Scooters, and their impact on noise annoyance

A case study in Amsterdam

Author: Thomas Steenbergen
Student number: 4001486

Supervisor: Dr. A.A. Voinov
Professor: Prof. Dr. M.J. Kraak

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Abstract

Scooters in the Netherlands are becoming more popular, especially the light-mopeds in urbanized areas. They are more affordable and mobile than cars, especially light-mopeds which may use bicycle lanes. Due to the increase in scooters, a growing number of people is annoyed by the noise scooters bring with them. Noise annoyance is related to health problems like tinnitus and stress. An Agent Based Model was constructed to identify which areas in the city have the most scooters driving by and in what way is this connected to noise annoyance.

The Agent Based Model was constructed by using an activity based model. Each individual has a set of activities scheduled and uses the scooter to move from one destiny to the other. Most common activities are work/school/shop/sport. Noise annoyance data is based on a questionnaire and is, together with model output data, analyzed with a logistic regression method. It is found that an increase in regular-mopeds is positively associated with serious noise annoyance. An increase of 100 regular-mopeds per road has a 6% to 17% higher chance of people experiencing serious noise annoyance. Light-mopeds have no association with noise annoyance. Due to a continuing increase in scooters over the next years, it is to be assumed that serious noise annoyance will grow in urban areas, although the most impact will be on people living next to highly dense traffic roads.

Preface

As a GIMA student with a background of Human Geography, I became interested in researching a social problem with the use of GIS. GIMA is a very wide masters study where we get a little bit of everything without specializing in a certain subject. Because of my Human Geography background, I had zero experience in programming. I thought this thesis would help me obtain programming skills, but also research a social problem, scooter nuisance. As a resident of Amsterdam and the city's growing problem with scooters, I had gained interest in this topic. I would like to thank a few people in this preface who have helped me through the tough times of thesis writing and programming. I would like to thank my supervisor Dr. Alexey Voinov, who have helped me with useful comments throughout the process. Even though we were not able to have physical contact due to the geographical distance between us, we were always able to connect via skype and have a productive meeting or use e-mail to communicate with each other. I would also like to thank my supervisor at my internship, Imke van Moorselaar, who have helped me through all stages of my thesis, even the ones where he did not have any experience in, like programming of an ABM. Luckily, the community of the GAMA website was very live and have helped me with example scripts for my model, or even have complete solutions for my model errors. It helped me to quickly gain experience with modeling to finally build my own Agent Based Model.

Content

1. Introduction

1.1 Background

Scooters in the Netherlands have largely grown in numbers over the past 7 years. Comparing scooter totals in Europe shows that the Netherlands has more scooters than popular scooter countries in southern Europe. Table 1 shows a comparison of the scooter fleet in several European countries based on the year 2010. Approximately 6% of the Dutch population owns a scooter, which is the highest rate in Europe and more than twice the EU average (CBS, 2013). In the Netherlands, both light-mopeds and regular-mopeds are defined as scooters. Light-mopeds and regular-mopeds differ in several aspects. Regular-mopeds are allowed to drive up to 45 km/h, require a helmet and are obliged to drive on the roadway, while light-mopeds can drive up to 25 km/h, do not require safety helmets and, in most cases, are allowed on bicycle lanes. In this paper the term scooters is used for both, unless a distinction has to be made (light-moped or regular-moped).

Since 2007 the number of scooters increased by 55% (97% increase in light-mopeds and 25% increase in regular-mopeds) (CBS[a], 2014). The increase in scooters since 2007 is due to several reasons. First, they are much cheaper than cars. Also, scooters have the advantage of being more mobile than a car. In congested areas, a scooter is the quickest method to travel and parking spots are easier to find than with a car. Finally, people are becoming more socially connected, which makes independent mobility an important part of their lives (yourmotorcycle, 2014; Dall'Osto, 2013; CBS, 2013).

Table 1: Number of scooters per 1000 inhabitants per EU country (2010)

	#scooters x 1000	#population	Scooters per 1000 inhabitants
The Netherlands	956	16575	58
Italy	3307	60340	55
Spain	2352	45989	51
Luxembourg	26	502	51
Finland	238	5351	45
Austria	335	8375	40
Cyprus	27	819	33
Portugal	326	10638	31
France	1748	64694	27
Germany	2153	81802	26
Belgium	260	10840	24
Poland	834	38167	22
Slovenia	42	2047	21
Greece	230	11305	20

Denmark	58	5535	10
Sweden	92	9341	10
Czech republic	86	10507	8
Latvia	18	2248	8
United Kingdom	157	62027	3
European Union	12677	501120	25

Source: CBS, 2013

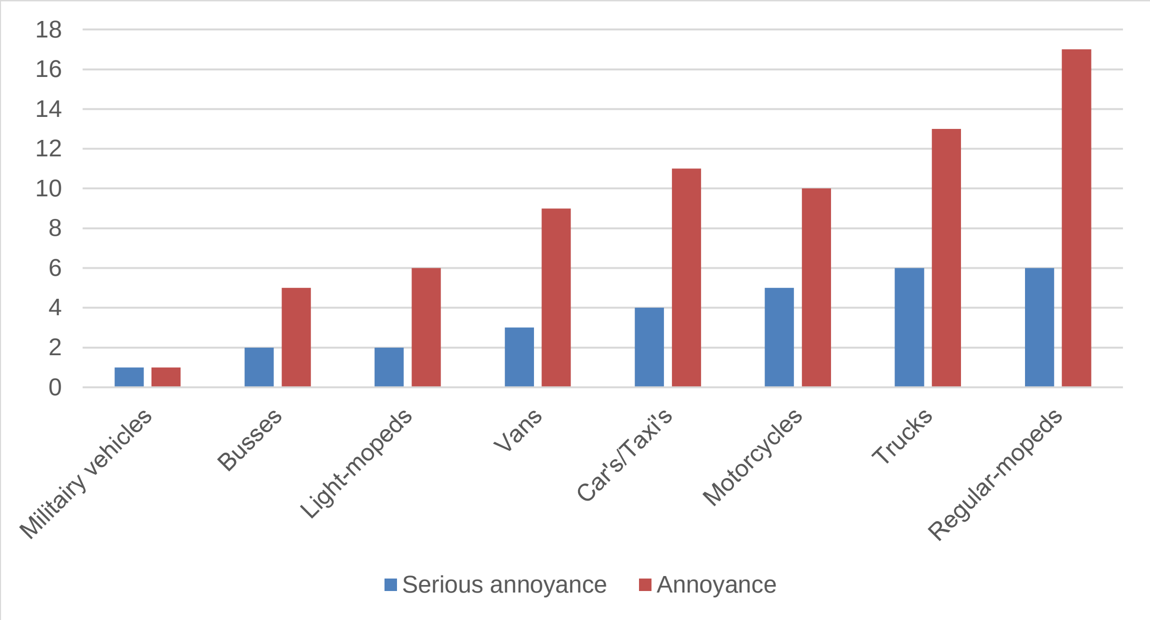
1.2 Scooter noise and human health

According to the EU, environmental noise is defined as the *"ambient sound levels beyond the comfort levels as caused by traffic, construction, industrial, as well as some recreational activities"* (EU, 2014). Scooter noise is categorized as environmental traffic noise (EU, 2014). There is growing concern for environmental noise and associated health impacts, because according to the World Health Organization, there is a link between noise annoyance and health issues, both physical and psychological, of which stress is the most common issue (WHO, 2011). Tinnitus, sleep disturbance, hearing impairment, cognitive impairment and cardiovascular disease have been associated with exposure to environmental noise, which includes environmental traffic noise (Vogiatzis, 2011; Paviotti and Vogiatzis, 2012).

In general, people in the Netherlands rate scooters as vehicles that produce the most noise annoyance. The "sound" of scooters is experienced as loud and rough. The subjective experience of sound is more important for noise annoyance than the actual noise level produced by scooters (in decibels). A research done by the RIVM examined the level of annoyance people have with scooters. A control group listened to an electric driven scooter passing by, the other group listened to a combustion engine scooter passing by. Although normally, a combustion engine creates a lot more noise than an electronic scooter, the produced decibels have been lowered artificially using a Traffic Noise Synthesizer (Sottek et al., 2012) to match the decibels of an e-scooter. Even then, combustion engine scooters scored higher on noise annoyance than an electric driven scooter. Possible explanation is that respondents recognize a certain noise source (scooter noise) and automatically ascribe a higher grade on noise annoyance (RIVM, 2013).

Regular-mopeds cause the most annoyance (together with trucks) (Table 2). Light-mopeds and regular-mopeds cause 8 percent of the (serious) annoyance due to environmental traffic noise and 23 percent of annoyance. Also, other reports show that scooters are one of the highest sources of noise annoyance in urban areas (Sound public support for quiet areas, 2009).

Table 2: level of annoyance by environmental traffic noise in percentages



Source: RIVM, 2013

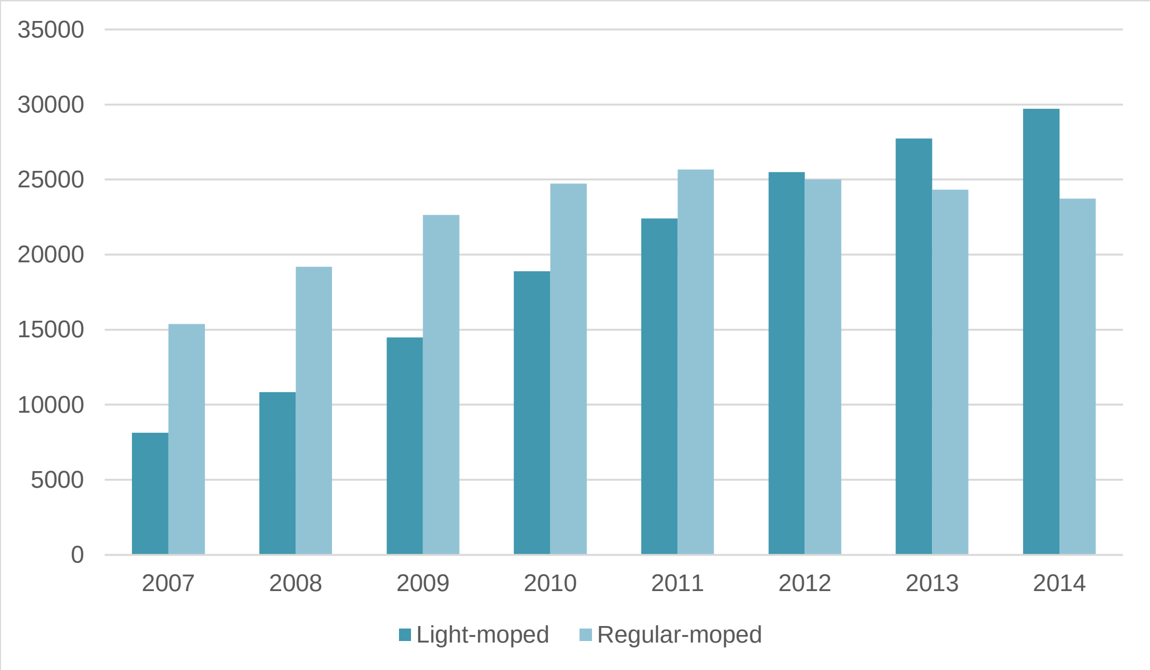
1.3 The study area: an introduction

Amsterdam was chosen as study area, because of its urban environment and a significant increase in scooters over the past years. According to the Rijksdienst voor het Wegverkeer (RDW), the number of light-mopeds has increased since 2007 by 233% (from 9,000 in 2007 to more than 30,000) in 2013, in Amsterdam (Table 3), (Amsterdam, 2014). CBS states that this is mainly due to increasing car traffic and parking problems in the city (CBS, 2013).

According to speed measurements on 10 different locations in the city of Amsterdam in 2013, 81% of the light-moped drivers crossed the speed limit (Dufec, 2013), which could cause safety problems for cyclists. Although scooters represent only a small percentage (1.5%) of the total amount of transportations in the city, they were involved in 30% of the fatal accidents in 2013. Scooters are becoming a serious safety problem and furthermore, are a growing concern for air pollution and noise annoyance.

One measure to increase safety is to oblige light-moped drivers to wear a safety helmet. On June 2, 2014, the Dutch Minister of Infrastructure informed the House of Representatives (Tweede Kamer) about possibilities for municipalities to do so. Amsterdam is one of the municipalities that wants to experiment with obligatory helmet regulation for light-moped drivers. In addition, light-moped drivers will be required to drive on the roadway instead of bicycle paths (Amsterdam, 2014).

Table 3: Number of scooters (light-moped and moped) in Amsterdam through the years



Source: CBS[a], 2014

By obligating light-moped drivers to use the roadway, the municipality of Amsterdam hopes to achieve a two third reduction in number of light-moped drivers (Amsterdam, 2014). It was estimated by the Stichting Wetenschappelijk Onderzoek Verkeersveiligheid that one third will switch to bike use or public transport, while the other third will switch to regular-mopeds (SWOV, 2013). Although plans of Amsterdam to reduce the number of scooters are focused on safety aspects, problems associated with noise annoyance and air pollution are likely to benefit as well due to a reduction in number of scooters, or by alternatives for scooters (for example, the electric driven scooters).

1.4 Social relevance

So far, little is known about the routes scooters drive throughout the city. It is difficult to map routes of all scooters in an urban area. However, an Agent Based Model (ABM) could offer a solution to this problem. ABM has proven to be an efficient way to simulate routings (Lee, 2007). Furthermore, ABM can be used to model different scenarios. Future scenarios (for example: new policies) can be simulated and analyzed and may pinpoint areas that could be at risk for increased noise annoyance, but also for other adverse effects of scooters.

There are several studies on noise annoyance caused by cars, but no further research is done for noise annoyance caused by scooters (Paviotti & Vogiatzis, 2012). Since noise annoyance is often associated with scooters in urban areas (RIVM, 2013; Sound public support for quiet areas, 2009) and the number of scooters continues to grow (CBS[a], 2014), an extensive study on scooter fleet, scooter routes through the city and associated noise annoyance is desirable. ABM allows to model scooter routes throughout the city, which furthermore could be used to investigate adverse effects associated with scooter use, such as air pollution and traffic accidents. This study will focus on noise annoyance, as reported by elderly in Amsterdam, and scooters.

