Smart and attractive travel alternatives for car users – a study from the Dutch context

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Abstract: *This paper explores the potential to reduce car kilometres, by presenting smart and attractive travel alternatives. Results from a survey show that the majority of people are willing to accept alternatives for car use. For "daily necessities" trips (work/study and shopping), the majority of people are open to alternatives (such as working or shopping from home, or using an (e-)bike instead of the car), while for "fulfilment" trips (going to hobby/sports and visiting family and friends), this appears to be less the case. Public transport (PT), is less likely to be chosen for the majority of activities, reflecting a need for improvement. In addition, having public transport reimbursed by the company or having a bike scheme at work makes people more open to the relevant alternatives. The conclusions can be used to develop various policy recommendations to promote more sustainable behaviour, e.g. employer policies towards bicycle schemes, parking pricing and zero-emission zones in the cities.*

Keywords*:* car km reduction, mobility alternatives, car users, PT attractiveness, social extended reality.

1. Introduction and Motivation

The Netherlands is struggling to meet the climate goals, challenged by growing population, the lack of space in its urban areas and the need to build thousands of new homes in or near those urban areas. Globally, the transport sector contributed to around 37% of CO_2 emissions in 2021 (IEA, 2023). In the Netherlands, mobility corresponded to about 21% of the CO_2 emissions shares in 2021, and the share went up to 23% in 2022 (CBS, 2023).
The fact that we aim to comply with the climate agreement and that the transport emissions are on the rise, shows that there is a need for impactful interventions, which do not only consider more sustainable travel modes, with less carbon emissions, but also the choice of not traveling - which was the norm in the most impactful years of COVID-19. The impact of the COVID-19 restrictions showed to some cities in the world the benefits that less car traffic could have in air quality (Butler et al., 2020).
Although in recent years a lot of effort has been put into tackling the CO_2 emissions from cars, that is not the only downside of using this transport mode (Kamruzzaman et al., 2015). Car usage and its negative outcomes can be connected to car dependence phenomenon, which is a situation that access to different transport modes other than the car becomes a struggle, and using the car becomes essential for accessibility and social participation (Mattioli, 2016). Car dependency in the European context is resulted from a historical process (Pooley, 2006) in which different aspects are interlinked and result in prioritization of car on the roads, diffusion of car-dependent land-use patterns (urban sprawl), issues with public transport (PT) being able to

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provide competitive service to the car use and a culture of consumption related to the car (Mattioli et al., 2020).
To reinvent current mobility narratives and possibilities, the technocratic and the imaginative system need to be challenged in order to go beyond the current and restricted set of alternatives that are present (Brömmelstroet et al., 2022). Smarter and attractive alternatives to the current private motorized transport modes are needed to create an improved transport system, that integrates also the land use (Dur and Yigitcanlar, 2015) and sustainable infrastructure development (Yigitcanlar, 2010).
The concept of traveling smarter has been introduced to address the negative effects of private vehicle usage (Golbabaei et al., 2020), while at the same time bringing a more sustainable transport system, where the environmental, economic and social effects of mobility are considered in a more balanced way (Paz et al., 2013). It is essential to, first, re-consider our need for travelling in specific situations, as well as to account for smarter solutions to be implemented, so as to offer sustainable travel alternatives to people and facilitate them in the best way possible to fulfil their activities. However, our current problem is that we lack knowledge about the potential of certain trips or activities (which are often made by car) to be avoided or replaced by more sustainable alternatives. Further, we lack knowledge about people's motivations or barriers to choose more sustainable alternatives. As Urry (2002) puts forward in his work, there are no simple ways to distinguish which trips are necessary, especially since they are part of a system that builds and brings together the social and economic life of an individual.
In this study, we combine the knowledge about recent travel habits with research into what would motivate or hinder people to travel less or with a more sustainable mode using travel data and a survey on preferences towards alternatives. This is in line with Hermwille (2016), by suggesting simple solutions to people in order to reinvent the travel alternatives. The results of the travel data analysis and the survey give insights into the potential to reduce the number of kilometres travelled by car and thus reduce CO_2 emissions, and to possible policy solutions that could be enhancing this potential.

