The challenge of active mobility. How to motivate commuters to use active mobility?

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June 11th, 2019

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Background

"Two hours of driving a day tanks your health" (Shape, 2018). "Commuting is bad for your body and health" (Time, 2014). "Cycling to work means better health and a longer life" (Washington Post, 2017). These are some examples of the actuality of the effects of driving to your health. But even though the media warns us for the effects of driving on our health, we cannot seem to decrease amount of time travelled to our work by car (Van Ommeren & Rietveld, 2005). In order to try and realise this, an in-depth view of private car usage, its consequences, especially physical consequences, and the relation between them is needed.

Since the commercialisation of the gasoline-powered automobile industry around 1900 (Rim & Mi, 2017), it rapidly expanded and increased its influence on society. The significant increase of the influence of this development on our society, resulted in what we now call a 'car dependent' society (Brew, 2017). How could the automobile become this influential? Firstly, the mobility of a person owning a car increases significantly compared to a person not owning a car (Urry, 2004). One can drive to any place at any time, even together with others, as long as there are roads. This is something public transport cannot realise. This increased mobility is associated by car owners with freedom (Jensen, 1999). Secondly, a person's car can fulfil the role of a 'smart home', a second home, but then mobile (Urry, 2004). The status you get from owning a car, or even owning a specific type of car, is also a reason for people to invest in their automobile (Urry, 2004). There is more to understand from the dominance of the car as a means of transportation. The automobile industry changed the earth's surface and cities and influences the social structure of society. But there is a downside to this system of automobility. Transportation vehicles significantly contribute to the rising level of carbon dioxide in the atmosphere (Oman, 2002). Carbon dioxide is the foremost reason assigned to global warming (Oman, 2002) and an increase results in decreased biodiversity around the world (Sala et al., 2000). The use of automobiles also significantly contributes to the atmospheric pollution, harmful for both people and the environment (Kennedy et al., 1987). Besides the effects of the automobile industry on the environment, negative consequences apply for people as well. Annually, 1.2 million people die

because of automobile accidents (Miller & Spoolman, 2018). When spending a lot of time driving, your health is affected in many ways. There is a strong connection between obesity and driving (Jacobson et al., 2011). Driving exposes you to more polluted air and time spent commuting negatively affects your cognitive well-being (Lorenz, 2018). Driving causes higher levels of stress (Kageyama et al., 1998). Transportation combined with sitting increases the risk of experiencing chronic disease (Bauman, 2013). It seems that these negative consequences can only be taken away by adjusting our overall transportation behaviour. Part of this transportation behaviour is necessary and cannot be fully eliminated from society. This is transportation related to commuting. How can we turn the negative aspects of automobile commuting into something positive for both us and the environment? This can be done by active commuting, physical activity combined with traveling to work. Active mobility can be promoted by increasing awareness around the benefits for your health and for the environment. For most people, however, arguments concerning their own health are most likely to convince them to start using active modes of transportation (Merom et al., 2008; Cass & Foulconbridge, 2016). Environmental arguments, however, do not explain differences in e.g. cyclist behaviour (Prins et al., 2016).
Continuing from this introduction, the research will cover the following elements: research problem, theoretical framework, conceptual model, hypotheses, methodology, data analysis and the conclusion.

Research Problem

As indicated in the introduction, active commuting can be part of the solution to both environmental and health problems. Health is an important reason for people to start using active modes of transportation. For health to become a reason for more people to walk, run or cycle to their work, increased awareness is one of the necessary aspects. Over the past years, media attention devoted to the negative aspects of driving increased (Shape, 2018; Time, 2014; Washington Post, 2017). Our awareness of and interest in our own health also increased (Gerralda, 2010). Besides the increased awareness, possible barriers to use active mobility to get to work must be identified for them to be solved and convince people to start using active modes of transportation to get to work (Prins et al., 2016). But, with plenty of motivational reasons and sufficient information on the consequences of their behaviour, why do most people still use their car to commute? Scientific research on this question is limited when it comes to a combination of spatial factors, awareness and behaviour.

The country of interest in this research is the Netherlands, the city of Groningen in particular. In 2017, the number of motor vehicles in the Netherlands increased to 12 million, of which 9,1 million cars intended for private use (CBS, 2017). The total distance covered by these passenger cars slightly increased to 119,1 billion kilometres (CBS, 2017). 28%, 33.3 billion kilometres, is work-related travel (CBS, 2017). 77% of commuter activity is done by car. Work-related travel is the point of interest in this research. Commuting is necessary and people commonly use the same route to work every day. If the commuting routine of people can be adjusted towards active modes of transportation, the environment and the people will benefit. In the Netherlands, Groningen is slightly above average in terms of commuter kilometres covered by its citizens. 23,6 kilometres compared to the Dutch average of 22,7 kilometres (CBS 2016). The figure below indicates the percentage of employees that travel from neighbouring municipalities to the municipality of Groningen.