2. Scope

This research will model current and potential future scooter routes in the city of Amsterdam. Furthermore, associations between self-reported noise annoyance and the number of scooters will be studied.

The main objective of this thesis is:

Model the most likely routes for scooters in an urbanized area and evaluate current and future associated risks of noise annoyance.

Research questions:

- *Who uses the scooter and for what purpose?*
- *How can behavioral patterns of scooter drivers influence the routing chosen for travel?*
- *How can an ABM be used to identify the most likely configuration of scooter routes?*
- *How can this model be validated?*
- *What are the current and future routings of scooters under various scenarios and regulations?*
- *What impact does the current scooter fleet have on noise annoyance and what impact could it have in the future under various scenarios?*
- *What policies can be most efficient to modify the behavioral choices of scooter drivers?*

3. Methodology

The workflow of this study consist of several phases. The first phase is a literature research to obtain data input for the model, primarily the behavior rules of individuals. Also, all datasets are obtained during phase 1 and a general outline of rules is presented. During the modeling phase, a continuous process was done to polish the model. See chapter 3.3.3 for a more detailed explanation. The rules obtained from the first phase are implemented and first results are tested with a validation method. Calibration and optimization is done to create the best possible outcomes for the next phase. During the third phase, model output (the results obtained via the scripting phase) are linked with noise annoyance data (obtained from questionnaires) and a logistic regression analysis is done to test for an association between the number of scooters and noise annoyance reports. This analysis is done for present and future scenarios. The last phase consists of discussion and conclusions based on results from phase 3. Finally, recommendations are presented, which could be used by the municipality to optimize their policies regarding scooters. Figure 2, presents an overview of the workflow.

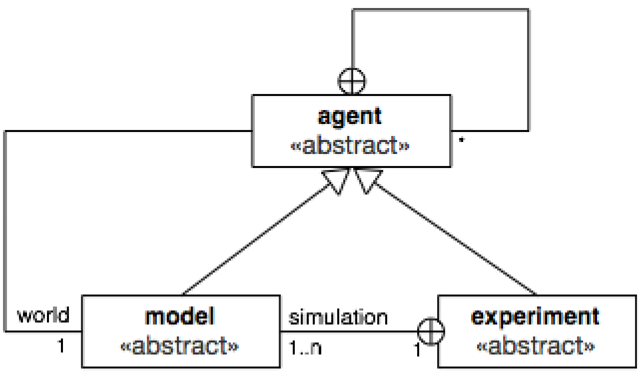
3.1 Software

A number of software packages were used to conduct this research, to prepare and analyze data, to build the ABM and to present and visualize the results.

3.1.1 GAMA

GAMA is a software tool to create an Agent Based Model. It is an open source software tool with its own modeling language called Gama Modeling Language (GAML). Other ABM tools include Netlogo, Repast and Mason, but these software tools require a more advanced modeler. GAMA wants to overcome the problem of complex programming skills by offering a "*[…] well-thought integration of agent-based programming, geographical data management, flexible visualization tools and multi-level representation* (Grignard et al., 2013).

Figure 1: UML of GAMA construct



Source: Grignard et al., 2013.

GAML is an *agent-oriented* language dedicated to perform *agent-based* simulations. It has its roots in object-oriented languages, like Java, but extends programming with new concepts, like skills and agent migration to allow better expressivity in its models

3.1.2 ArcGIS/QGIS

ArcGIS and QGIS will have a prominent role during this research. The GIS software tools were used to prepare data by creating selections, optimizing the network of the study area, joining datasets together etc. Also, ABM exports results as a shapefile for ArcGIS/QGIS to read, so results are also analyzed with this software.

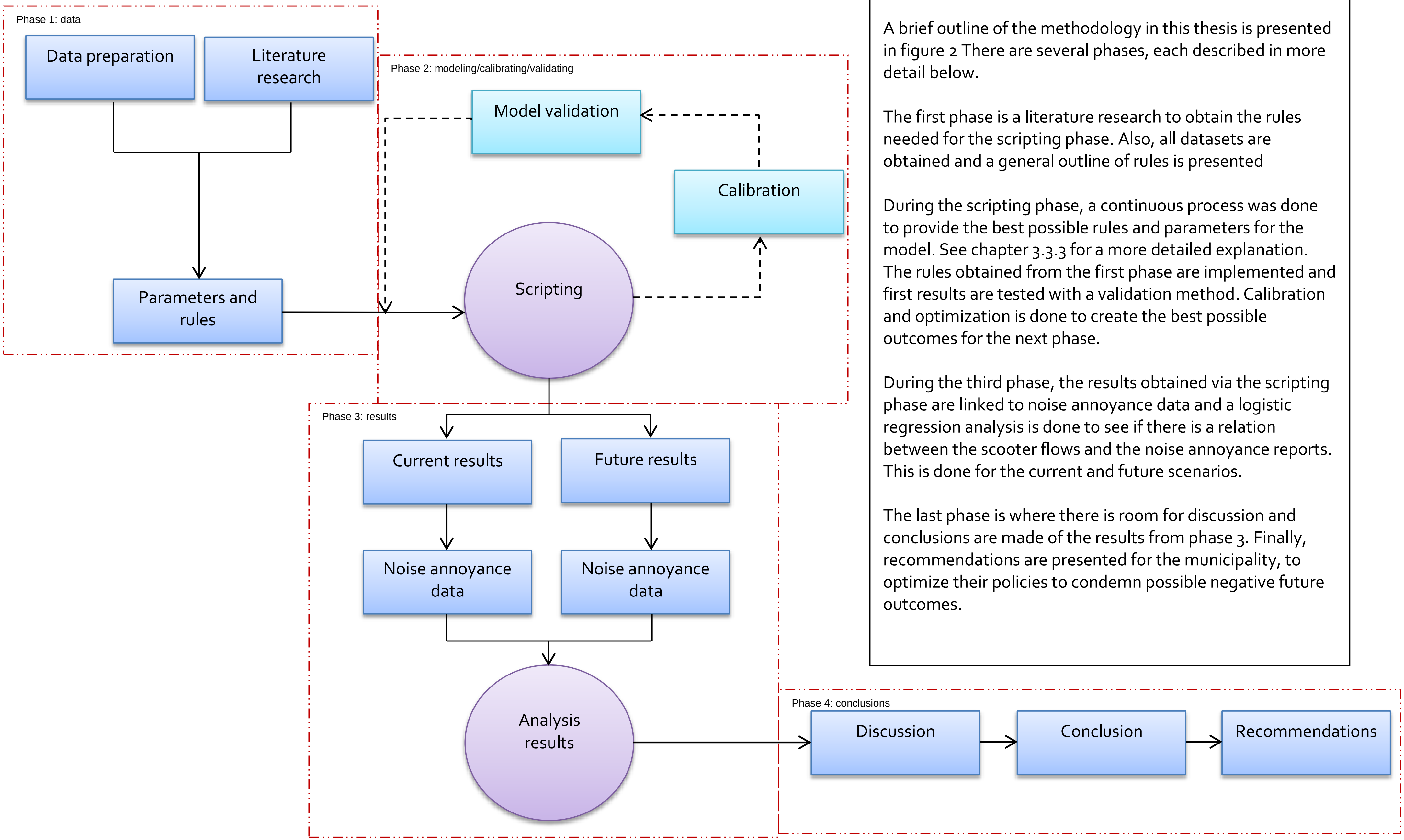
3.1.3 SPSS

SPSS was used to connect data from the noise annoyance questionnaire with model output from the ABM. Logistic regression analyses were done in SPSS. Noise annoyance were dichotomized for analyses and set as the dependent variable. Scooter counts were used as an independent variable.

3.1.4 Excel/Word

Word was used for writing the thesis, Excel to create csv files, which are used in QGIS, but are also exports from GAMA.

Figure 2: Methodology overview



A brief outline of the methodology in this thesis is presented in figure 2 There are several phases, each described in more detail below.

The first phase is a literature research to obtain the rules needed for the scripting phase. Also, all datasets are obtained and a general outline of rules is presented

During the scripting phase, a continuous process was done to provide the best possible rules and parameters for the model. See chapter 3.3.3 for a more detailed explanation. The rules obtained from the first phase are implemented and first results are tested with a validation method. Calibration and optimization is done to create the best possible outcomes for the next phase.

During the third phase, the results obtained via the scripting phase are linked to noise annoyance data and a logistic regression analysis is done to see if there is a relation between the scooter flows and the noise annoyance reports. This is done for the current and future scenarios.

The last phase is where there is room for discussion and conclusions are made of the results from phase 3. Finally, recommendations are presented for the municipality, to optimize their policies to condemn possible negative future outcomes.

3.2 Phase 1: data

3.2.1 Location of scooter (agents)

Agents in this research are scooters in Amsterdam, both light-mopeds and regular-mopeds. Scooter registration addresses are important as they are the starting point of most travel. Via CBS registration (CBS, 2015), addresses of scooters were obtained for the year 2014. An extra variable was made to differentiate between moped and light-moped users. By joining the CBS data with a point-map in ArcGIS, a shapefile of all registered scooters was created and ready to be imported in the ABM.

Figure 3: location of scooter process overview

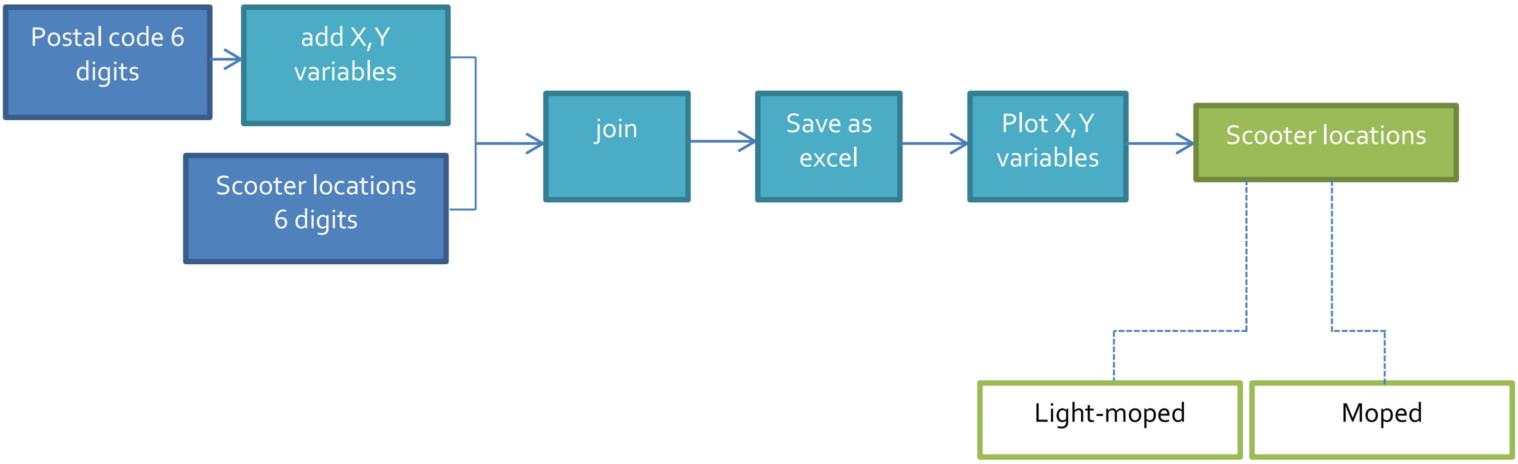


Figure 4: Heat map scooter location in Amsterdam

Looking at the scooter registrations in Amsterdam, the most dense locations are located in Amsterdam West and parts of Amsterdam Zuid. Amsterdam West is also the densest housing district of the city, which could explain the high density area.

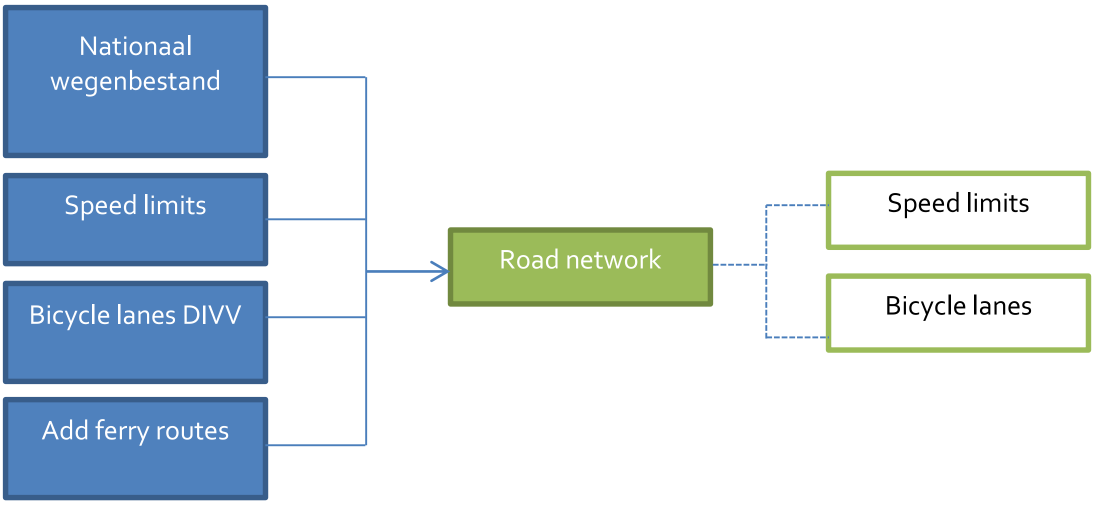
3.2.2 Road network

The road network for agents to travel upon is created from several datasets. First, the Nationaal Wegenbestand was used (NWB, 2015). This dataset contains all roads (from highways to urban roads). However, it does not contain several important factors, such as maximum speeds and restricted areas. Computations based on shortest/fastest paths are calculated with maximum speed attributes among other calculations. Light-moped users and regular-moped users, by law have to follow different rules and regulations, therefore different network types should be within the attribute table of the road network. This data were obtained from the Dienst Infrastructuur Verkeer en Vervoer (Service of Infrastructure, Traffic and Mobility, DIVV, 2014).

