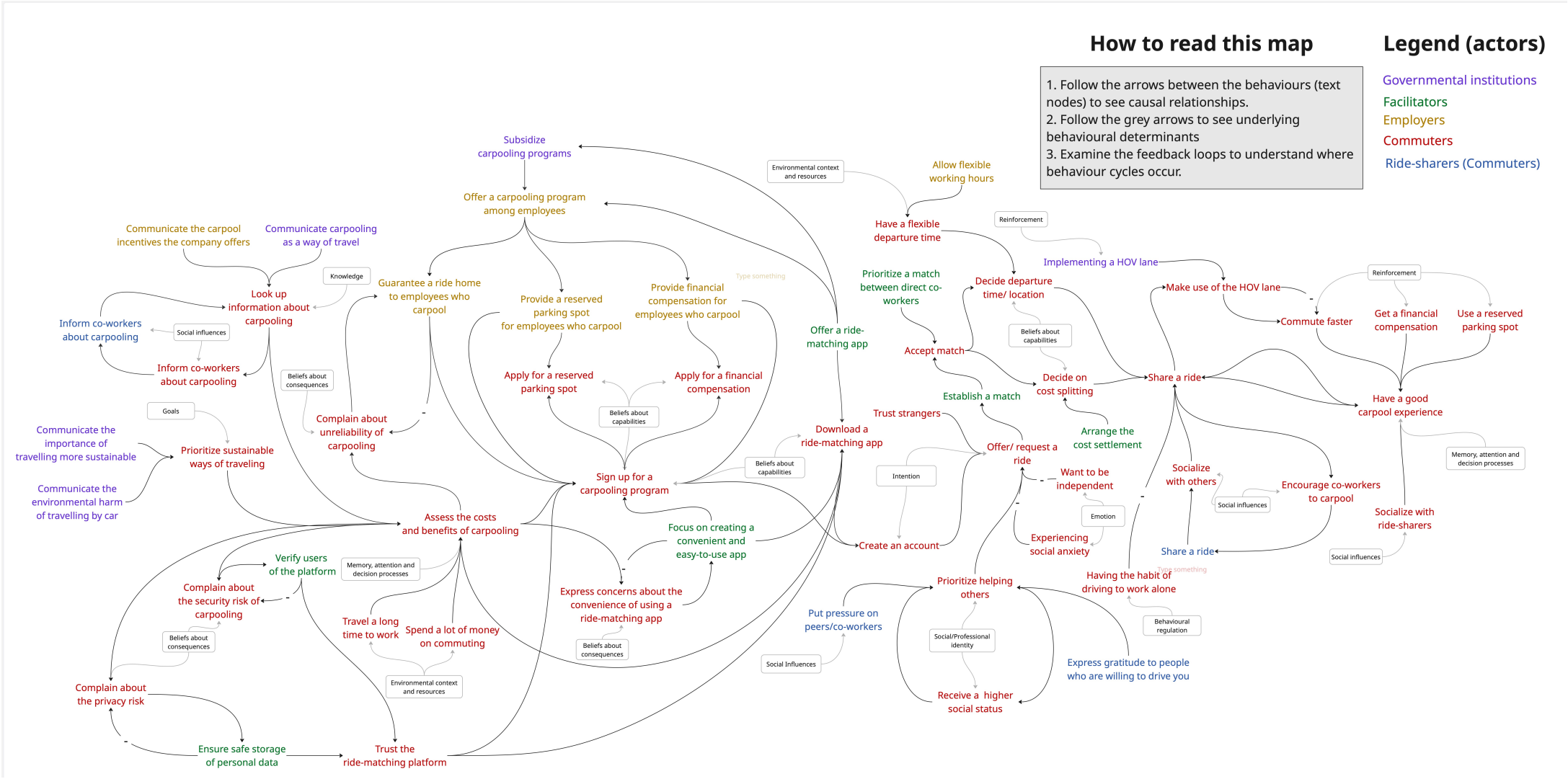


Figure J.1: Behavioural System Map of commuters' decision-making when considering carpooling based on literature.

The grey box at the top right explains how to read the map. The colour of the text node shows which actors display the behaviour, this is presented in the legend at the top right. The small text nodes grouped under a behaviour show specific types of actions that fall under that behaviour. Section 4.1.4 discusses this BSM.