2. Research approach

2.1. Dutch travel survey analysis

Travel patterns from the Dutch population were explored using data from the Dutch National Travel survey ODiN (Onderweg in Nederland) from the year 2019 (as a pre-pandemic year). This analysis indicated that the percentage of short trips (considered as up to 12 km) for different trip purposes, made by car are relatively high, especially since the Netherlands has a strong cycling culture and good cycling infrastructure, with substantial public transport and shared mobility systems. Overall, short trips correspond to a total of 15.35 billion kilometres travelled during the year. The trip purposes for which a lot of short car trips were made, (as identified in the ODiN data) were shopping (groceries and other) (29.3%), picking-up/dropping-off people and goods (17.7%), going from/to work (15.9), sports/hobby (9.7%), and for social visits (9.2%). Also, the share of car kilometres for long distance trips (longer than 50 km) is high. For 2019, the data revealed that around 48 billion kilometres were travelled by car for long distance trips, and about 1/3 of these trips were from/to work.

2.2. Data collection

The fact that many (very) short trips and the high share of long distance trips are made with the car, highlights the need to explore alternatives for either avoiding the trip or substituting the transport mode or making the trip shorter. Also interesting to explore are the motivations and barriers behind the preferences of people to adopt or not such an alternative. For the above, additional data had to be collected, which was achieved via an online survey, in the format of a questionnaire. The survey was set up and distributed via ANWB's (the Royal Dutch Touring Club), panel and, in total, 1965 responses were obtained. The data was collected between November and December 2022. A weighting factor was used to make the sample representative for the ANWB members, which were 5 million in total in the panel.
The respondents were asked whether they would consider several alternatives proposed, and if so (or not) what the motivations or barriers were for choosing a specific alternative. The alternatives formulated in this study were centred around the idea that to travel in a smarter way, doing activities at home/closer to home should be a priority, or travelling by a more sustainable mode (in some cases combined with doing activities closer to home). For some trip purposes, doing activities online or using other advanced virtual technologies, such as Social eXtended Reality (SXR), was offered as an alternative. Performing activities closer to home was introduced by the elaboration of alternatives such as using the (e-)bike or by going with public transport. Table 1 gives an overview of the selected trip purposes, based on short trips that were often performed by car from ODiN data (2019), and the alternatives proposed for each trip purpose.

Trip purpose	**Alternatives proposed**
Shopping	Online; Closer to home; Use a cargo bike; Use PT
From/ to work trips	Work-from-home; Use Social eXtended Reality (SXR) in a close by facility; Use (e-)bike; Use PT; Carpooling
Leisure/ sports & hobby	Do it closer to home; Use (e-)bike; Use PT; Carpooling
Social visits	Meet people online; Use (e-)bike; Use PT

Table 1: Trip purposes and selected alternatives proposed for short distance trips.

Not all the participants were asked to respond for the alternatives for all trip purposes, since this was based on whether they had mentioned that they were frequent car users for certain trip purposes or not. Then, they were assigned to follow-up questions only for the trip purposes which they were mainly taking the car for.
For long car trips, the respondent could select one trip purpose as being the main one for their long distance trips, from the following set: going to work; to work meetings or business trips; visiting family and friends; going shopping; going to sports; and doing leisure activities such as cinema and nature parks. The alternatives offered were not travelling, travelling less often, travelling a shorter distance, using SXR for online activities and using a more sustainable mode (such as public transport, bike or carpooling). Multiple responses in this question were possible.
For each trip purpose, the respondents were given a small set of alternatives to declare preference on, to avoid a complicated and long questionnaire. The alternatives regarding active travelling presented are in line with Xia et al. (2013), by bringing its sustainable and health benefits of travelling. Also, public transport, a more traditional

alternative, is considered as well, because it has advantages over private vehicles, due to its higher carrying capacity, and, thus, lower emission CO_2 rate (Xia et al., 2013). Another more traditional and still contemporary alternative presented to some of the trip purposes, was carpooling, which is a form of ridesharing that exists for many years (Butler et al., 2020) but is still not very broadly used.
As mentioned above, the questionnaire focused on exploring the potential for more sustainable travelling, by offering smart and attractive alternatives for specific trip purposes, looking further at motivations and barriers related to the use of these alternatives. The focus of the survey was on frequent car users, the target group of this study, and the potential replacement of car trips or reducing the car trip length.
Other questions addressed the respondents' trip satisfaction when using different modes; peak hour avoidance; pre- and post-pandemic public transport use; mobility benefits offered by the employer; familiarity of people with some mobility concepts and innovative technologies; the alternatives that are currently available to person; and what people considered as most important elements for using public transport.