Speed limits had to be incorporated in the model. Scooters are assumed to use the fastest routes rather than the shortest. It is therefore important to implement speed limits as one of the attributes of the road network. Also, speed limits serve to restrict certain parts of the road (like highways). Scooters are not allowed to travel over highways, or other routes with a certain speed limit. With speed limits obtained via DIVV, it was possible to restrict scooters from parks, highways and other restricted areas. Light-mopeds have the possibility to drive on bicycle lanes. A weight class has been created in the ABM to let light-mopeds choose roads with bicycle lanes before normal roads.

Finally, ferry routes of Amsterdam were manually added. Scooters are allowed to travel via a ferry to the North side of the city. There are ferry routes connecting the north side of the city with the rest of Amsterdam. With all these extra attributes loaded in an ABM, the network is complete and ready to use.

Figure 5: Road network process overview

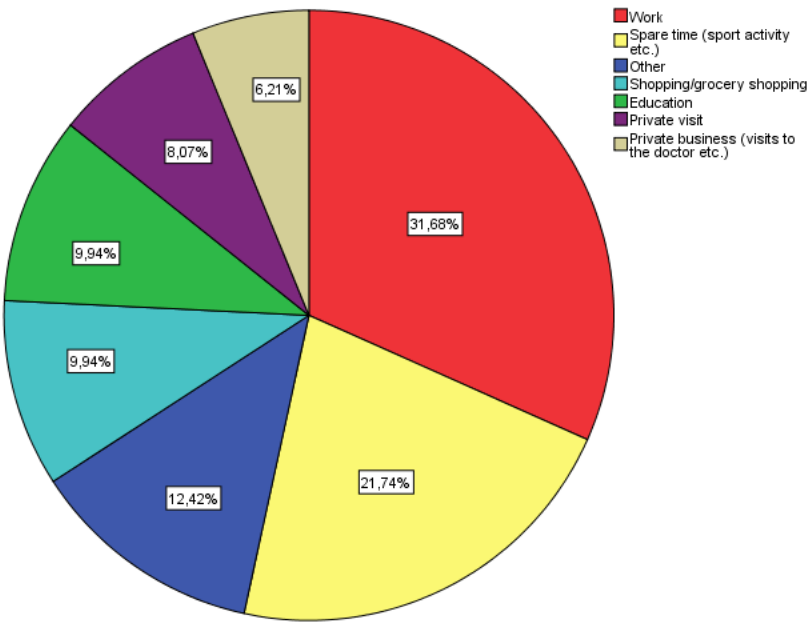


3.2.3 Destinations

Identifying scooter destinations is a more complex process. It is important to first know what the main destinations are. Destinations were obtained via literature research. DIVV, performs a survey called 'Onderzoek Verplaatsingen in Amsterdam (OViA)', which is identical to the nationwide survey 'Onderzoek Verplaatsingen in Nederland', done by the CBS annually. This survey is done to identify mobility of people (CBS, 2013). The survey has asked over 6000 inhabitants of Amsterdam what their destinations were for a whole week and what type of transport was used to get to there. A selection was made based on respondents owning a scooter and using it as the main vehicle. Of all the individual travels undertaken, only 161 used the scooter as their main vehicle (DIVV, 2013). Considering that 6% of the population owns a scooter in Amsterdam (Amsterdam, 2014), 161 travels seems low. However, the number 161 indicates unique scooter travels, not unique respondents. Apparently, although owning a scooter, individuals did not use them for every travel they did. Other vehicle types were used as well.

Respondents were asked what their destination was for each trip. Figure 7 shows a pie chart with destinations of scooter users. Approximately 31% uses the scooter for work related purpose, which is the highest transportation motive. Other frequent motives are spare time (21%), shopping (10%) and education (10%).

Figure 7: Destination types for scooter users in Amsterdam



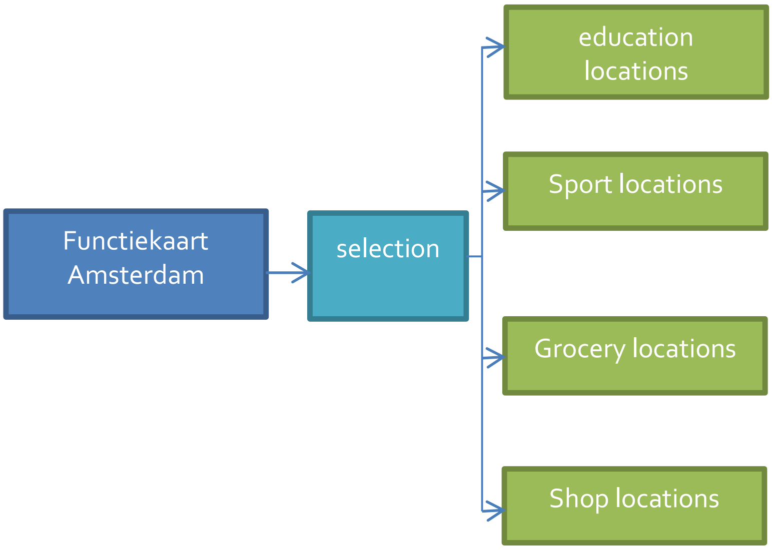
Source: OViA, 2013

The average number of trips per day according to the survey was 4 (DIVV, 2013). However, scooters were not used for all trips. The survey question was: *How many trips were made that day?* Although the selection was based on respondents who use a scooter as main vehicle, these respondents could have used a different vehicle for a different trip. Therefore total number of trips may not be equal to trips done with the scooter. A calculation was made on the actual number of trips with a scooter divided by the total number of trips that person had during a day. An average of 74% of the total number of trips per respondent used a scooter, which means that on average, 3 trips per day were done using a scooter (74% of 4 trips per day).

A selection was made of the four most used destinations. Adding more destinations would have caused the model to become too complex and extra assumptions had to be made. The average number of trips per day was taken into account. The 4 most common destination types were used: work, spare time, shopping and education. The category Other was removed from the top 4 selection because modeling this would not be based on literature, but rather on assumption. Private visits and private business visits also were removed for the same reason.

Most destination types were selected with the help of the Functiekaart Amsterdam (Gemeente Amsterdam, 2015). This is a collection of all non-residential buildings within the city, including their function. All office buildings, supermarkets, cafes etc. are classified and presented in a shapefile. This map was used to create selections for the other destination types (see figure 8).

Figure 8: destinations process overview



Within this shapefile, there is also a subcategorization of these categories. For example, scooter users who travel to school with a scooter can either go to a high school, or to a University/HBO school.

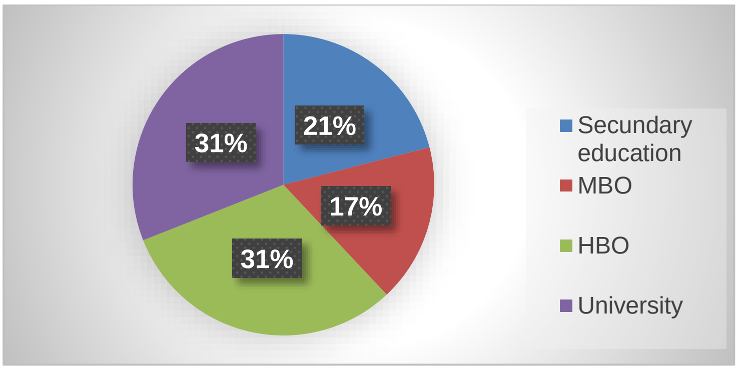
3.2.3.1 Work

For work related destinations, it is difficult to identify locations. Amsterdam has a few business areas (for example Amsterdam Zuid), but most of the offices are scattered throughout the city. Many factors are related to a work location, including status and accessibility. Offices in the canal district were chosen for status rather than accessibility and vice versa. Also, people can work at shopping malls, hospitals etc, which makes the variety of locations in the city immense. Therefore, to model the destination type work, a random location in the city will be used for each agent.

3.2.3.2 Education

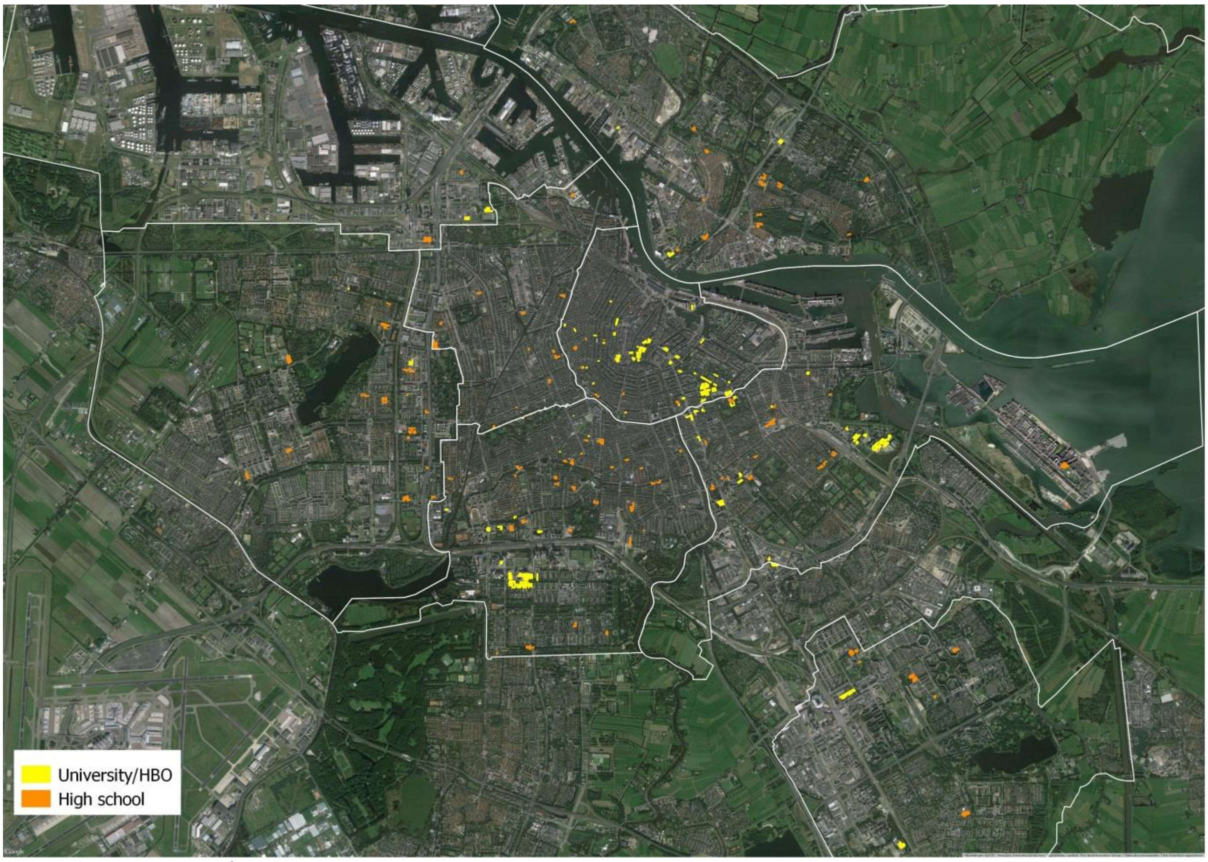
As mentioned above, scooter owners who travel to school can either go to a high school or to a University/HBO. It is important to know how many people are going to school, and how many of the people work. According to the CBS, around 24% of the scooter owners uses the scooter for school related destinations, of which 38% is registered at a MBO or high school (CBS[b], 2014). All others are registered at a University or HBO. This subcategory is created and used as an input variable in the ABM.

Figure 9: distribution of education types in Amsterdam 2013/2014



Source: CBS[b], 2014

Figure 10: Distribution of educational buildings in Amsterdam

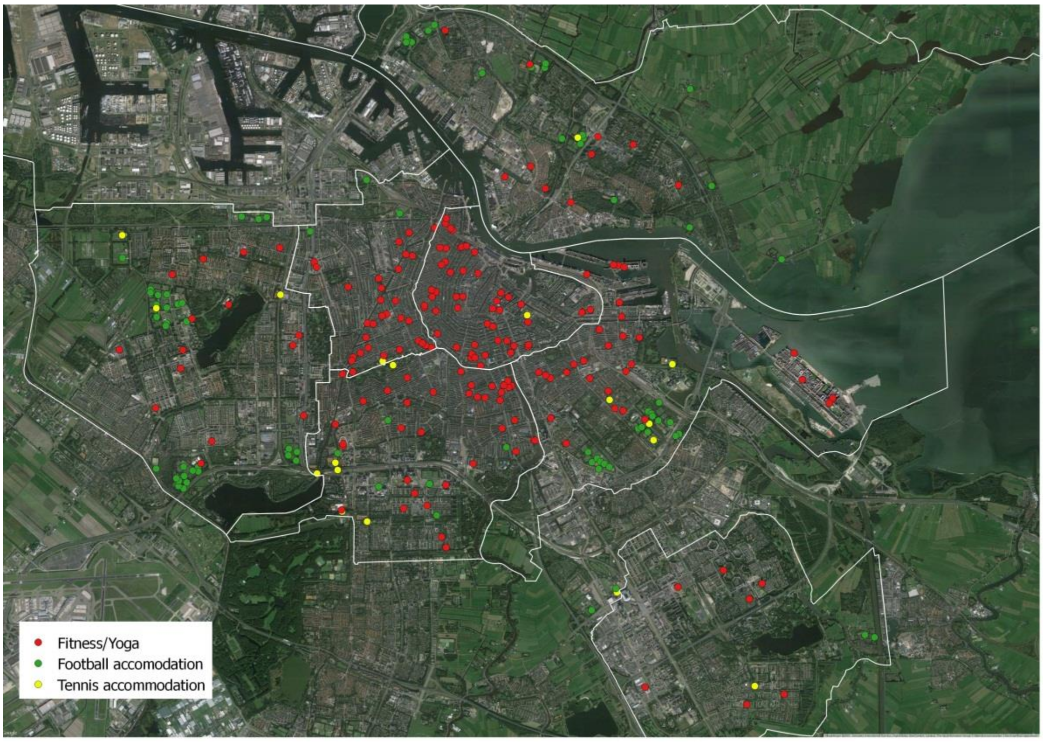


Source: Gemeente Amsterdam, 2015

3.2.3.3 Sport

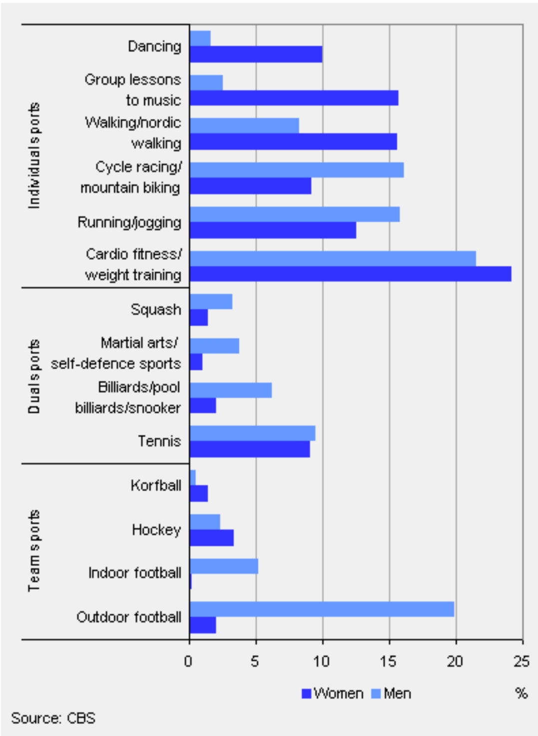
According to the CBS, around 68% of the population practices a sport and does this on a weekly basis at least (CBS, 2010). Because there are many sports to practice, a selection of the three most common sport destinations have been chosen. As seen in table 4, most common sport types are fitness, football and tennis. Although some activities seem more popular (like running), they were not placed in the selection, because there are no specific locations for them, or a scooter is not used to travel to these activities.