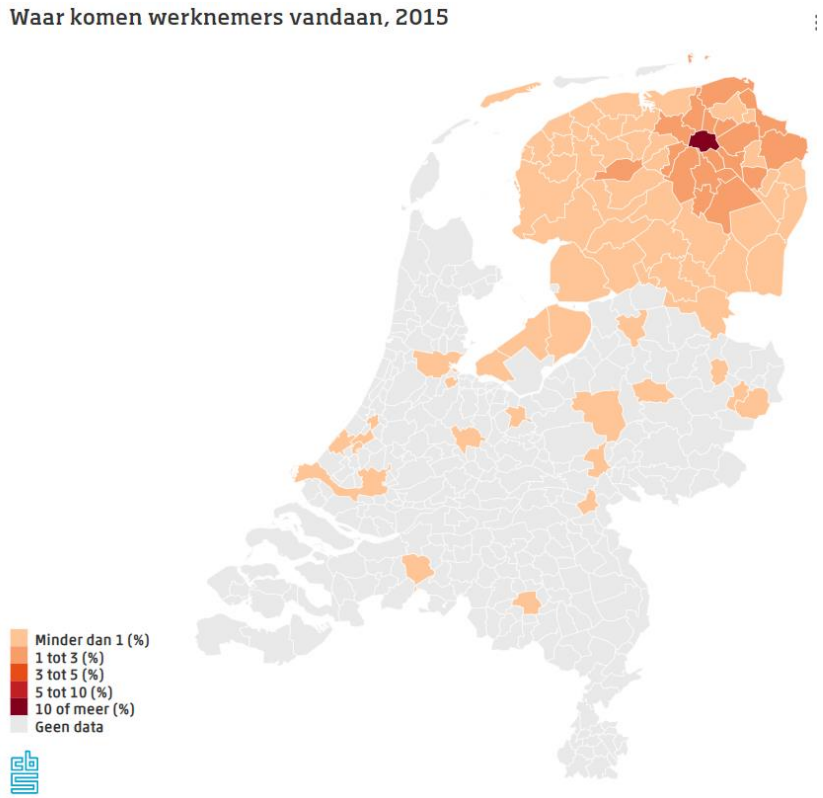


Figure 1. Source: CBS, 2015. Where do the employees working in Groningen come from?

Considered the information presented and the identified gap in scientific literature, the following research question has been formulated:

"How could people be encouraged to use active mobility (walking, cycling, public transport) to get to work in Groningen?

This research wants to establish understanding about the underlying reasons people have to continue to drive to their work and the motives people have to switch to active mobility. Once these reasons and motives have been identified and analysed, policy can be adjusted, of both the municipality and of the employers, to stimulate people to use sustainable modes of transportation. The people, the environment and the government could benefit from the adjusted policies.
In order to structure the answer of the research question, five sub questions have been formulated:

-What are the factors possibly influencing commuters' mode choice?

-What could be possible barriers to use active mobility to get to work? E.g. no convenient road to run/cycle, distance too big, facilities needed at work.

-Which of the identified factors influencing sustainable mode choice is the strongest determinant?

-How could people be encouraged through governmental policy or employer measures to use active mobility to get to work?

Theoretical framework

The theoretical framework has been built up of theories and concepts concerning active mobility and its barriers, modal shift, health, safety, social identity, habits, behaviour and new possibilities around the development of the e-bike.

Active mobility

Active mobility is defined in this research in the following way: Transportation of people using only modes of transportation which require physical activity. The questions focus on walking, running and cycling. Walking includes public transport.

Ramezani et al. (2017) have identified the most important factors of the urban environment in mode choice. In stimulating the use of sustainable modes of transportation, a diverse urban environment, urban design and well-connected streets are effective when combined. Following these factors, convenient bicycle paths in a fine environment would increase the change of sustainable mode choice for instance. Besides the physical environment, attitudes also influence mode choice. According to Fazio (1986), attitudes can determine a person's behaviour without other options being consciously evaluated. For people to adopt the right attitude towards sustainable mobility, policies influencing the costs (financial and time), people's valuation of sustainable mobility and the preferred modes of transportation have shown to be effective (Ramezani et al, 2017). People's valuation can be linked to the social identity theory (theoretical framework). The attitude towards the preferred modes of transportation (walking, cycling and public transport), can be influenced by adopting policies to make these modes of transportation more beneficial and making driving less beneficial in terms of time, costs, distance, experience.

The results from a research conducted by Heinen et al. (2013) indicate several ways in which people are influenced in their commuting cycle behaviour. An optimistic attitude towards cycling and facilities provided by the employer (bicycle storage, showers) stimulate cycling activity to work. The results of the same questionnaire conducted by Heinen et al. (2013) also indicate factors negatively influencing cycling behaviour. An increase of the distance between home and work and having sufficient parking places available at work decreases the likelihood of an employee cycling to work.

The use of public transport in particular is affected by some of the same factors already discussed in the previous text part. The two most important factors influencing public transport use, according to a research conducted in Australian cities by Wang & Liu (2015), are duration and cost of the trip. An increase in the duration and/or an increase in the cost of the trip result in a lower probability of using public transport. The third most important barrier to using public transport is the comfort of the private car.

Modal shift

Modal shift policies concerning the environment seem to have little to no influence on the people using their car for private ends (Cass & Faulconbridge, 2016). For modal shift policies to be able to work, it is important that these policies must function at societal level (Cass & Faulconbridge, 2016). The people who need to be influenced by modal shift policy need to directly experience possible costs or benefits from the choices they make. When stimulating a modal shift, the ratio between time spent and distance covered need to be clear (Cass & Faulconbridge, 2016). With this ratio not being clear, people do not know what loss or gain they precisely get, and they will stick to their old way of traveling. These issues around modal shift are important when addressing the topic in the questionnaire.

Health

In this research, health is defined the following way: A person's mental and physical condition. To make health measurable, not in a precise number but in terms of better or worse, the conditions mentioned in the introduction need to be assigned to one of the two values. Breathing in polluted air: worse. Strong connection between obesity and driving: worse. Driving causes higher levels of stress: worse. Traveling combined with sitting increases the risk of chronic decease: worse. Physical activity: better. Other advantages or disadvantages of active mobility or driving will be assigned a value accordingly. Important to add to the notion of health is that taking the first step in physical activity is the most important one (Jones, 2003). If a person's physical activity goes up from nothing a day to something, the benefits for his or her health are significant. This first step is also the hardest step (Jones, 2003). If people are not used to exercising, it will take them much more effort to put themselves to it than it takes for someone who regularly exercises.

Safety

The division between health and safety has been made intentionally, for health to focus on physical fitness and the physical and mental consequences of driving, and for safety to focus on the risks of using active mobility. An important aspect in choosing your mode of commuting, is the actual and the perceived safety level. According to Lee et al. (2013), people are discouraged to walk in the presence of high-speed traffic and high traffic intensity. People are encouraged to walk in areas with properly connected streets and clear entrance to possible destinations. This establishes the view that spatial planners can stimulate active mobility by adjusting neighbourhoods to the preferences of pedestrians. The most important safety measure to enhance the actual safety of pedestrians and cyclists, is to lower the speed limit applied to roads frequently used by pedestrians and cyclists (Pucher & Dijkstra, 2003). This does not only decrease the number of accidents between automobiles and pedestrians or cyclists, but also decreases the fatality rate in such accidents (Pucher & Dijkstra, 2003). Other possible measures to enhance the safety of pedestrians and cyclists are spatial design focused on their needs in traffic, automobile restrictions in urban areas and improved education for all traffic users (Pucher & Dijkstra, 2003).