3. Results

3.1. Descriptive statistics from the sample

The first set of questions from the survey collected socio-demographic characteristics from the sample, and from que 1965 answers obtained, when comparing the sample to the whole Dutch population, the differences found were small. Table 2 provides an overview of the descriptive statistics from the survey sample.

Descriptive statistics		%
Gender	Man	52.3
	Woman	46.8
	Other	0.3
	I would prefer not to say	0.5
Age	18-34	18.0
	35-49	29.0
	50-65	28.0
	>=66	25.0
Educational level	No or basic education	0.4
	LBO / VMBO / MBO 1 / VBO	4.5
	MAVO / HAVO of VWO / VMBO / (M)ULO	8.2
	MBO 2, 3, 4 or MBO 1998	24.4
	HAVO of VWO / HBS / MMS	15.6
	bachelor (HBO or university)	27.8
	Master/PhD/Postdoc (HBO or university)	19.1
Gross yearly income	minimum (less then € 12.500)	2.2
	below average (€ 12.500 - € 35.000)	13.1
	average (€ 35.000 - € 40.000)	17.7
	between 1 and 2 times the average (€ 40.000 - € 70.000)	29.8
	two times the average or more (more than € 70.000)	17.5
	don't know/prefer not to say	19.6
	One-person household	21.6

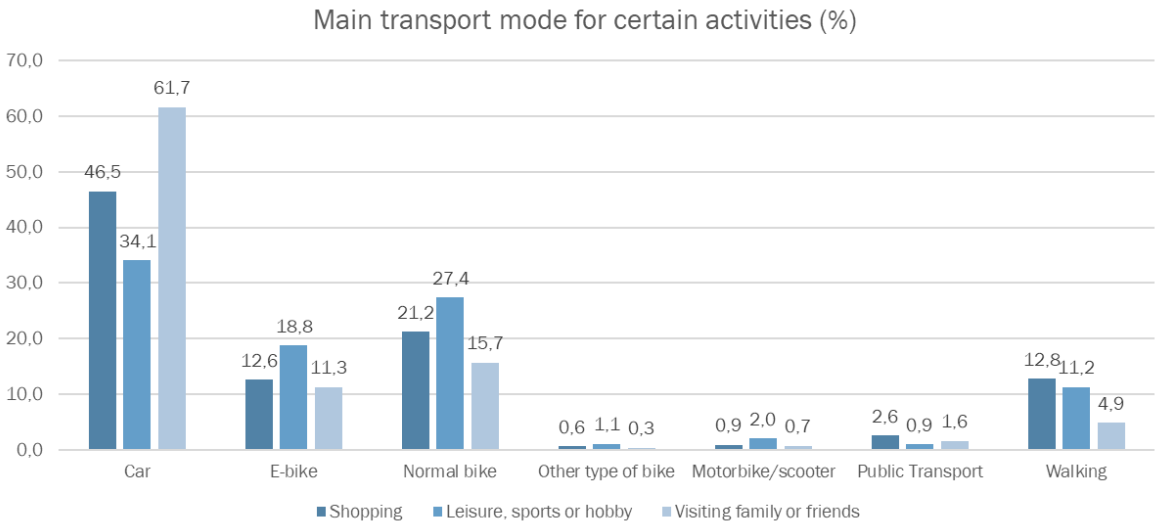
Household composition	Couple	43.1
	Couple + kid(s)	28.2
	Couple + kid(s) + others	0.9
	Couple + others	0.5
	Single parent + kid(s)	3.1
	Single parent + kid(s) + others	0.1
	Other	2.4
Employment status	Full time employed (36 hours+)	33.3
	Part-time employed(0-36 hours)	24.4
	Unemployed	2.4
	Self-employed	4.5
	Student	0.4
	Retired	26.5
	Other	8.4

Table 2: Sociodemographic characteristics from the sample.