Figure 11: distribution of sport locations subdivided by category



Source: Gemeente Amsterdam, 2015

Table 4: popularity per sport activity



Source: CBS, 2010.

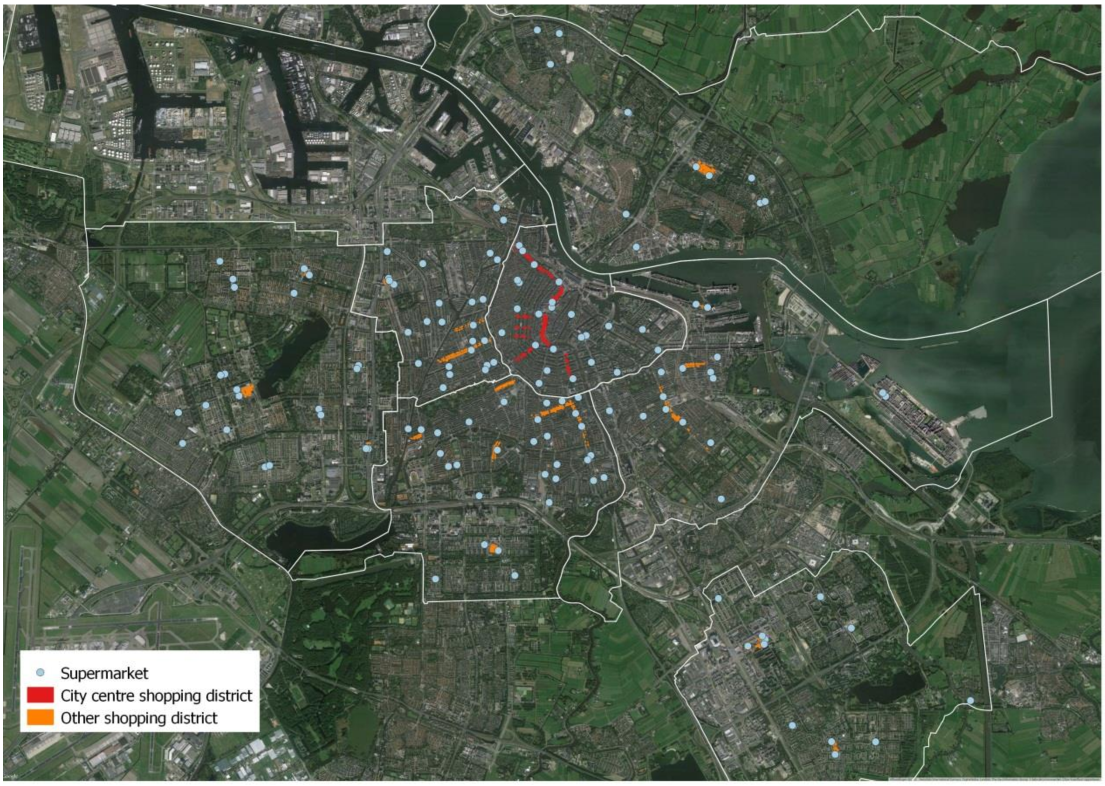
Because fitness is more popular than football, and football more popular than tennis, scooter owners are placed in a category based on certain probability distribution. From the randomly selected 68% of the scooter owners, 50% will practice fitness, 30% practices football and the remaining 20% will practice tennis.

3.2.3.4 Grocery shopping/shopping

Amsterdam is a big city. Therefore, a differentiation was made between grocery shopping and merchandise shopping. Most of the scooter owners do not travel to the city center for grocery shopping. Supermarkets have been selected from the functiekaart. According to CBL (Centraal Bureau Levensmiddelenhandel), the average amount of grocery shopping is 3 times per week (CBL, n.d.).

Merchandise shopping on the other hand, is less frequent. According to an independent research bureau, people do merchandise shopping once every 2 weeks (direct research, 2014). Amsterdam has several shopping districts, but it is assumed that people will often choose the city center for merchandise shopping.

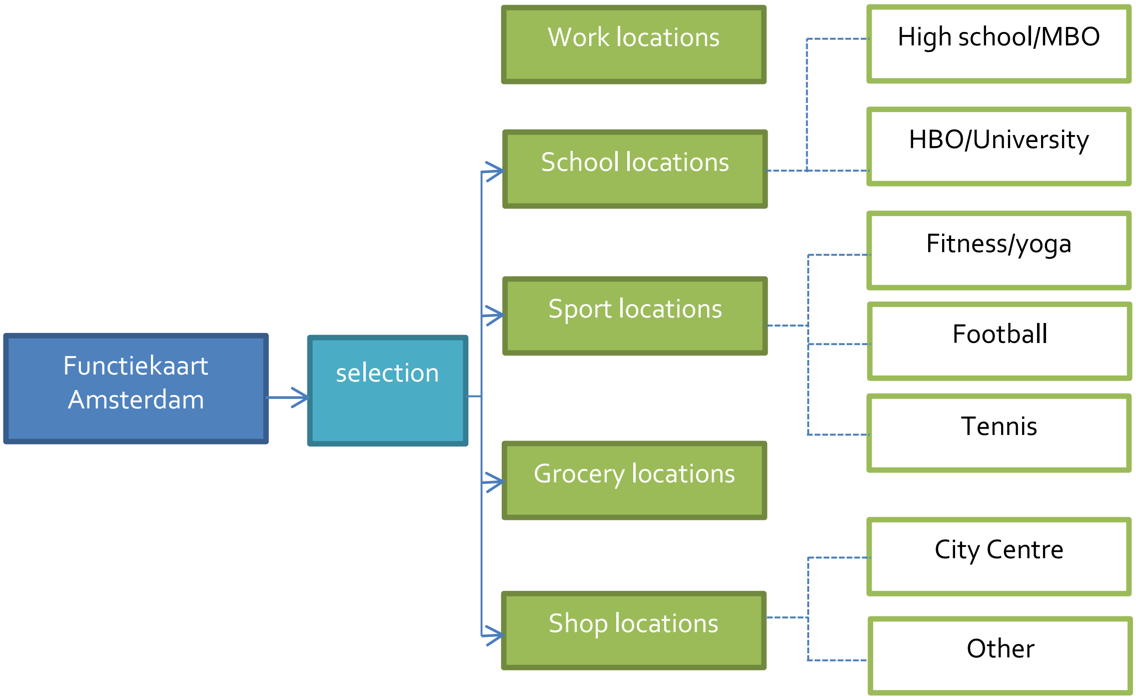
Figure 12: shops in Amsterdam, shopping districts and supermarkets



Source: Gemeente Amsterdam, 2015

With the different categories and sub categories, the updated version of the destination types is shown in figure 13.

Figure 13: Process overview of all destination types, subdivisions included



3.3 Phase 2: programming

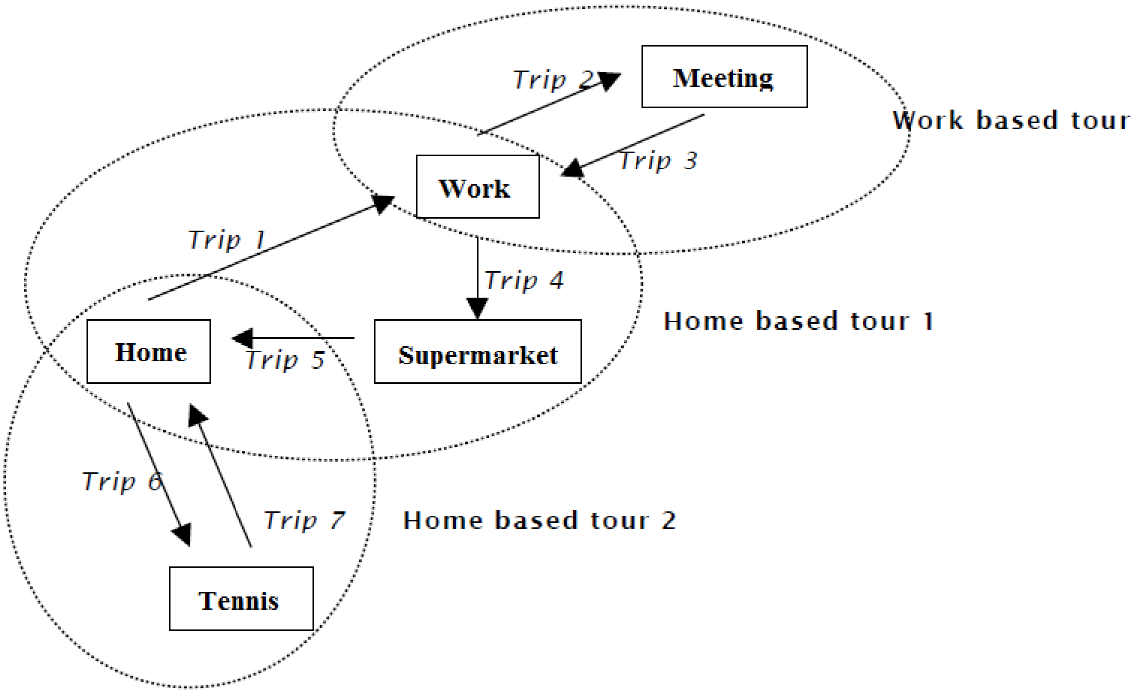
3.3.1 ABM

ABM was chosen as method to simulate scooter traffic. In social science, ABM is an emerging approach of simulating complex processes and phenomena (Chen, 2012; Grignard et al., 2013). There is no consensus for the term agent. Some say an agent is *"…Just something that perceives and acts"* (Russell and Norvig, 1995, p. 7). However, a more detailed description has been given by Lee, which is a summary of definitions by Jennings, Franklin and Epstein: "*an agent is an autonomous software entity which is situated within (or acts as a component of) an artificial environment, being able to sense and interact to its neighbor agents and local environments, over time, to achieve its own goal and so as to effect what it senses in the future*" (Lee, 2007). For this research, agents will be scooters, which are able to take actions of its own within an artificial environment: the road network of Amsterdam.

ABM is used to develop an activity travel demand modeling approach. These models predict behavior based on different activities (Jovicic, 2001). Scooter owners participate in several activities (see chapter 3.1). These activities become trips when a scooter owner travels from one activity to another. Figure 14 shows a hypothetical situation of such a sequence of trips during one day for an individual. An activity based model captures all these activities. Five essential features for activity based models (Jovicic, 2001) are:

- Travel is a derived demand from the activity participation.
- The activity based approach focuses on sequences of patterns of activities.
- Individuals' activities are both planned and executed in the household (family) context.
- Activities are spread throughout a 24-hour period in a continuous manner, rather than using the simple categorization of 'peak' and 'off peak' events.
- Travel and location choices are limited in time and space, and by personal constraints. This framework is based on Hägerstand's concept of the space-time prism.

Figure 14: example of a sequence of trips for one individual

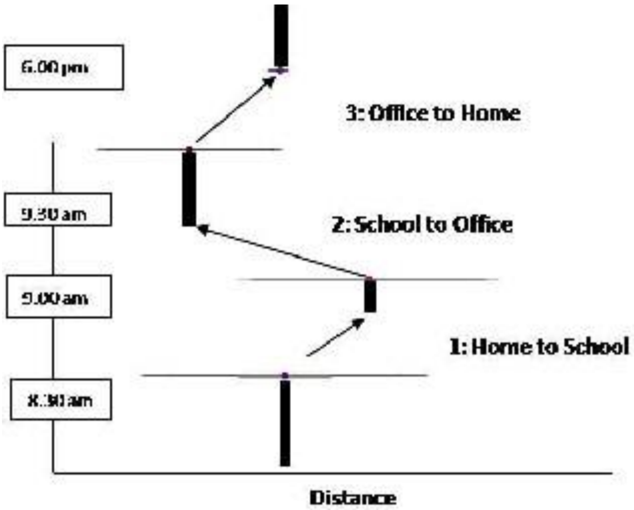


Source: Jovicic, 2001.

The space-time prism is a concept of Hägerstand, created in the early 70's. It describes human spatial behavior (see figure 15 for an illustration). A day consists of several activities (work, school, shopping etc.) As you can see in figure 15, when a person is doing such an activity a vertical line is drawn. Movement can also be drawn, which are the arrows in the figure. Together, space and time are represented for an individual and is called the space-time prism(Raubal et al., 2005; Hägerstand, 1970). There are several constraints for certain activities. For example, a person should be home at dinner time or a person needs to be at work at a certain time etc. An activity such as work is a fixed activity, since start and end time of workdays are mostly fixed. For certain spare time activities, time is more flexible. One can go to a fitness activity when other activities are completed, but do have other constraints, like closing hours.