Social identity

The social identity theory refers to the process in which individuals try to maintain a positive view of themselves (Tajfel & Turner, 1979). This theory explains social behaviour in terms of the process of social categorization, social comparison, and social identification. The social identity theory assumes that people define themselves based on personal and social aspects (Wang, 2017). People want to belong to a particular group and want to participate in society. The social identity is about the individual's self-concept, and the person's value towards the membership of a social group (Wang, 2017).

In a research conducted by Heinen et al. (2013), results from a questionnaire indicated that cycling behaviour of a person is influenced by the expectations of their fellow workers. These expectations are accounted for in the social identity theory and are used to determine the respondent's reaction to these expectations.

Habits

For people to change their mode of commuting, they need to change their habits. Changing a habit is difficult, because in doing so an additional barrier exists and needs to be overcome. According to Gardner & Rebar (2019), a habit is the situation in which a certain context automatically generates a certain action. Strong habits are mostly dominant over determining one's action than motivational arguments, especially when it comes to behaviour related to one's health, such as a person's diet or

exercise (Gardner & Rebar, 2019). Human habits are formed through repeated behaviour in a certain context for 'cue-behaviour associations' to develop (Gardner & Rebar, 2019).
According to Lally & Gardner (2013), the development of a habit can be broken down into four parts. Part one is the part in which you decide to act upon a certain motivation. Part two is actually performing the action. Part three is repeating the action. Part four is repeating the action in a way that 'cue-behaviour associations' are being created. These associations are created in the context of performing the action. To replace an existing habit with a new one, at least one of the four parts of a habit must be addressed when taking measures.

Behaviour
Michie et al. (2011) created a model to help understand behaviour. This model, the COM-B model, is depicted in figure 2.

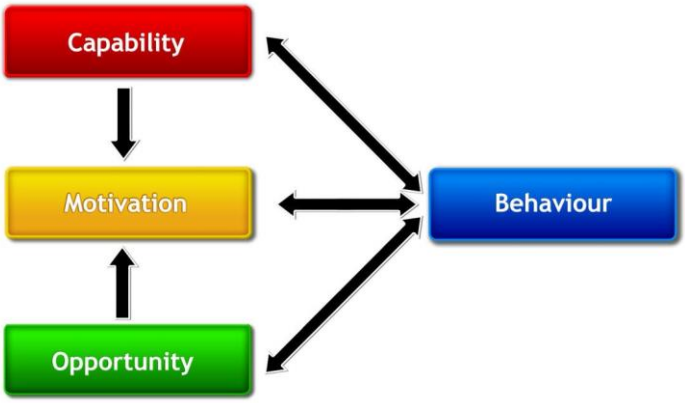


Figure 2. Source: Michie et al. (2011). A model that can be used to understand the way behaviour works.

In the COM-B model, capability is defined in the following way: "The individual's psychological and physical capability to engage in the activity concerned" (Michie et al., 2011). This includes that knowledge of the consequences of an action and the performance capacity needed to perform an action, must be present in the individual. Motivation entails all brain activity concerned with behaviour. It is not restricted to the goal and the conscious process of making a choice. Opportunity entails all other aspects necessary for the behaviour to be performed or stimulated. The COM-B model particularly focuses on step 1 of the habit theory of Lally and Gardner (2013).

New possibilities e-bike

The e-bike changes the realisable distance one could cover for work. In figure 3, the time needed to reach the inner city of Groningen using an e-bike is indicated. If this map is compared to the map in figure one, a significant part of the commuters coming to Groningen live within the distance realistically travelled with an e-bike. The employer can influence transportation behaviour by rewarding e.g. cycling to work by serving lunch at reduced costs or facilitate showers and e-bike storage.