3.2. Current travel behaviour

To investigate current travel behaviour from the respondents, questions about their main transport mode, enjoyment of travelling and familiarity with certain concepts were addressed. First, the results from their main transport mode show that the car is the most frequently used transport mode for the respondents, for all trip purposes, which is also consistent with the data in ODiN (2019). Figure 1 shows the percentage of respondents that indicated their main transport mode for three different activities: going shopping, going for leisure, sports or hobby, and visiting family and friends. The figure does not bring the share of people that selected “not valid” or “other” as a response. The high share of car use confirms the need to explore the potential to decrease the number of car trips.

Figure 1: Main transport mode for different trip purposes (in %).



With regards to the enjoyment of travelling, driving a car and riding a bike, according to the data, seem to be the most enjoyable means of travel for people, with 76.9%

liking it (very much) to drive a car and 67% liking it (very much) to ride a bicycle. In terms of public transport, trains are more attractive (24.5% enjoy travelling by train very much) than travelling by bus, tram or metro (13.7% enjoy it very much).
Familiarity with different mobility concepts was also asked in the survey. Around 89% of the respondents said they are familiar with trip planning apps, and half of the sample knows well the concept of first and last-mile transport options. On-demand transport is familiar for 37.3% of the respondents, however a share of 34.9% is unfamiliar with it. SXR is in general not well known (66%), as expected due to its innovative nature, but 18% has at least heard of it, while 16% indicate they know exactly what it is.

3.3. Preference of alternatives

To explore the potential to reduce or avoid unsustainable car kilometres travelled for short car trips, participants were asked how likely they are to choose an alternative for different trip purposes, measured in a four-point Likert scale. Table 3 shows the combined percentage of people that said they are quite or very likely to choose the proposed alternatives, for each alternative given for the various trip purposes. As explained in Table 1, not all the alternatives were offered to all the trip purposes (as indicated with the '-'). N corresponds to the number of valid answers to the question.
Multiple travel alternatives could be chosen in each given trip purpose. The table shows that doing the activity online, when offered, and using an (e-)bike to get to an activity were the most popular alternatives chosen, while using public transport or carpooling were less popular among the respondents and, interestingly, only slightly more popular than using SXR facilities.

Likelihood to choose an alternative per trip purpose – short distance car trips (% of respondents that choose the alternative)				
Alternatives	Trip purposes			
	Shopping (N=913)	Work/study (N=1230)	Sports and hobbies (N=669)	Meet family and friends (N=1212)
Online	60.8	56.7	-	7.3
Closer to home	56.9	-	40.5	-
Use a (cargo) bike	43.7	-	-	-
Use Public transport	10.3	22.6	7.9	14.8
Use SXR	-	18.9	-	-
Use (electric) bike	-	38.5	50.1	53.3
Carpooling	-	20.1	247	-

Table 3: Likelihood to choose an alternative - short distance trips.

For long distance trips, first, the respondent had to select which was the main purpose of the trip, and then they could select which alternative(s) would they be willing to choose instead of making the trip by car. Table 4 shows the percentage of respondents that chose an alternative per trip purpose. From the numbers at the bottom row in Table 4, it is evident that the majority does not seem willing to adopt an alternative to their

car trip at all. However, although with a small acceptance, not and less travelling seem as rather as promising alternatives, especially for going to work/study location, business trips and going to leisure activities. Travelling in a more sustainable way for business trips and leisure activities also showed potential from the responses. Since the reference considered here are long distance trips (above 50 km), this potential could make a considerable impact in terms of emissions and kilometres travelled.