The geographical area in which an activity is chosen depends on the mobility of the individual. A pedestrian has a smaller area of choice than a scooter user, to name an example. Due to certain constraints in the space-time prism, only a limited number of activities can be done per day (Raubal et al., 2005).

Figure 15: example of a space-time prism



Source: Raubal et al., 2005.

Activity based models have different methods: the discrete choice activities and the rule based simulation activity based models. A discrete choice model lets individuals create their schedule before executing it. This is on individual basis and based on their preferences. Their travel patterns will not change after their schedule is made for a particular day. Peter Stopher (1996) notices that most of the travelling is habitual, and therefore, makes travel patterns stay the same in most cases. The rule based model is based on families rather than individuals, which makes this type of model less effective for a scooter flow simulation (Jovicic, 2001).

An important aspect of ABM is the use of parameters to describe activities, and create different scenarios to simulate real life events. By changing these parameters we can also study the sensitivity of the model (and maybe real life dynamics if the model is correct) to changes in various activities and user preferences. An integration of Activity Based Models with ABM has therefore the advantage of having several parameters which are able to test multiple scenarios. This combination was used during the research.

3.3.2 The model

Describing the model will be based on the ODD principle, proposed by Grimm et al. (2006). The ODD principle is a standard protocol to describe an ABM and consists of 3 blocks: Overview, Design concepts and Details, each having its own subdivisions (see figure 16).

Figure 16: ODD principle overview

Overview	Purpose
	State variables and scales
	Process overview and scheduling
Design concepts	Design concepts
Details	Initialization
	Input
	Submodels

Source: Grimm et al. 2006.

3.3.2.1 Purpose

The purpose of the model is to identify which roads have the most scooters travelled on per day. This can be used to identify risk zones by applying certain relationships between scooter numbers and noise annoyance. The model can also be used to analyze other problems associated with scooters, for example: identify the risks associated with scooter emissions and/or scooter related accidents. The model will serve as the basis for examining current, future or past scenarios.

3.3.2.2 State variables and scales

Individuals, network and behavior, all described in chapter 3.2 are state variables in this model. Individuals or agents are scooter registrations subdivided into light-moped and regular-moped. The network of Amsterdam is the model extend, where all individuals drive to their destinations. These destinations are loaded as shapefiles into the model. Each individual creates its own schedule (see the process overview and scheduling section below) and uses the road network to move from one destination to the other. As mentioned in chapter 3.2, activities have certain restrictions or rules, which an agent has to follow. The model stores the numbers of scooters per road segment and exports them as a shapefile at the end of the model run.

3.3.2.3 Process overview and scheduling

Figure 17: overview of different time measures in GAMA

```
float step                          <- 60#mn;
int current_hour update:            (time / #hour) mod 24;
int current_day update:             (time / #days) mod 7;
int current_day_2weeks update:      (time / #days) mod 14;
```

Time in GAMA is measured in seconds. These seconds can be used to identify hours, days and weeks. This is needed to schedule activities for each agent. The model will run in cycles, where each cycle takes a certain time step. In this case, each cycle takes steps of 60 minutes, which means that during the model run, visualization of the current situation is seen in steps of 60 minutes. This research is based more on model exports of cumulated scooter numbers on each road segment rather than the actual visualization of the model, so time steps could also have been programmed at 24 hours per step, which would not have mattered for the result, although computation time seemed longer then.

Work and school are the least flexible activities. Work and school times are fixed and have priority over other activities. Therefore, these activities are scheduled first before planning other activities. Furthermore, these activities are only scheduled between Mondays and Fridays. Figure 17 showed that GAMA reads time, and keeps track of hours, days and weeks. GAMA can read the days and restrict activities to be planned on certain days. For example: work and school activities will not be planned on Saturdays and Sundays (not on day 5, 6, 12 and 13). After an individual has been scheduled with the first activity, the next follows. This is programmed in a loop, so that each individual gets their own set of unique activities. Also, spare time activities (sport, shop) are not practiced daily. These activities are scheduled based on a probability. If, for example, a sport activity is practiced once per week, GAMA randomly chooses a day (between Monday and Sunday) when this activity should be practiced.

Table 5: set of activities on a two week period for one individual

#	days	end	location	name	proba_targets	start
0	[0,1,2,3,4,7,8,9,10,11]	19	{2863.32147...	'work'	[1.0]	6
1	[5,12]	18	{494.022567...	'sport'	[1.0]	17
2	[13]	16	{3030.36384...	'shop'	[0.7,1.0]	14
3	[]	0	{3780.31429...	'grocery'	[1.0]	0

In table 5, a set of activities for one individual is presented. This individual has a work activity from Monday till Friday. For each individual, the start and end time of an activity is programmed. This particular individual has a long workday from 6:00 to 19:00. Because of this, it has little time to do other activities like practice a sport or shop. Therefore, activity sport and shop have been scheduled in weekends (space-time prism). All these activities are scheduled before the model run except grocery shopping, which is scheduled during certain days when there is time. Each activity has an already planned destination (see location coordinates in table 5). As mentioned in chapter 3.3.1 most of the travelling is habitual, which makes travel patterns stay the same in most cases (Stopher, 1996). This creates certain scheduled patterns.

A discrete choice activity model was chosen to identify the scooter routes (see chapter 3.2.1). In GAMA, activities are scheduled in a sequence. Due to the constraints of the space-time prism, agents will not be able to schedule too many activities per day and can only be planned at certain times per day. If there is enough time, an activity can be planned while obeying certain behavior rules explained in phase 1.

3.3.2.4 Design concepts

Emergence: although all individuals create their own schedules and execute them, together they form a road network of Amsterdam where risk zones are identified due to the number of scooters passing by per road segment.

Prediction: future predictions of scooter numbers per road are based on current trends and data.

Sensing: individuals should know what scooter type they drive, so that they can choose their route based on this vehicle type. Also, they are aware of the current day and time, so that the planned schedule will be executed correctly (certain activities are at specific time and date in a 2-week schedule).

Stochasticity: work locations are randomly chosen for individuals who have a job. Also, percentages obtained via literature (percentage of people practicing a sport etc.), are used to randomly select individuals to practice these activities.

Observation: for testing, distribution of scooters was observed and validated using real life counts of scooters.

3.3.2.5 Initialization

Initial parameter settings are based on data (unemployment percentage and retirement percentage), although other activity parameter settings are based on assumptions: sport activity, shopping activity and school activity. Each model run starts on Monday at 00:00 and ends on Sunday 23:59 14 days later. Although initialization stays the same in different simulation runs, parameters are changeable. Changing settings is possible after the model is initialized.

3.3.2.6 Input

There are no environmental changes in this model. However, there is a distinction between light-moped drivers and regular-moped drivers. A light-moped driver is allowed to drive on bicycle lanes whereas regular-mopeds cannot drive there. A weight value has been given to bicycle lanes, only for light-mopeds to choose a bicycle lane over a regular road.

3.3.3 Calibration

To assess the model behavior, it is required to run multiple trials (Stonedahl, 2011). With the use of parameters, behavior of agents can be tweaked. All activities described in chapter 3.2 have their own parameters in the ABM to modify the number of agents scheduling for a particular activity. These types of parameters are included and based on unemployment (10%) and retirement percentages (6%) in Amsterdam (CBS[b], 2014). These percentages can vary through time and are therefore also valuable parameters for future trend studies. Future trend showed that retirement percentage will increase to 13% in 2020. Unemployment is difficult to prognosis, but is probably will stay around the same percentage (NRC, 2013)

As mentioned in chapter 3.2.2, it is assumed that light-moped users tend to use roads with bicycle lanes more often than roads without them. This rule is already programmed, but a parameter can identify the impact changes have on the roads weight. Also, a future scenario might be that light-moped users are banned from the bicycle lanes and obliged to drive on normal roads. This scenario can be presented in the model by setting the weight of bicycle lanes to zero effectively making them impossible to choose.

Table 6: parameter overview of ABM

Parameter	Based on literature/assumption	Default value
Scooter percentage (2014=100)	literature	100
Unemployment percentage	literature	10
Retirement percentage	literature	6
Percentage non-scooter use sports practicing	Assumption	25
Percentage non-scooter use education purpose	Assumption	25
Percentage non-scooter use shopping	Assumption	25
Percentage non-scooter use grocery shopping	Assumption	35
Average days per week the scooter is used	Assumption	5
Weight bicycle lanes for light-moped drivers	Assumption	2

There may be other factors why people will not use the scooter, e.g. in case of bad weather, or when individuals use the scooter for work less than 5 times per week etc. For each activity, a parameter was implemented to give a percentage of how many individuals use the scooter for a certain activity. For example, from the 68% of people practicing a sport on a weekly basis, a few might use public transport or walk to their destination, despite the fact that they own a scooter. These types of behavior probabilities can be put in the model by parameters. Since these factors are based on assumptions, it is best to be able to tweak them with a parameter setting.

To identify which activity has the most impact on the outcome of the model, a sensitivity analysis is done. Main parts of a sensitivity analysis are: which parameter settings result in realistic behavior and which parameters have significant effects for which outputs? (Burgers et al., 2010). Experimenting with parameters that describe a certain activity and leaving all others constant, one can spot the activity which has the most impact on the results. Policy makers can examine which activity has the most impact on scooter density in the city and focus their policies on this specific activity to effectively apply them. A sensitivity analysis does not have to be completed with the whole dataset; a smaller part of the study area also returns the more sensitive activities (parameters) (Stonedahl, 2011). The dataset on Amsterdam is too huge to quickly capture sensitivity for each factor, however, city district Zuid, including a 20% sample of the registered scooters was used as a sample.

3.3.4 Validation

Burgers et al. (2010) mentioned that it is necessary to identify if the model outcome gives realistic results and which parts of the city have more realistic results than other. This can be analyzed with a validation method. Dufec is a research bureau, which annually monitors speeding of scooters in Amsterdam. This is done at 10 different locations on three different dates (Dufec, 2013). For the purpose of a better validation, an additional number of locations were chosen to count scooters passing by and compare these with results from the model.

8 locations per city district were chosen to sample, which resulted in over 50 locations in the city (see figure 18). A distinction was made between streets in the background (neighborhoods) and busy streets. The busy and background roads were paired together for practical reasons. A method used also by van Roosbroeck et al. (2007) who counted for 15 minutes outside rush hours at each location was chosen for this validation. To create an average number of scooters passing by every day, a calculation was made with the 15-minute count. According to Dassen et al. (2000), the traffic during daytime accounts for 78% of the total traffic in the Netherlands. The assumption was made that this percentage did not change between 2000 and 2015, so it was kept the same. Daytime is between 7:00 and 19:00, which is a time span of 12 hours. The traffic count was therefore multiplied by 48 (4x12). To also add the traffic of nighttime, the number total was also multiplied by 1.29 (1/0.78).

Figure 18: validation location subdivided in background or busy roads

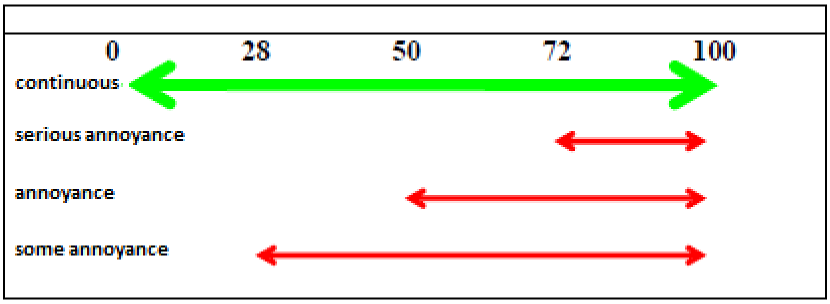
All counted locations were compared to the results from the model run. A detailed explanation can be read in chapter 4.1.

3.4 Phase 3: analyzing

3.4.1 Noise annoyance

Data on noise annoyance was obtained from the ROAM questionnaire. ROAM is a research project between GGD Rotterdam, GGD Amsterdam in collaboration with IRAS (Institute for Risk Assessment Sciences, University of Utrecht), Erasmus University, DCMR Milieudienst Rijnmond, RIVM and NIVEL (Academische Werkplaats, 2014). The goal of this project is to improve knowledge on associations between public health and the living environment. The project focusses on air and noise pollution and availability of green space near residents (Academische Werkplaats, 2014). The respondents of the ROAM dataset were retired elderly (65-70 years) in the city of Amsterdam, chosen because some health symptoms are more prevalent amongst this group, but have relative vitality and relative limited presence of severe illnesses. Out of the 25.000 residents in Amsterdam who fall within this age group, a random sample of 10.000 people were asked to complete a questionnaire. Respondents from the questionnaire had filled in their 6-digit zip-code and with the Geocoder plugin of QGIS, respondents were located on the map and spatially joined to the closest road. The attribute table was exported as a csv file which was loaded into SPSS to statistically analyze the relationship between the two datasets.

Figure 19: continuous scale of noise annoyance



Part of the ROAM questionnaire focused on self-reported noise annoyance for different vehicle types. Respondents used a Likert scale to indicate their degree of annoyance. A Likert scale is widely used in surveys to specify the level of agreement for a specific statement (Statistic Cafe, 2012). A widely used type of Likert scale is the 10-point Likert scale, better known as the school grade. Although, grades are subjective (a 6 for one person may be different for another), using this grade with a variety of other questions/variables with this grading scale, a correct analysis can be done.

Noise annoyance was measured by a standardized questionnaire (ISO norm, see question in figure 20) to enhance similar research possibilities. Respondents answered their level of annoyance of several noise sources on a 10-point Likert scale. According to a research by National Institute of Public Health and the Environment (RIVM), “serious annoyance” and “annoyance” account for 72 percent and 50 percent of the continuous scale, respectively (see figure 19) (RIVM, 2013).