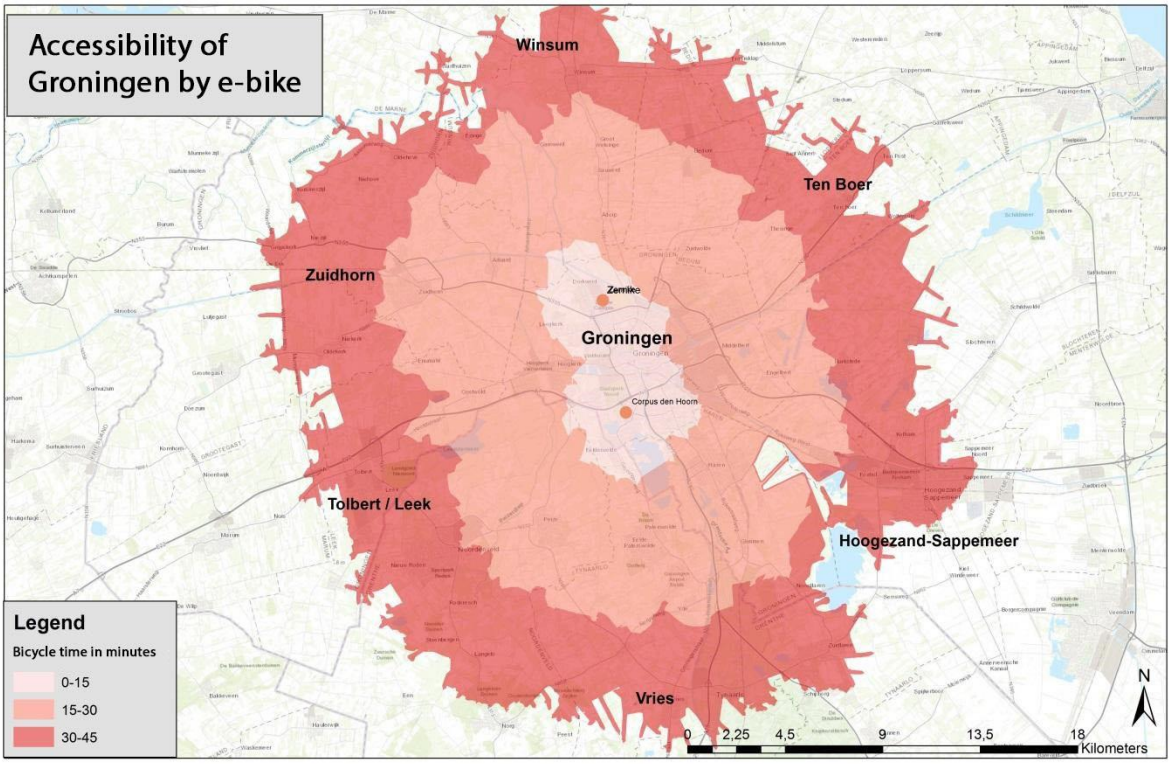
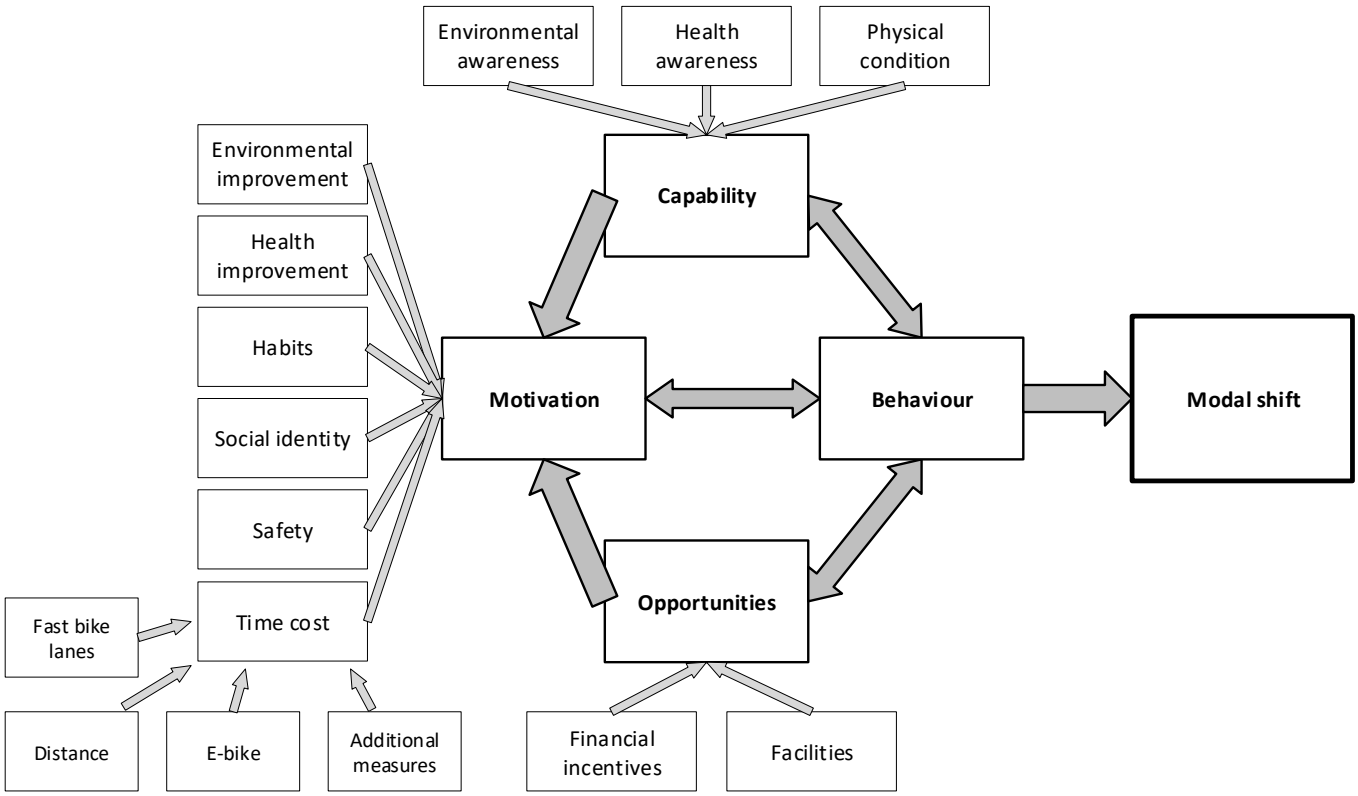


Figure 2. Source: GIS, 2019. Time in minutes needed to reach the inner city of Groningen while using an e-bike.

Conceptual model



Explanation conceptual model

The different factors in the conceptual model are all embedded in the literature discussed. All factors can lead to a change in behaviour, possibly resulting in a modal shift. The core of the model is the behavioural change model COM-B (Michie et al., 2011).

The capability of an individual using active mobility is influenced by three factors. Environmental awareness is necessary for an individual to act on the negative effects of private car usage on the environment, mentioned in the background section. Awareness about one's health is necessary for an individual to act on the negative effects of (extensive) private car usage to one's physical or mental state. For an individual to start using active mobility to get to work, one must have the physical condition to do so. Physical condition implies having the necessary fitness and the absence of obstructing handicaps.