Alternatives	Likelihood to choose an alternative per trip purpose – long distance trips (% of respondents)						
	Going to work/ study	Going on a business trip (at a different location than your work)	Going to visit family or friends	Going for shopping	Going for sports	Going for leisure activities	Other
Not travelling	17.9	13.6	7.8	8.0	9.1	12.6	2.2
Travelling less often	14.1	13.7	14.1	14.5	0.0	12.2	0.8
Travelling shorter distance	1.9	0.0	0.5	1.0	0.0	5.7	1.6
Using SXR for online activity	6.1	7.8	0.9	2.0	0.0	0.4	0.8
Travelling in a more sustainable way (e.g., with PT, bike or carpooling)	11.4	15.0	13.4	11.1	10.8	13.6	9.0
None of the above	63.8	59.1	68.5	68.6	80.2	63.2	89.4

Table 4: Likelihood to choose an alternative - long distance trips.

3.4. Motivations and barriers

As a follow-up question to the one on alternatives for short distance trips, participants were asked to select motivations and barriers that they would have in relation to choosing that alternative instead of the car. For **short shopping trips**, the main **motivations** considered were saving time/no travel time for online shopping (N=351) or shopping closer to home (N=312); more convenience when shopping online (N=335); getting extra exercise by going by (e-)bike (N=226); and not having to search for parking when taking public transport (N=64). As main **barriers**, longer travel times when using PT (N=457) and less flexibility (N=343) were most often chosen for this trip motive, followed by enjoying the actual experience of shopping (N=278); and less variation in available shops when shopping closer to home (N=182).
For **going to work/study** (short trips), the main **motivations** were no travel time due to working from home (N=602); getting extra exercise by going by (e-)bike (N=362); choosing the (e-)bike (N=224), PT (N=136) or carpooling (N=127) because they are more sustainable options; and having less travel costs (N=130) for carpooling. The main **barriers** for choosing an alternative for the car were the perceived difficulty in arranging carpooling with others to go to work (N=634); longer travel times when using

public transport (N=615) or (e-)bike (N=493); and the lack of possibility to work from home (N=450).
For **short leisure trips**, main **motivations** were also related to getting extra exercise by going by (e-)bike (N=247); less travel time when doing it closer to home (N=204) and being more convenient than using the car (N=104); using an (e-)bike (N=118) because it is a more sustainable option; and getting social contact with other people by carpooling (N=96). In terms of **barriers**, longer travel time (N=329), higher trip complexity (N=199) and higher costs (N=186) for using PT were the most chosen; followed by 'difficult to arrange with others' for carpooling (N=289); and less variation with options for leisure locations closer to home (N=164).
Lastly, for **short social trips** such as visiting family and friends, the results showed that the main **motivations** also relate to getting extra exercise by going by (e-)bike (N=471), choosing this option because is more sustainable (N=238) and less costly (N=169) compared to the car; taking the public transport as a more sustainable option (N=68); and lastly with only a few mentions, meeting people online because there is no travel time (N=56) and is more convenient than travelling (N=35). In relation to the main **barriers**, lack of social contact if meeting online was highly cited (N=888); next, longer travel time for using PT (N=555) or (e-bike) (N=296) followed; and higher costs (N=317) and higher trip complexity (N=258) when using PT.

3.5. Public transport preferences

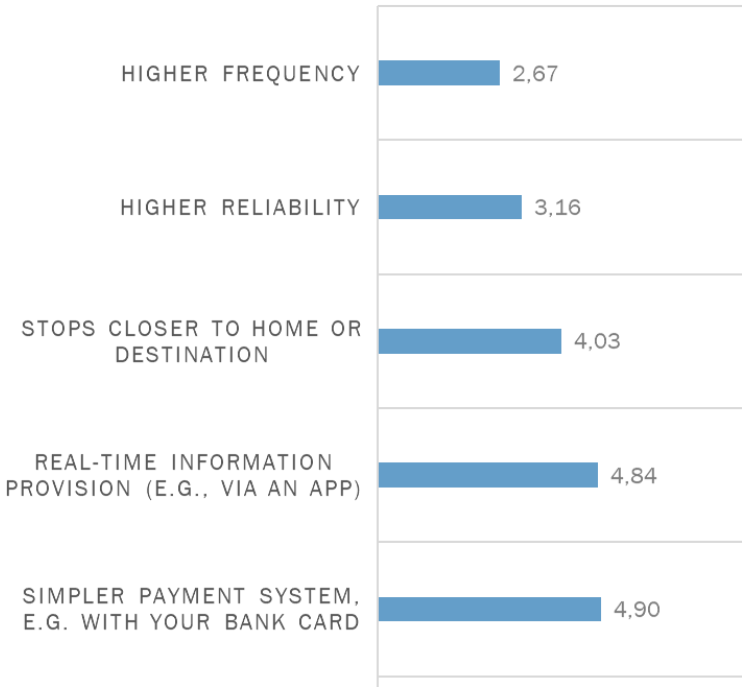
To further investigate the potential of public transport, respondents were asked to rank the five most important characteristics for them (from 1 to 5), regarding their preferences towards this transport mode. The characteristics offered were the following:

- Demand responsive (operate in a similar way as a taxi or Uber service, but shared with more people).
- Smarter features, i.e. free Wi-Fi, USB ports, electricity outlet, etc.
- Real-time info provision (e.g. via an app that shows where you are in relation to your destination or how soon the vehicle will arrive at your stop).
- Higher frequency.
- Higher reliability.
- More comfortable interior space.
- Reservation of seats.
- Easily accessible/ used by everyone (e.g. for physically or mentally impaired people).
- Easier payment system, e.g. with your bank card.
- Special discount for specific population groups (for example students or 65+).
- 24 hour service.
- Stops nearer my home or destination .
- Better combination with other transport modes in stations/ stops, so that more options are offered for the last part of your trip (e.g. possibility to rent a scooter or bike after you leave the bus stop).
- Many amenities at the stations.

Results show that people still miss the "basics" from public transport. The top three that compose the rank are: having higher frequency, higher reliability and stops closer to home or destination. The fourth most chosen was real-time information provision and in fifth place simpler payment system. The "smart" elements seem to not have a big importance for the respondents, since they do no show in the top five categories

such as having on-demand transport, reservation of seats or smarter functionalities (Wi-Fi, USB ports and charging infrastructure). Figure 2 shows the ranking, from the most important to the least important characteristic for public transport, according to the respondents.

Figure 2: Ranking of most important characteristics for public transport.