Figure 20: example of the question concerning noise annoyance

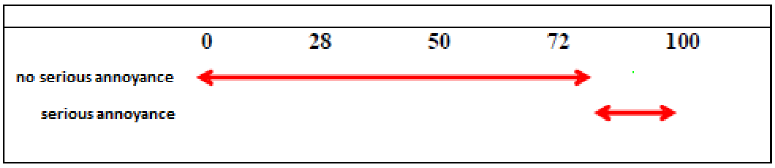
In the question below, you can tick in what degree noise annoys when you are at ***home****. If you are not annoyed at all, tick 0. If you are extremely annoyed, tick 10. If it is somewhere in between, tick between 0 and 10. If noise is inaudible, tick the last column.*

"If you think about the past 12 months, which number between 0 and 10 would describe best your level of hinder or annoyance with the noise of …. when you are at ***home****?"*

Tick one answer on every line.	*0* *Not hindered at all*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10* *Extremely hindered*	*inaudible*
a. *road traffic*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. *neighbours*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. *trains*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. *airplanes*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. *Industry*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. *scooters*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
g. *bars/restaurants*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
h. *demolition activities*	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

In international research, only serious annoyance is reported. Therefore, category annoyance with its 10-point Likert scale is rescaled to serious annoyance: yes or no, a dichotomous variable. A dichotomous variable is a nominal variable with only two categories (yes/no etc.) (Statistic Cafe, 2012).

Figure 21: rescaling of noise annoyance to create a dichotomous variable



Serious annoyance accounts for 72% of the Likert scale (see figure 21) (RIVM, 2011). However, this percentage is not a category in the Likert scale, as it falls between 7 and 8. For analysis the question was dichotomized in subjects with score 8 or higher (seriously annoyed) and 7 or lower (not annoyed).

3.4.2 Logistic regression

To analyze noise annoyance in relation to number of scooters passing-by a logistic regression was used. Healy (2006) states that "*logistic regression is preferred by many researchers in the analytical fields due to its robust practical nature, intuitive assumptions and its ability to produce a predictive representation of real world situations"* (Healy, 2006: 3). Logistic regression is a powerful statistical way of modeling a binomial outcome with one or more explanatory variables. In other words, the level of annoyance (dependent variable) can be modeled in relation to the number of scooters passing by (explanatory variable).

In logistic regression the dependent variable (noise annoyance) is dichotomous, independent variables or explanatory variables can be either dichotomous, categorical or continuous (Healy, 2006). In a logistic regression, these independent variables predict the possibility of an event occurring.

Logistic regression has several assumptions like: resulting logit transformation is linear and the resultant logarithmic curve does not include outliers (Healy, 2006; O'Halloran, n.d.).

Figure 22: Odds ratio calculation

$$\text{Odds}_i = \left[\frac{p_i}{1-p_i}\right] = e^{b0+b1X1+.......bnXn}$$

One of the outcomes of a logistic regression is an odds ratio (OR) (see figure 22). P is the probability of event i, where b0 + b1x1 + …. represents the regression model (Healy, 2006). The OR states probabilities of a specific binary outcome to occur. For example: someone wants to investigate odds of graduating (dependent, dichotomous variable: yes or no) compared to hours studying for the exam (independent variable, continuous: 0 hours to 'infinite' hours) by using a logistic regression method. If the OR outcome is 1.12, it means that for every extra hour a student learns for his or her exam, odds of graduating increase with 12%. In this research, if scooter counts were used as a continuous variable, an OR of 1.12 would mean that there is a 12% higher chance on serious annoyance if the number of scooters passing by increases by 1. A standard OR calculation with a dichotomous variable is called a crude analysis.

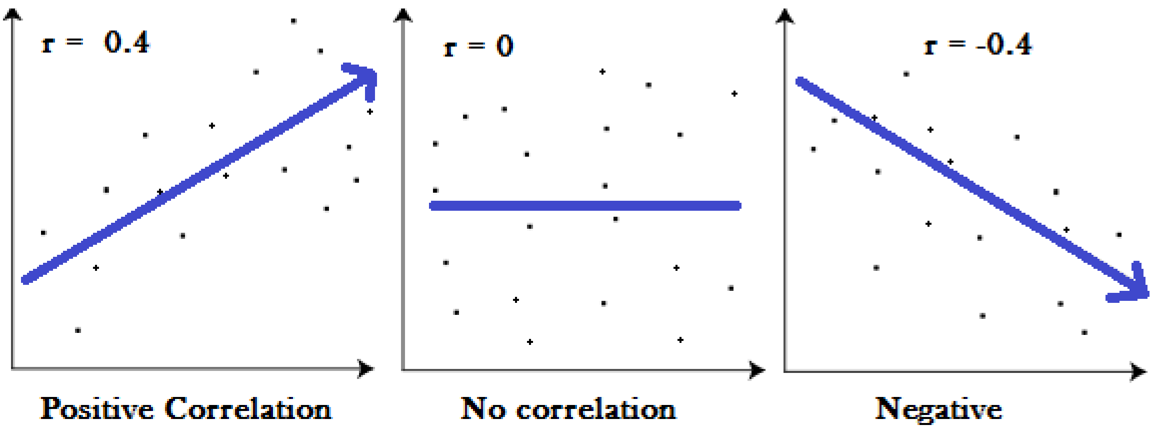
However, there are possible confounders, which could have effect on the OR outcome. For example, someone who lives at the third floor could experience less noise annoyance than someone living at the ground floor, even though he lives in a busier street. Other variables might also affect noise annoyance, while they are also associated to the number of scooters passing by. These other variables are shown in appendix B, which includes the ROAM questionnaire used for the logistic regression analysis. Associations between noise annoyance and number of scooters are adjusted for these potential confounders. To adjust for potential confounders, they are added to the regression analysis as covariates in order to control them (University Texas, n.d.). After controlling for potential confounders, the predictive error occurrence must be measured for the OR to be veracious. This is done by the log-likelihood and coefficient of determination (R^2), standard calculated by SPSS (Healy, 2006). The adjusted OR gives the most reliable odds predicting the dependent variable.

4. Results

4.1 calibration/validation

In the methodology chapter 3.3.4, it was mentioned that 64 locations were chosen to validate the model with real life data. With these locations, a correlation coefficient was calculated in Excel, which is Pearson's r. It shows the linear relationship between two datasets (Statistichowto, 2015), in this case between model numbers and real numbers. The outcome of Pearson's r is always between -1 and 1, where -1 is an absolute negative relationship and 1 and absolute positive relationship.

Figure 23: comparison of different correlation outcomes in a scatter plot



Source: Statistichowto, 2015.

This correlation result can be plotted in a scatter diagram. In figure 24, the scatter diagram shows the correlation between the model results and the scooter count results. The total correlation is 0.81, which is a high and positive correlation. The most extreme outliers are from the model outcome, which are around 5000 scooters passing by each day on one particular road.

Figure 24: scatterplot of model validation

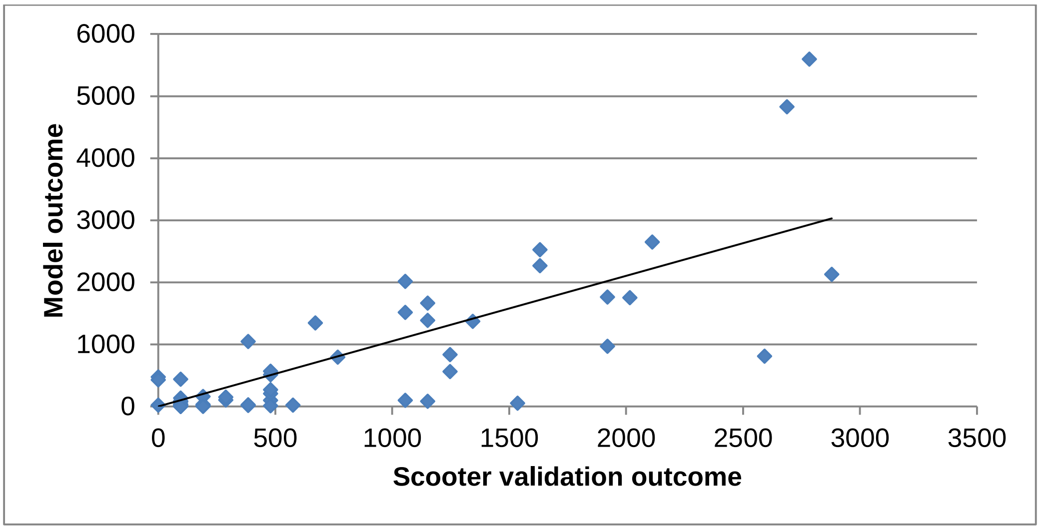


Table 7: correlation per district

City District	Correlation
West	0.95
Noord	0,92
Zuid-Oost	0,90
Zuid	0,88
Centrum	0,81
Oost	0,81
Nieuw-West	0,50

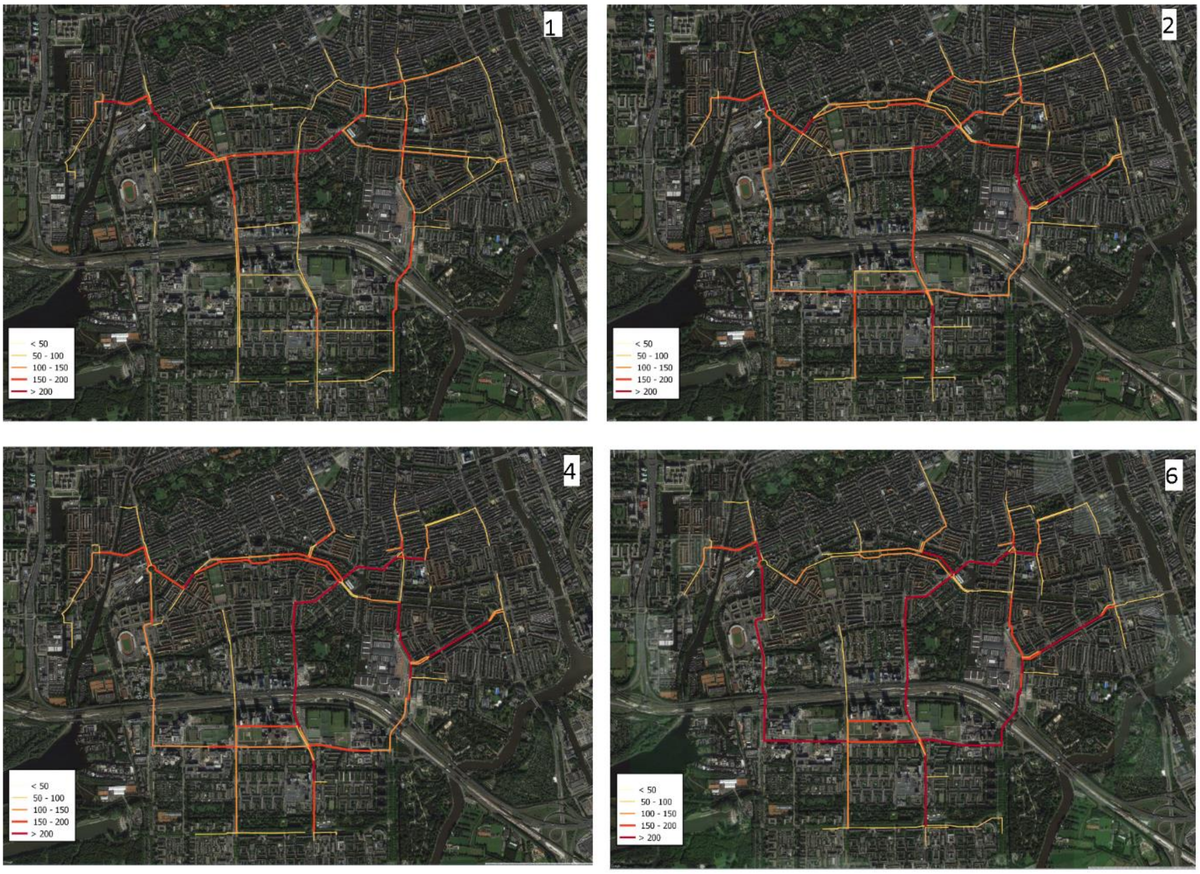
Burgers et al (2010) mentioned that it is necessary to examine which parts of the study area result in more realistic behavior than others. The validation method of counting scooters was done in 7 parts of each city district. Although this number is rather low, a correlation coefficient was calculated for each city district. Almost all districts show a high correlation, although Nieuw-West shows a very low value. Without this district, the overall correlation would have been higher. Possible reason for this is that some road segments were not connected to each other in GAMA due to a hash code error. Agents 'fell off' the road network and start floating through the map. To overcome this problem, these roads were modeled as dead ends so that agents choose a different path, but it was not a real life representation of the network. This 'dirty trick' was used throughout the analysis, because the bug could not be fixed before the analysis. Most roads which had this problem were situated in Nieuw-West.

4.2 Sensitivity analysis

Several different parameters were analyzed: the weight on bicycle roads and each of the five activities. To map changes in parameters the fastest, one city district (Amsterdam Zuid) was the chosen study area during the sensitivity analysis. Although all activity destinations have been added, the number of scooters has been reduced to 20% of the study population.

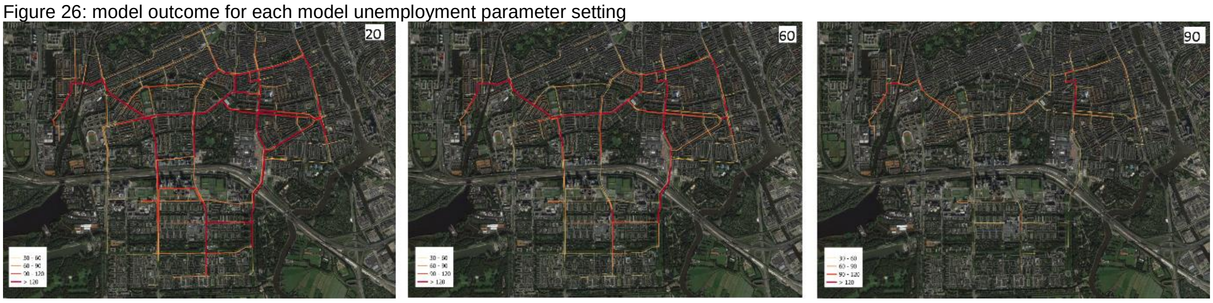
The weight on roads with a bicycle lane has been multiplied. The higher the number, the higher the chance an agent chooses that particular road. As can be seen in figure 25, the biggest difference is seen between 1 and 2 times the chance people choose bicycle lanes. The amstelveenseweg (road on the left side, passing Olympisch Stadion, is chosen when weights on bicycle lanes is higher. Road segments become more darker-red when weight on roads with bicycle lanes become higher because these roads are frequently used due to the higher weight class. Of course, these parameter settings have no effect on regular-moped drivers, who choose the fastest route without weights on any road segment.