The motivation of an individual is primarily influenced by six factors. Environmental improvement can function as a motivator to use active mobility. The prospect of improved health can also function as a motivator to use active mobility. Time spent commuting influences the motivation of mode choice. The more time a certain mode of transportation costs, the less likely it is for that mode to be used. Four identified factors influence the time spent commuting while using active mobility. The e-bike allows a person to reach their destination faster compared to a regular bike. Fast bike lanes are more convenient for cyclists to use than regular bicycle paths. They are designed to allow someone to cycle to their destination without unnecessary barriers. Creating new fast bike lanes or improvement of the existing ones will limit the time needed when cycling to work. Distance is a determining factor in time spent travelling while using active mobility. The distance of a route can be decreased by creating more direct roads, abolishing one-way traffic and adding physical elements (e.g. an extra bridge or intersection). Additional measures can be taken to decrease the time spent using active modes of

transportation, such as decreased waiting time at traffic lights or constructing a roundabout. The perceived and actual safety of a certain mode of transportation influences the motivation of mode choice. Lower safety in a certain mode of transportation leads to a lower probability of using this mode. The perceived and actual safety of cyclists and pedestrians, whether or not using public transport, can be increased by lowering speed limits, additional education on behaviour in traffic and automobile restrictions in urban areas. The four factors influencing motivation discussed up to now, are primarily part of the conscious decision-making process of a person. Habits and social identity are primarily part of the subconscious decision-making process. Habits influence motivation because of the routine embedded in a person's behaviour. Even when a person is motivated to change its behaviour, the systematic change of a routine action can be a barrier itself. A person's desired social identity can affect behaviour through the valuation of their membership of a certain social group. Therefore, an alteration in the behaviour of (a part of) a social group can motivate someone to alter its own behaviour. Social identity can, however, also be a barrier in changing behaviour, when other members of the same social group do not value the change.
There are two options identified in using opportunities to influence commuters' mode choice. The first option is to provide facilities at work, such as a bike storage to protect (costly) bikes from theft and weathering, and showers for hygienic purposes. The second option is to give financial incentives to employees using active mobility. A discount on public transport use or e-bike purchases for instance. The most convenient way for an employer to encourage the use of active mobility is through these opportunities.

Methodology

Types of data being used

In this research, primary, quantitative data has been collected through conducting a survey. The research question, along with its sub questions, has been answered by analysing the results of the survey data. To strengthen or weaken claims resulting from the analysis, sources referred to in the background, research problem and theoretical framework have been used.

Literary basis

According to Clifford et al. (2010), conducting a survey is the appropriate way of figuring out the opinions and attitudes of people on social, political and environmental issues. Furthermore, staying objective in the interpretation of your data is easier compared to interviewing as a data collection method. Semi-structured interviews have the advantage that more detailed information can be collected from the respondent (Clifford et al., 2010). Since all the information necessary for this research will be covered by the survey, there is no need for semi-structured interviews.

Literature study

The literature study consists of analysing various articles concerning the characteristics of the automobile industry, the advantages of driving (what has it brought us), the disadvantages of driving (for the environment and our health) and the benefits of using active modes of transportation while commuting. The literature study identified possible barriers to using certain modes of transportation and provided this research with the adequate information in the theoretical framework on active mobility, modal shift, health, social identity, safety, habits and behaviour. The literature established the basis for the variables used in the conceptual model and their possible relation to the respondent's mode choice in commuting.

Survey creation

The survey has been created through an (partly) iterative process depicted in figure 4. The process consists of five stages.

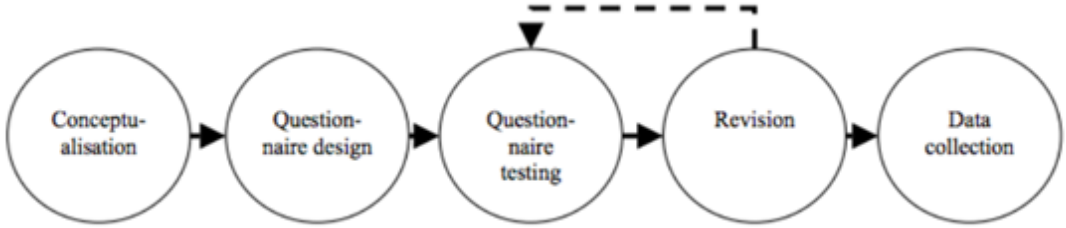


Figure 4. Source: Brancato et al. (2006). The five stages of the design and testing of a questionnaire.

The answer possibilities from the questions in the questionnaire are ordinal and structured in the same direction. In this way, a variable can be computed from the different questions concerning the same topic. These variables can then be compared, since the answer possibilities range from very low to very high, with a total of five possible answers. The answer possibilities are structured based on a fixed, five-point Likert scale. At the end of the survey, respondents have been asked to indicate the likelihood of using active mobility on a daily basis. If the respondent scores high on all the separate variables but thinks the likelihood of switching to active mobility on a daily basis while commuting low, the conclusion might be that the variables do not influence the respondent's behaviour.

Data collection

The respondents for the questionnaire are employees working in firms in Groningen. The respondents for this research have been found in two ways. The first way was to go directly to stores, mainly situated in the neighbourhoods around the city centre, areas primarily used by (larger) retail stores. For the employees to have time to answer the questionnaire, stores have primarily been visited in the morning or beginning of the afternoon. According to data provided by google, many stores situated in these areas are least busy during these hours. When entering a store, asking for the manager has proved to be unsuccessful. Mostly, they lack time and interest to listen to or participate in the research. A method proven to be more successful, is simply asking the first employee you see if they use a car to get to work and if they want to spend a few minutes answering questions concerning active mobility. Employees helping other customers have not been disturbed. The second way in which respondents for the survey have been found, is via jobs of acquaintances in Groningen. With someone already working in a certain firm, it is easier to get a few employees to take a survey.

Ethical considerations

One of the ethical considerations applicable to this research, is that respondents must not feel like being judged on their commuting behaviour. It is not the intention of this research to address a feeling of guilt. The researcher will be on the same level as the respondents, only interested in their motives. The respondent can stop answering the questionnaire at any moment. The privacy of the respondent will be valued, they will not be connected to a name or a number. The impact of this research on society will be to make people think about their commuting behaviour and provide them with a complete view of the effects of commuting behaviour.

Data analysis

The data from the questionnaire has been analysed in SPSS, a quantitative statistical analysis program. A total of 68 respondents conducted the questionnaire. The questionnaire can be found in the appendix (1).

General statistics

The first part of the data analysis consists of comparing the descriptive statistics of the general questions in the survey to the statistics of Groningen or the Netherlands.

Age

In figure 5, the distribution of the respondents' age groups is presented. The most frequent response to the question about the respondents age group is 15-25. A total of 23 respondents (frequency) is between 14 and 26 years old. These 23 respondents account for 33,8 percent of all the respondents found. In figure 6, the age distribution of Groningen is depicted, corrected for the absence of age group 0-15. The percentage level in figure 6 can be compared to the percentage in figure 5. In both figures, the age group best represented is 15-25. The age group not represented in the questionnaire is 65+. This answer possibility has never been used. This is probably because most people over 65 years of age are retired.