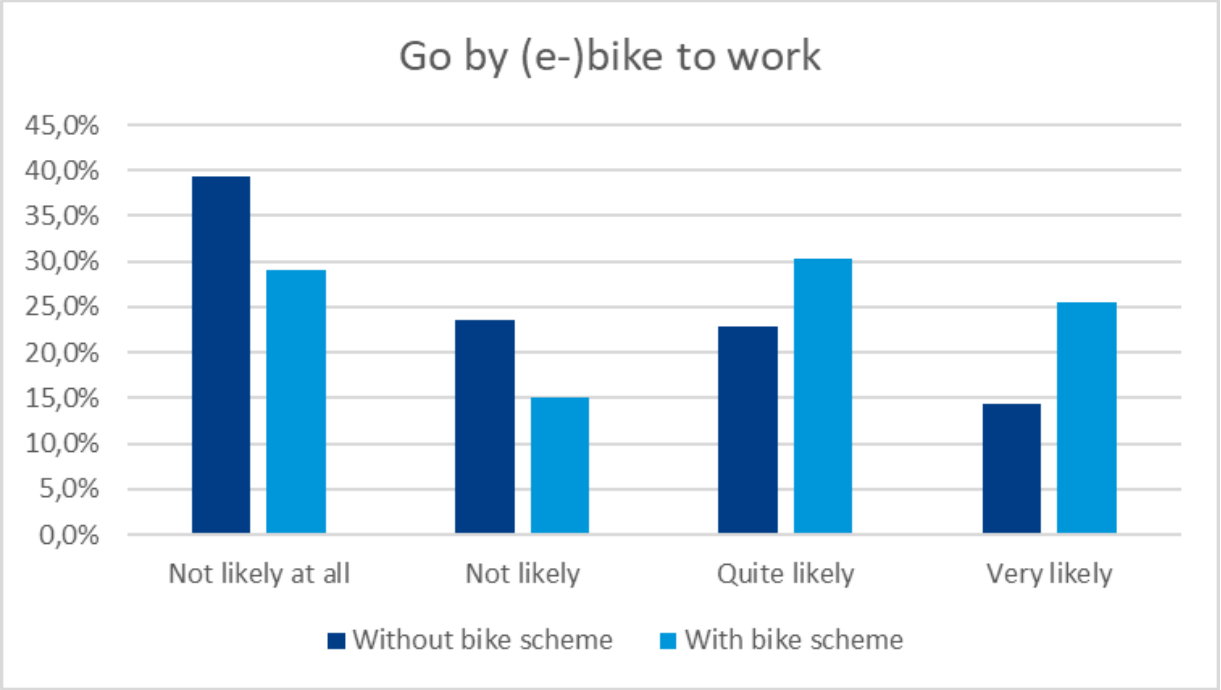


3.6. Potential travel behaviour and policies schemes

As a further investigation on the results, some cross analysis was conducted with the data, as a way to connect potential travel behaviour identified in the chosen alternatives and mobility benefits, which could be translated into new policy schemes. Respondents were asked if they had access to the following mobility benefits (multiple answers were possible): company fuel/recharging pass, kilometres compensation (car and other transport modes), access to a company car, company bicycle, public transport reimbursement or car reimbursement.

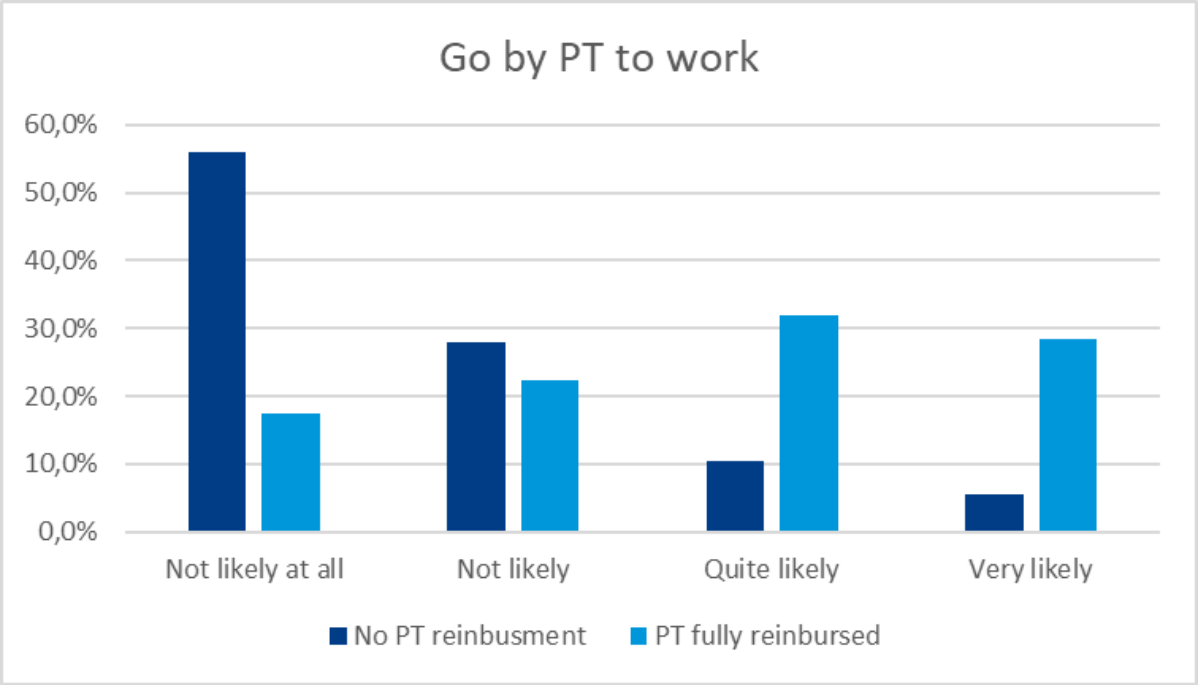
From the available mobility benefits, two cross references were conducted. First, people that were willing to go to work by (e-)bike and had access to a bike scheme at work. The results show that people who have a bike scheme at work are more open to take the (e-)bike as an alternative to the car, compared to those who do not have such a scheme, see also Figure 3 on these results. In general, around 55% of the respondents with a bike scheme would be quite or very likely to go by (e-)bike to work, and this percentage falls to around 36% of the respondents that don’t have the bike scheme.