Figure 25: bicycle weight, changes in routes



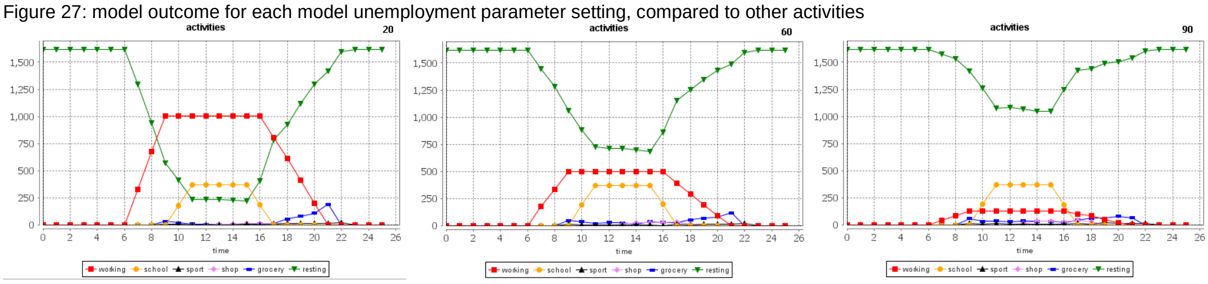
The work (or unemployment) parameter is changed to several extents. Percentage of unemployment has been set to 20, 60 and 90 percent. As seen in the figure 26, the number of agents on the road increases greatly with less unemployment. However, no real evident changes can be seen in route choice. Most major roads are still used, although the intensity decreases when unemployment is higher.

Figure 26: model outcome for each model unemployment parameter setting



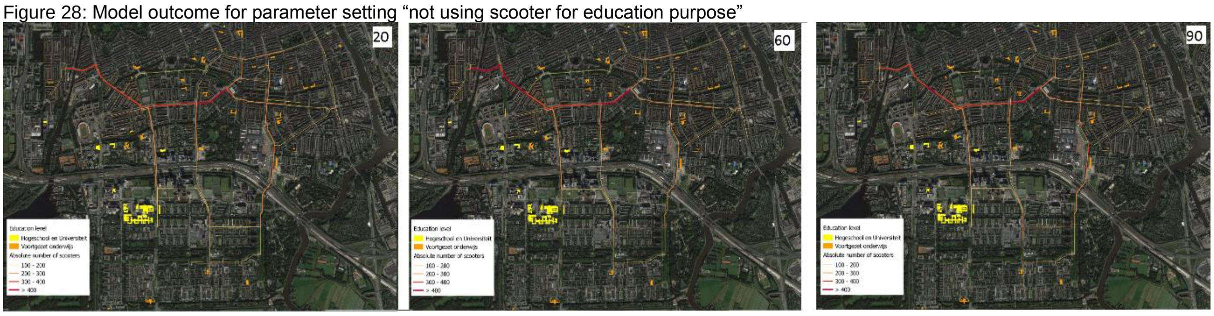
As mentioned in chapter 3.3.1, the space-time prism makes sure an individual plans its daily activities beforehand. As seen in figure 27, because work activities reduce, other activities stay the same. Stopher (1996) mentioned that activities are habitual, which means that travel patterns stay the same. This means that although more spare-time is available for a greater number of people when unemployment is higher, the day a specific activity is done (for example: fitness) will not change for that individual. Therefore, reduction in work activities does not affect the day a certain activity is done. However, grocery shopping for example, is done most of the time at the end of the day when the unemployment parameter is set low (because most people have spare time only in the evening, after work), but when unemployment is higher and more people have spare time, other planned activities are spread more evenly on that day rather than a high peak early evening. The overall number of scooters for these activities will therefore not change, but it will cause less scooter traffic at the same time.

Figure 27: model outcome for each model unemployment parameter setting, compared to other activities



School activity does not have much effect on the outcome of the model, even though 24% of the population with a scooter is following a course at some school degree. When only 20% of the individuals follow an educational course, some roads at the upper side of the district were used more often due to the fact that there are several high schools present. Other than that, no real changes in outcome.

Figure 28: Model outcome for parameter setting “not using scooter for education purpose”



Sport and shopping activities have very little effect on the model outcome. This is mainly due to the fact that shopping is only scheduled once per 2 weeks for each individual and a sport activity only once per week and, in addition, only 68% of the population practices a sport.

There are some visible changes when altering parameters during a sensitivity analysis, but most of the model outcome stays the same when it comes to routes chosen, although absolute numbers do decline when fewer activities are scheduled. Most of the traffic is work related, which makes it the activity with the most impact on the model outcome. Other activities are not daily activities which automatically makes them of less impact. However, because no extreme changes are seen in different model outcomes, one can speak of a stable model.

4.3 results for the present situation

4.3.1 Model output

The model computes per individual their set of activities for a 2-week period. It makes sure that each individual is not influenced by other individuals, so it calculates its own shortest path, and creates its own space-time prism (see chapter 3.3.1 for a detailed explanation of the space-time prism). A simulation run of 2 weeks takes a lot of calculation time, mainly because the ABM calculates 2-week set of activities for over 50.000 individuals.

Several output files were created after the model run. First, a shapefile, which shows the road map of Amsterdam including the scooter count (totals, light-moped and regular-moped numbers) of each street in absolute numbers.

Figure 29: distribution of scooters in Amsterdam are presented on a gradual map

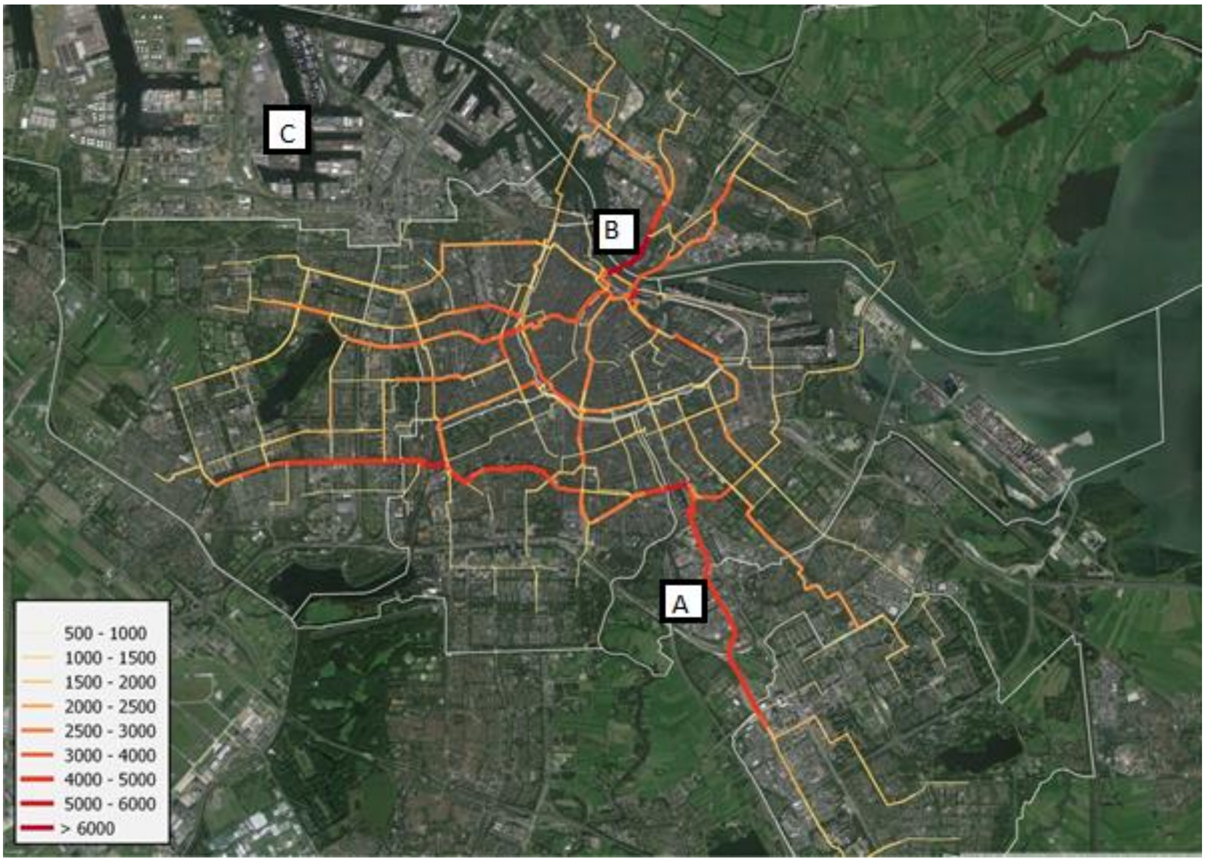


Figure 29 shows that roads most often used by scooters run from Amsterdam Zuidoost (Spaklerweg, A), all the way through Nieuw-West. Furthermore, many roads in West have a high number of scooters passing by but, as seen in the introduction chapter, there is a very high density on scooter registrations in Amsterdam West, which makes this an accurate possibility. Roads near the Central train Station (B), including ferry routes connecting the city centre with Amsterdam-Noord also have a high scooter density on roads. Westpoort (C), the industrial area of the city almost has no population and, according to the ABM outcome, no high amount scooters passing by.

Figure 30: kernel density analysis on distribution of scooters

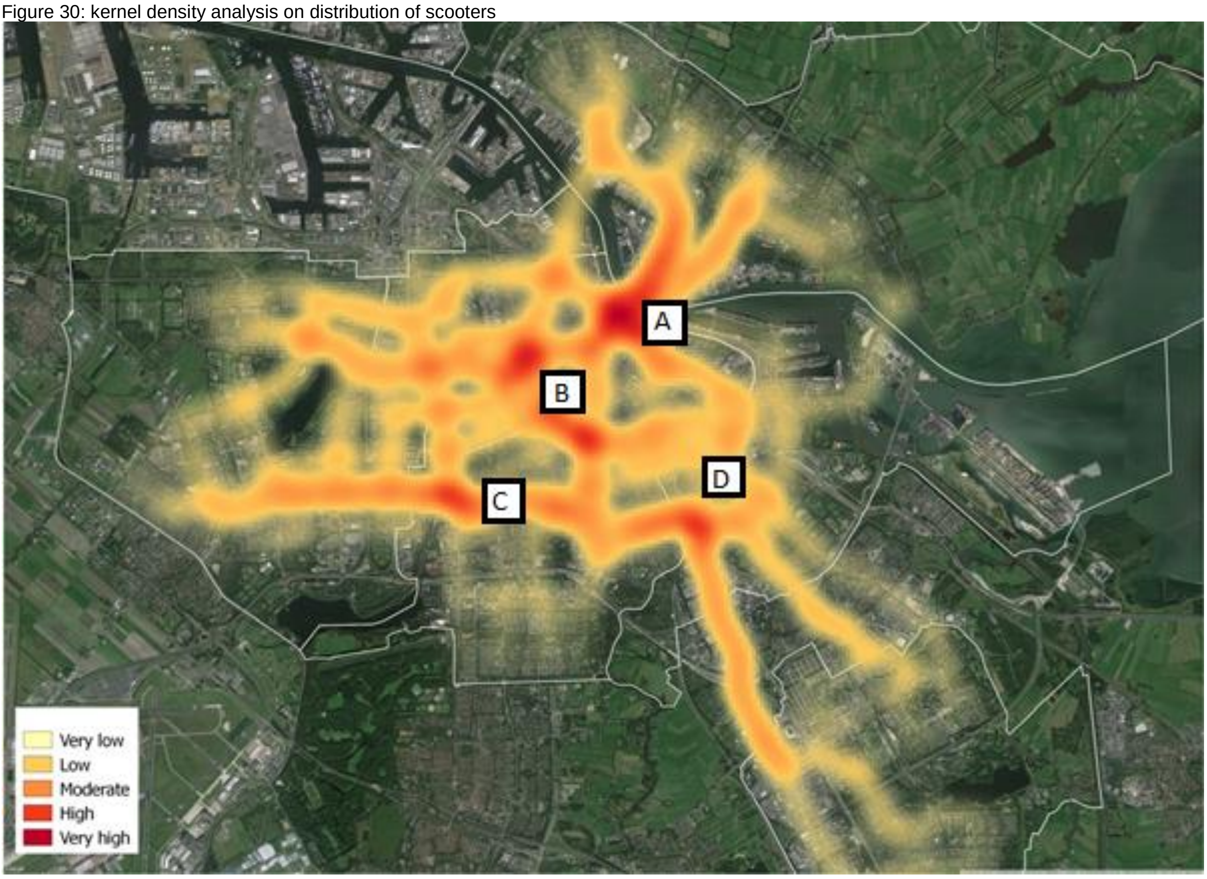


Figure 30 presents a heat map of scooter routes, based on Kernel density analysis. A Kernel density analysis identifies hotspots that are based on the likelihood of a scooter passing by in a certain district. Hot spots in Amsterdam include the area around Central Station (A), Marnixstraat (B), Haarlemmermeerstation (C) and Prins Bernhardplein (D). In comparison to the gradual map, the heat map shows a very dense area around the city centre (Marnixstraat – Weteringsschans).

Another output is a csv file which has data on scooter numbers per road segment, and were linked to the ROAM dataset explained in chapter 3.3.1, which had a response rate of 46.6%.