Age		Frequency	Percent	Cumulative Percent
Valid	15-25	23	33,8	33,8
	26-35	19	27,9	61,8
	36-45	12	17,6	79,4
	46-55	11	16,2	95,6
	56-65	3	4,4	100,0
	Total	68	100,0	

Figure 5. Source: Questionnaire (2019). Age distribution of age of the respondents.

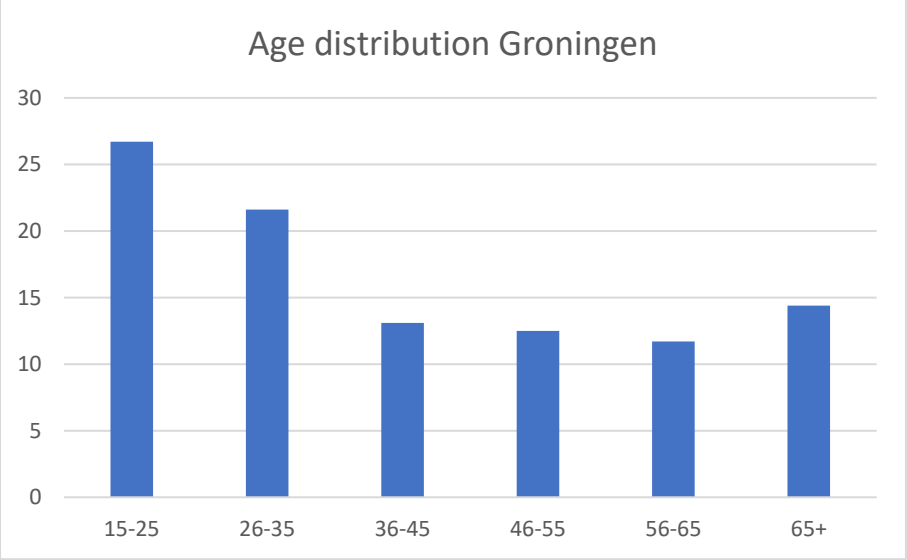


Figure 6. Source: Alle cijfers Gemeente Groningen (2018). Distribution of inhabitants of Groningen in %, corrected for the exclusion of age group 0-14.

In figure 7, the histogram of the age groups of the respondents can be seen. This distribution matches for most part with the demographic distribution of Groningen (figure 6). However, the slope in the histogram of the age distribution of the respondents (figure 7) is too steep to be completely representative for Groningen. The overrepresentation of age groups 15-25 and 26-35 can be explained in the way the respondents have been found. A part of the respondents has been found via acquaintances of the researcher (student). Acquaintances of the researcher are mostly students as well, probably belonging to the first two age groups.

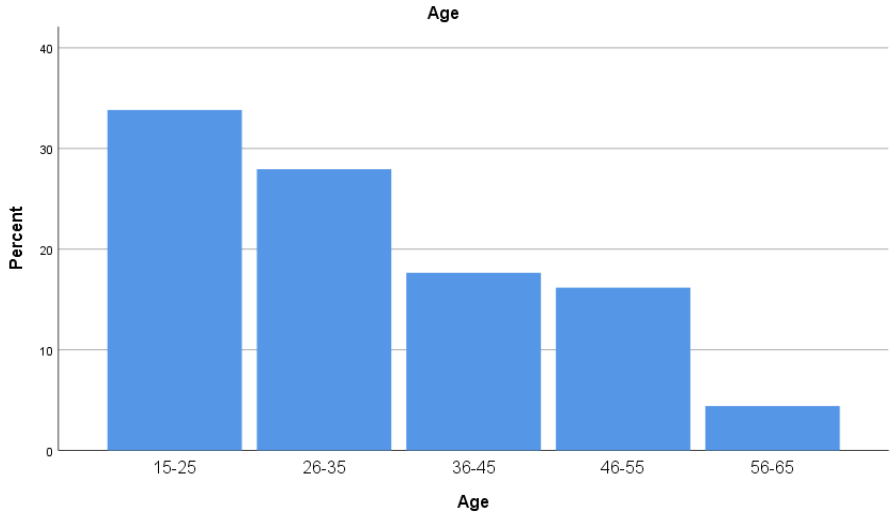


Figure 7. Source: Questionnaire (2019). Histogram of the age distribution.

Gender

The distribution of the gender of the respondents in is depicted in figure 8 (percentage). A total of 40 male and 28 female respondents has been found. The answer possibilities 'other' and 'none' have not been used. In the municipality of Groningen, the distribution of men (49,95%) and women(50,05%) is approximately equal (Statline, 2019). The overly representation of men among the respondents can be explained by analysing the data collection method. The acquaintances from the researcher used to find respondents are mostly men.

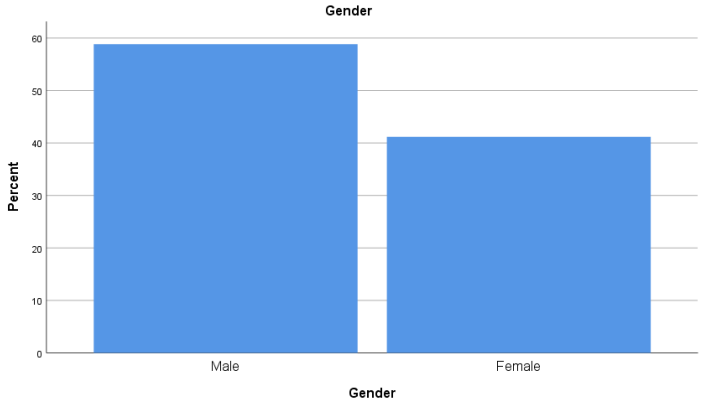


Figure 8. Source: Questionnaire (2019). Histogram of the distribution of the gender of the respondents.