Figure 3: Likelihood of respondents that would go to work using a(n) (e-)bike - with and without a bike scheme at work (in %).



The second cross analysis related people who were willing to go to work with public transport and that could have it fully reimbursed by their employer. Results show that people with reimbursement for public transport seem much more willing to adopt it as an alternative. Figure 4 shows the likelihood of respondents that would go to work using public transport, having it or not fully reimbursed by their employer.

Figure 4: Likelihood of respondents that would go to work using public transport – with and without having it fully reimbursed by the employer (in %).



4. Conclusions

The insights from the analysis of the survey lead to several interesting takeaways regarding the willingness of people towards alternatives for certain trip purposes and their motivations and barriers. First of all, the majority of people are willing to accept alternatives for car use. However, there are some who do not seem open at all, and this is often related, as respondents indicate in their comments in the survey, to the nature of work or employers' policies, physical disabilities or simply their love for driving. Overall, the respondents' decisions are very much context-dependent, and exploring them for different trip purposes has been very insightful.

Regarding the different trip purposes, when it comes to "daily necessities" (work/study and shopping), the majority of people are quite open to alternatives, while for "fulfilment" trips (going to hobby/sports and visiting family and friends), this appears to be less often the case. This comes in contrast to some studies on alternative transport modes, which often indicate that, especially for habitual trips, changing the travel behaviour of people is much harder. This further implies that when aiming at influencing behaviour change, there is a need to be creative with the types of alternatives we offer to people, and take into consideration the various preferences and needs.

Regarding the types of alternatives offered, staying at home and performing activities online seem to have high potential, especially for work/study and shopping trips, while also the use of e-bike seems to be a "favourite" option for the majority of the trip purposes. This can be encouraged further via, for example, the existence of a bike scheme at work.

In addition to the conclusions regarding the alternatives, public transport seems less likely to be chosen for the majority of activities, with answers from the respondents reflecting the need for improvement of basic characteristics such as frequency or reliability. Public transport and carpooling, more traditional options, appeared about as popular as more innovative alternatives, such as Social eXtended Reality (SXR).

Interestingly, although not unexpected, the preference for not travelling for several trip purposes decreases greatly when it comes to the trip purpose 'visiting friends and family'. The need for social interaction became quite obvious from this survey. Another interesting result is that combining travelling with exercising seems a quite appealing aspect for a large number of respondents, as getting more exercise was one of the most often chosen motivations for using the (e-)bike.

In terms of motivations and barriers for choosing an alternative, sustainability as an attitude has started gaining audience. In addition, there is high and an interesting variation in the motivations and barriers as indicated by the respondents. However, travel time is always at the top of the list as an influential factor for making a mobility choice (and is thus rightly considered an important factor in transport modelling).

Analysing more in depth factors, like the provision of mobility benefits from work/study, provides even stronger insights on the potential adoption of alternatives. The results shows, for instance, that having public transport reimbursed by the company or having a bike scheme at work make people more open to the associated alternatives.

The conclusions presented can be linked to various policy recommendations that could act as push or pull factors to realise more sustainable behaviour, such as employer policies towards bicycle schemes and having public transport costs for work reimbursed, but also parking pricing, zero-emission zones in the cities, etc. Also, the motivations and barriers that were most cited can offer insights into what can be investigated further, like potential other alternatives that could be developed to better

suit current and future trends, or new technologies that could act as enablers for the proposed alternatives.
Further research could distinguish various respondent groups (e.g. based on age, income level, gender, as indicated by the respondents in the survey) and explore the differences in their preferences for certain alternatives, and their motivations and barriers. The identification of differences in population and their needs can facilitate the customization of policies, for example, by addressing a different focus in population groups that have the intention in changing their behaviour versus those who do not have that intention. Some insights to have that distinguished can be obtained by further investigating the open answers from the questionnaire.

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