Distance

The frequency distribution of the commuter distance of the respondents can be seen in figure 9. The average distance travelled to work by the respondents is 13,65 kilometres. This is low compared to the average of Groningen of 23,6 kilometres (CBS, 2016). The difference in distance travelled by commuters can be explained by looking into the composition of the respondents. The identified overrepresentation of students decreases the average distance travelled. Students mostly live in or in the neighbourhood of Groningen.

Distance		Frequency	Percent	Cumulative Percent
Valid	0-3	19	27,9	27,9
	3-10	10	14,7	42,6
	10-20	24	35,3	77,9
	20-30	8	11,8	89,7
	30-40	5	7,4	97,1
	40+	2	2,9	100,0
	Total	68	100,0	

Figure 9. Source: Questionnaire (2019). Distribution of the distance travelled for work by the respondents.

To test whether the commuter distance has any relation with the probability of the respondent switching to active mobility in the future, an ordinal logistic regression analysis has been performed. The results of this test can be seen in figure 10. There is a significant relation (0.000) between the commuter distance and the probability of a respondent switching to active mobility. The further a respondent lives from their work, the less likely switching to using active mobility daily is. Based on the literature, this relation was expected.

		Estimate	Std. Error	Wald	df	Sig.
Threshold	[Modal_shift = 1]	-4,968	,825	36,298	1	,000
	[Modal_shift = 2]	-2,503	,586	18,217	1	,000
	[Modal_shift = 3]	-1,085	,518	4,391	1	,036
	[Modal_shift = 4]	1,104	,627	3,104	1	,078
Location	Distance	-,750	,188	15,943	1	,000

Figure 10. Source: Questionnaire (2019). Ordinal logistic regression analysis of distance and modal shift probability.

Car use

Car use indicates the percentage of workdays the respondent used a car to get to work. The frequency distribution of car usage of the respondents is shown in figure 11. The average distance travelled by commuters to Groningen from CBS is based on full-time jobs. The respondents' average distance travelled is not. This means, respondents travelling in only 20% of their workdays by car got the same weight in the calculation as respondents who use a car in 100% of their workdays. The weight in the calculation of a person travelling in 100% of his/her workdays by car can be multiplied by five compared to someone travelling in only 20% of their workdays by car. The new average calculated will be more meaningful because, on average, someone using their car daily simply travels more kilometres than someone using their car only once a week.

Car use		Frequency	Percent	Cumulative Percent
Valid	Always	29	42,6	42,6
	80%	10	14,7	57,4
	60%	5	7,4	64,7
	40%	6	8,8	73,5
	20%	18	26,5	100,0
	Total	68	100,0	

Figure 11. Source: Questionnaire (2019). Frequency distribution of car use of the respondent.

Education

The distribution of the completed education of the respondents is depicted in figure 13. In figure 12 can be seen that there are eight missing values in this question. This is due to the absence of an answer option concerning MBO education of any kind. The education most often completed by the respondents is HBO (mode: 5). Answer possibilities 'primary school' and 'PHD' have not been chosen.

N	Valid	60
	Missing	8
Mode		5

Figure 12. Source: Questionnaire (2019). Descriptive statistics education completed.

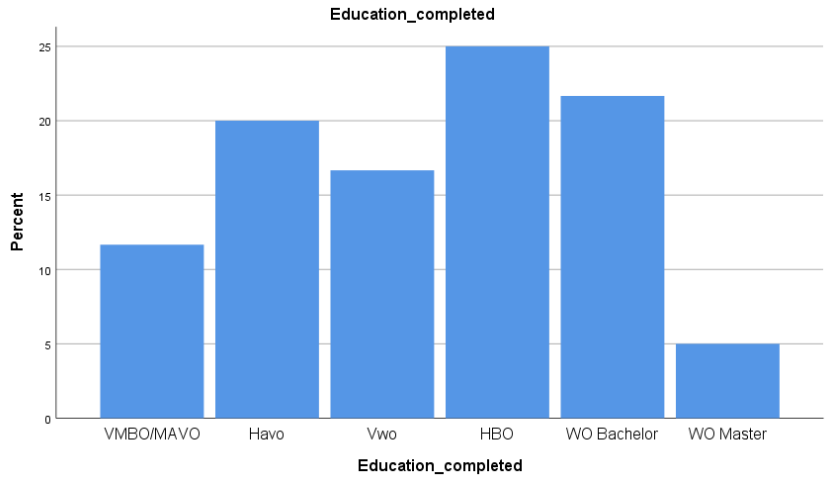


Figure 13. Source: Questionnaire (2019). Histogram of completed education of the respondents.

To test whether completed level of education has any relation with the probability of the respondent switching to active mobility in the future, an ordinal logistic regression analysis has been performed. The results of this test can be seen in figure 14. There is no significant relation (0.264) between the level of education completed and the probability of a respondent switching to active mobility. Based on the literature, this relation would have been expected.

		Estimate	Std. Error	Wald	df	Sig.
Threshold	[Modal_shift = 1]	-2,063	,614	11,267	1	,001
	[Modal_shift = 2]	,018	,498	,001	1	,972
	[Modal_shift = 3]	1,247	,521	5,730	1	,017
	[Modal_shift = 4]	3,289	,698	22,231	1	,000
Location	Education_completed	,126	,113	1,247	1	,264

Figure 14. Source: Questionnaire (2019). Ordinal logistic regression analysis of education and modal shift probability.

Factor influences

In this section, the influence of different variables on the probability of switching to active mobility in the future while commuting. These relations will be tested by conducting an ordinal regression analysis. According to the model fitting information (0.001) and the Goodness-of-Fit test (0.817 & 1.000), the variables were suitable for this test to be performed. The results of the ordinal logistic regression analysis can be seen in figure 15.

		Estimate	Std. Error	Wald	df	Sig.
Threshold	[Modal_shift = 1]	-6,072	2,555	5,649	1	,017
	[Modal_shift = 2]	-3,508	2,464	2,026	1	,155
	[Modal_shift = 3]	-1,943	2,442	,633	1	,426
	[Modal_shift = 4]	,415	2,464	,028	1	,866
Location	Health_importance	,045	,257	,031	1	,860
	Physical_activity_weekly	-,478	,263	3,304	1	,069
	Safety_concerns	-,137	,275	,247	1	,619
	Environment_importance	-,120	,268	,203	1	,653
	Social_identity	,722	,298	5,883	1	,015
	Barriers_time	-,617	,239	6,657	1	,010
	Barriers_sweating	-,225	,216	1,083	1	,298

Figure 15. Source: Questionnaire (2019). Ordinal logistic regression analysis of the relation between variables and modal shift probability.

According to the results from the analysis, the strongest determinants in predicting modal shift probability are social identity (0,015) and time (0,010). This means that the more someone cares about the opinion of their social group, the bigger the chance is that this person will switch to active mobility in the future. The relation between time and modal shift is the less someone sees time as a barrier when thinking about switching to active mobility, the bigger the chance of this person switching to active mobility in the future.

Conclusion

The research question, along with the sub questions, has been answered through data analysis of the conducted questionnaire. From the literature, the factors expected to have the most influence on mode choice are time, distance, health and the environment. The results of this research indicate that the most important factors influencing modal shift probability are distance, social identity and time. The further someone lives from his work, the less likely this person is to switch to any form of active mobility on a daily basis to get to work. The established relation between social identity and modal shift probability is the more someone cares about the opinion of their social group, the bigger the chance this person will switch to active mobility in the future. The relation between time and modal shift is the less someone sees time as a barrier when thinking about switching to active mobility, the bigger the chance of this person switching to active mobility in the future. Surprising about the results of the analysis is the absence of a significant relation between health and modal shift probability. This relation was clearly established in the literature.

An opportunity for future research is investigating the relation between the different factors influencing modal shift behaviour.

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Appendix

1. The questionnaire used to answer the research questions

This questionnaire is about different influences on using active mobility. Active mobility entails walking, running, cycling, using public transport or any other form of physical activity to get to work.

General information

1. What age group are you currently in?
   ○15-25 ○26-35 ○36-45 ○46-55 ○56-65 ○65+

2. What do you associate yourself with the most?
   ○Male ○Female ○Other ○None

3. What village or city do you currently live?

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4. How many kilometres do you need you need to travel to work?
   ○0-3 ○3-10 ○10-20 ○20-30 ○30-40 ○40+

5. What is the highest level of education you completed?
   ○Primary school ○VMBO/MAVO ○Havo ○Vwo ○HBO
   ○ WO Bachelor ○WO Master ○PHD

6. On average, how often (in %) do you use your car to get to work?
   ○Always ○80% ○60% ○40% ○20%

Health

Driving for more than two hours on a daily basis affects your health in a negative way. It increases the chances of experiencing chronic disease (back and neck), exposes you to more polluted air and causes higher levels of stress compared to active modes of mobility.

7. To what degree do you think health issues are important for you?
   ○Very low ○Low ○Mediocre ○High ○Very high

8. To what degree could the prospect of improved health motivate you to use active modes of transportation to get to work?
   ○Very low ○Low ○Mediocre ○High ○Very high

9. How many times a week do you physically put effort in an activity, for at least 20 minutes? E.g. walking, running, cycling, sports.
   ○0 ○1 ○2 ○3-5 ○5-10 ○10+

Safety

10. To what degree do you think the road to your work is pedestrian and cyclist friendly?
    ○Very low ○Low ○Mediocre ○High ○Very high

11. Using active mobility can be accompanied by feelings of lower perceived safety. To what degree do you think safety concerns withhold you form using active mobility to get to work?
    ○Very low ○Low ○Mediocre ○High ○Very high

Environment

Private car usage is one of the main causes of the rising levels of CO2 in our atmosphere. The rising levels of CO2 contribute to global warming and negatively affect the biodiversity around the world.

12. To what degree do you think environmental issues are important to you?
    ○Very low ○Low ○Mediocre ○High ○Very high

Social identity

13. If the people you interact with, e.g. at work or sports clubs, all start cycling to their destination. To what degree would you start thinking and talking about their motivations to cycle to their work?
    ○Very low ○Low ○Mediocre ○High ○Very high

E-bike

One of the reasons people use active modes of transportation more often to get to work than before is because of the development of the e-bike. The e-bike allows you to reach your destination faster, without sweating too much and also helps to improve your health.

14. To what degree would you consider trying the e-bike to get to work?
    ○Very low ○Low ○Mediocre ○High ○Very high

Possible barriers

15. If you were to live three kilometres from your workplace. To what degree would you consider switching to active mobility to get to work?
    ○Very low ○Low ○Mediocre ○High ○Very high

16. Are there any barriers you encounter in case you would use any form of active mobility to get to work? E.g. drawbridges, traffic lights, inconvenient intersections. To what degree do these barriers hinder you from comfortably reaching your work when using active mobility?
    ○Very low ○Low ○Mediocre ○High ○Very high

17. When using active mobility to get to work, you can be forced to take a detour, e.g. when heading for the closest bridge to cross the water or avoiding one-way traffic. To what degree are you hindered by such detours when using active mobility to get to work?
    ○Very low ○Low ○Mediocre ○High ○Very high

18. To what degree is time spent commuting a reason for you to withhold from using active mobility?
    ○Very low ○Low ○Mediocre ○High ○Very high

19. To what degree would you consider sweating as a problem of using active mobility to get to work?

○Very low ○Low ○Mediocre ○High ○Very high

Financial aspects

20. To what degree do the purchase costs of an e-bike withhold you from buying one?
    ○Very low ○Low ○Mediocre ○High ○Very high

21. To what degree would you consider theft of your e-bike as a problem when thinking about buying one?
    ○Very low ○Low ○Mediocre ○High ○Very high

22. To what degree do the costs of using public transport withhold you from using it on a daily basis to get to work?
    ○Very low ○Low ○Mediocre ○High ○Very high

Concluding

23. Bearing in mind the possible consequences and opportunities mentioned in the survey. To what degree do you consider switching to an active mode of commuting on a daily basis?
    ○Very low ○Low ○Mediocre ○High ○Very high

Thank you for your participation. If you are interested in the results of the research, please enter your e-mail below.

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