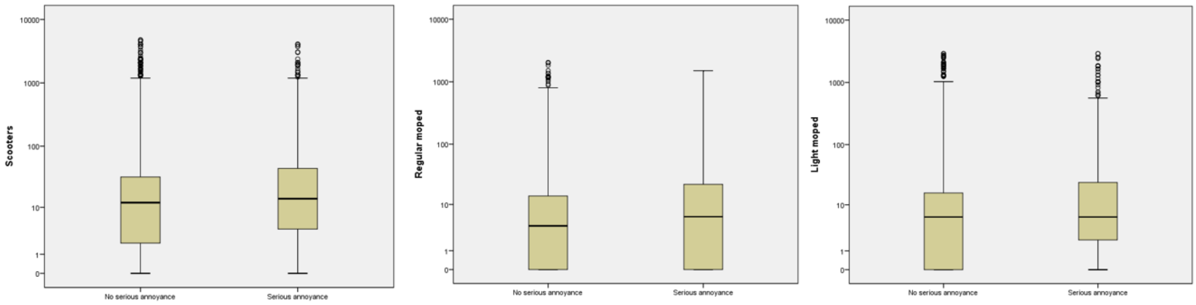
4.3.2 ROAM dataset on sleep and noise annoyance

Characteristics of the study population are shown in table 8. 16.1% of the study population was seriously annoyed by scooter traffic noise. The percentage for sleep disturbance was somewhat lower, 9.9%. Most of the population had an average or above average income, which corresponds with the education level of the population (mostly middle or high education levels). Distribution of male/female is almost evenly distributed.

Table 8: Characteristics of the study population (n=4133, noise annoyance and n=4075, sleep disturbance)

Sociodemographic		**N**	**(%)**
Sex	Male	1992	(48.2)
Marital status	Maried/shared household	2426	(58.7)
	Single	570	(13.8)
	Divorced	749	(18.1)
	Widowed	388	(9.4)
Income	< 1300 euro	870	(21.1)
	1300 – 1900 euro	1685	(40.8)
	> 1900 euro	1578	(38.2)
Education	Low	461	(11.2)
	Middle-low	1485	(35.9)
	Middle-high	758	(18.3)
	High	1429	(34.6)
Ethnicity	Migrant	841	(20.3)
Hinder		**N**	**(%)**
Noise annoyance	Serious annoyance	666	(16.1)
Sleep disturbance	Serious annoyance	402	(9.9)

Figure 31: Population exposure to scooters



The boxplot in figure 31 shows that there are a lot of outliers in all three exposure measures (total number of scooters, regular-moped and light-moped exposure). In all three cases, 75% of the respondents have exposure to 50 scooters or less per day (third quartile or upper boxplot border is 75% of the population). It seems that the seriously annoyed population is slightly more living in higher dense scooter streets. Both variables, light-moped and regular-moped, correlate greatly with each other. According to Pearson's R, with a significance of 0,0001, correlation between the two variables is 0.721, which means a high correlation. Because of this, one has to look at possible multicollinearity between them. If there is collinearity, the variables are too alike and cannot statistically be split. Multicollinearity is calculated in a linear regression analysis with the same variables as in logistic regression analysis. Basic rule is that variance inflation factor (VIF) should not be above 5 (statisticalhorizons, 2012). If the VIF is higher than 5, one should look further for possibilities of multicollinearity. VIF in this regression analysis does not exceeds 2, which means that multicollinearity is probably not a factor and light-moped and regular-moped can be split from the total number of scooters.

4.3.3 Model output in relation to sleep and noise annoyance

Table 9 shows crude and adjusted OR and 95%-confidence intervals (95%-CI), presented per 100 scooters increase for noise annoyance and sleep disturbance. For noise annoyance crude and adjusted OR's were similar and statistically significant. For noise annoyance adjusted OR was 1.04 (95%-CI 1.02-1.06), indicating that for every 100 scooters increase, odds for serious noise annoyance increase by 4%. In other words: the odds to experience serious annoyance is 4% higher on a road with 100 scooters passing by a day, compared to a road without scooter exposure. It probably is a stable OR because it increases or stays the same when adjusting for several variables (noise annoyance stays the same when adjusted, while sleep disturbance increases by 1%). Both dichotomous variables, noise annoyance and sleep disturbance, are significant (P-value <0.05). To generalize the results to the whole population a confidence interval was calculated. With a 95% confidence interval, OR for the whole population will fall between 1.02 and 1.06 for noise annoyance and between 1.02 and 1.07 for sleep disturbance. Similar results were found for sleep disturbance. Adjusted OR's for sleep disturbance was 1.05 (1.02-1.07). Part of the adjusted variables are not significant (floor number, double glazing, sex, marital status, education) which means they are not part of the logistic regression calculation. Living room at street side, bedroom at street side and income are significant. OR's of bedroom at street side show that the chance on serious annoyance is 20% lower when they don't sleep near street side (49% lower when comparing to sleep disturbance). Chance on serious annoyance when the living room is not at street side is 21%. When income levels are around average, chance on noise annoyance is 71% more than a low income (74% higher chance on sleep disturbance). High income levels also show that the chance on serious annoyance is bigger than low incomes: 31% (and 37% higher chance on sleep disturbance).

Table 9: Crude and adjusted OR analysis on total number of scooters

	Crude			Adjusted[a]		
	OR	(95%-CI)	p-Value	OR	(95%-CI)	p-Value
Noise annoyance						
Total scooters	1.04	(1.02, 1.06)	0.000	1.04	(1.02, 1.06)	0.00
Floor number	-	-	-	*0.99*	*(0.95, 1.03)*	*0.51*
Double glazing	-	-	-	*1.08*	*(0.85, 1.37)*	*0.53*
Living room not at street side	-	-	-	*0.79*	*(0.66, 0.95)*	*0.01*
Bedroom not at street side	-	-	-	*0.80*	*(0.67, 0.96)*	*0.02*
Male	-	-	-	*1.01*	*(0.85, 1.21)*	*0.88*
Maried	-	-	-	*REF*	*REF*	*REF*
Single	-	-	-	*1.01*	*(0.74, 1.38)*	*0.94*
Divorced	-	-	-	*1.04*	*(0.72, 1.50)*	*0.82*
Widowed	-	-	-	*0.97*	*(0.68, 1.37)*	*0.85*
Income < 1300	-	-	-	*REF*	*REF*	*REF*
Income 1300 – 1900	-	-	-	*1.71*	*(1.29, 2.26)*	*0.00*
Income >1900	-	-	-	*1.31*	*(1.05, 1.63)*	*0.02*
Low	-	-	-	*REF*	*REF*	*REF*
Middle-low	-	-	-	*1.05*	*(0.75, 1.46)*	*0.78*
Middle-high	-	-	-	*1.07*	*(0.81, 1.29)*	*0.83*
High	-	-	-	*1.03*	*(0.79, 1.33)*	*0.84*
Migrant	-	-	-	*0.52*	*(0.34, 0.81)*	*0.00*
Sleep disturbance						
Total scooters	1.04	(1.02, 1.06)	0.000	1.05	(1.02, 1.07)	0.00
Floor number	-	-	-	*1.02*	*(0.97, 1.07)*	*0.40*
Double glazing	-	-	-	*1.03*	*(0.75, 1.40)*	*0.87*
Living room not at street side	-	-	-	*0.90*	*(0.71, 1.13)*	*0.36*
Bedroom not at street side	-	-	-	*0.51*	*(0.41, 0.64)*	*0.00*
Male	-	-	-	*0.87*	*(0.70, 1.09)*	*0.23*
Maried	-	-	-	*REF*	*REF*	*REF*
Single	-	-	-	*1.26*	*(0.85, 1.85)*	*0.25*
Divorced	-	-	-	*0.85*	*(0.52, 1.37)*	*0.49*
Widowed	-	-	-	*1.07*	*(0.70, 1.65)*	*0.75*
Income < 1300	-	-	-	*REF*	*REF*	*REF*
Income 1300 – 1900	-	-	-	*1.74*	*(1.23, 2.47)*	*0.00*
Income >1900	-	-	-	*1.37*	*(1.04, 1.81)*	*0.03*
Low	-	-	-	*REF*	*REF*	*REF*
Middle-low	-	-	-	*1.41*	*(0.95, 2.10)*	*0.10*
Middle-high	-	-	-	*1.25*	*(0.94, 1.68)*	*0.13*
High	-	-	-	*1.09*	*(0.80, 1.53)*	*0.61*
Migrant	-	-	-	*0.59*	*(0.35, 0.99)*	*0.05*

a. adjusted for sex, marital status, income, education, ethnicity, floor number, double glazing, bedroom at street side, living room at street side

The total number of scooters passing by is a combination of light-mopeds and regular-mopeds. Separate logistic analyses were performed on exposure to regular-mopeds (table 10), light-mopeds (table 11) and exposure to regular and light-mopeds (table 12), to assess independence of effects.

Table 10: Crude and adjusted OR analysis for regular mopeds

	Crude OR	(95%-CI)	p-Value	Adjusted[a] OR	(95%-CI)	p-Value
Noise annoyance						
Regular-moped	1.10	(1.05, 1.15)	0.000	1.11	(1.06, 1.17)	0.000
Sleep disturbance						
Regular-moped	1.09	(1.04, 1.15)	0.001	1.12	(1.06, 1.19)	0.000

a. adjusted for sex, marital status, income, education, ethnicity, floor number, double glazing, bedroom at street side, living room at street side

Table 9 shows crude and adjusted OR's for noise annoyance and sleep disturbance in relation to regular-mopeds. Adjusted OR's for noise annoyance was 1.11 (1.06-1.17) and was increased compared to the OR for total number of scooters . Adjusted OR's for noise annoyance and sleep disturbance were slightly increased compared to crude OR's. Table 10 shows crude and adjusted OR's for noise annoyance and sleep disturbance in relation to light-mopeds. Adjusted OR's for noise annoyance was 1.05 (1.02-1.08) and stayed the same compared to crude OR's. adjusted OR's for sleep disturbance were also 1.05 (1.02-1.10).

Table 11: crude and adjusted OR analysis for light-mopeds

	Crude OR	(95%-CI)	p-Value	Adjusted[a] OR	(95%-CI)	p-Value
Noise annoyance						
Light-moped	1.05	(1.02, 1.08)	0.001	1.05	(1.02, 1.08)	0.001
Sleep disturbance						
Light-moped	1.05	(1.01, 1.08)	0.005	1.05	(1.02, 1.10)	0.001

a. adjusted for sex, marital status, income, education, ethnicity, floor number, double glazing, bedroom at street side, living room at street side

When splitting the total number of scooters passing by between light-mopeds and regular-mopeds, OR's increase in both cases compared to the OR outcome explained by the *total* number of scooters. This is possible because part of the OR for regular-mopeds in relation to noise annoyance is explained by light-moped drivers. The question arises how much of regular moped OR outcome is explained by light-mopeds and vice versa. By doing another logistic regression where both regular and light-moped variables were analyzed in the same regression, one can see what odds are explained by which scooter type. Interestingly, the light-moped number becomes insignificant and has P-values of 0.600 and higher. Also, OR's of regular-mopeds are higher and significant compared to light-moped. This indicates that the OR of light-mopeds is mostly explained by the regular-moped numbers which means that the relation between light-moped users and experience of noise annoyance is a spurious association.

Table 12: crude and adjusted OR analysis on scooters, adjusted by each scooter type

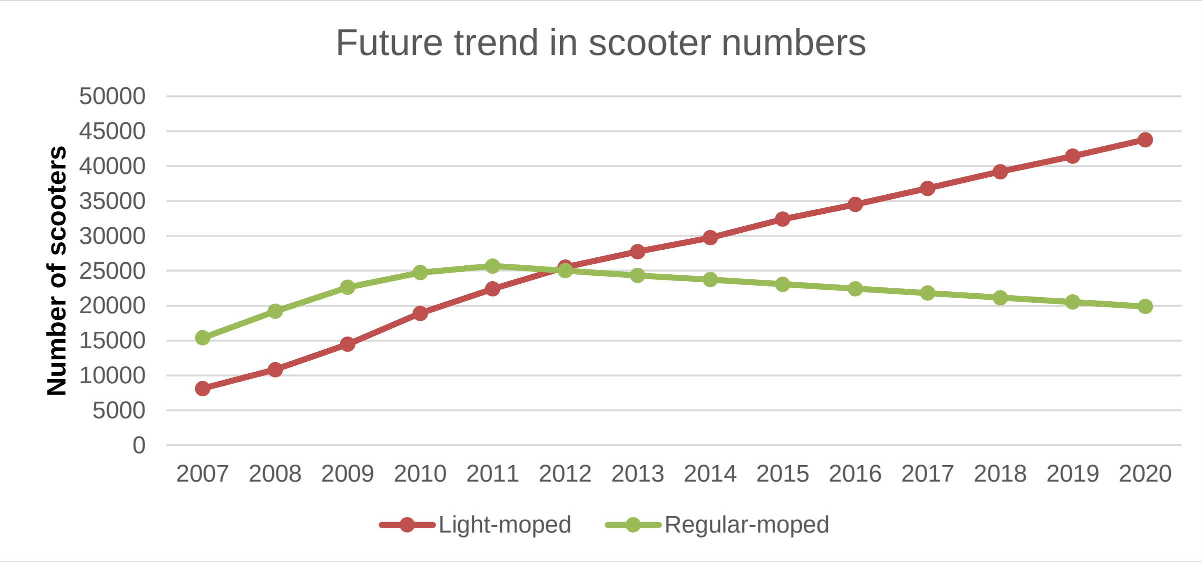
	Crude OR	(95%-CI)	p-Value	Adjusted[a] OR	(95%-CI)	p-Value
Noise annoyance						
Light-moped	1.01	(0.96, 1.05)	0.812	1.00	(0.96, 1.05)	0.929
Regular-moped	1.09	(1.02, 1.17)	0.011	1.11	(1.03, 1.20)	0.005
Sleep disturbance						
Light-moped	1.01	(0.96, 1.06)	0.717	1.02	(0.96, 1.07)	0.600
Regular-moped	1.08	(1.00, 1.17)	0.053	1.10	(1.01, 1.21)	0.028

a. adjusted for sex, marital status, income, education, ethnicity, floor number, double glazing, bedroom at street side, living room at street side

4.4 results for future scenarios

Two future trends were investigated until 2020: 1) extrapolating the current increase rate in scooters up to 2020 and 2) introducing the policy that bans light-mopeds on bicycle routes, as discussed in chapter 1.3. Using linear regression, future numbers of light-moped and regular-mopeds were estimated based on the scooter data from 2011 onwards. In 2020, an extra 10,000 scooters is predicted to be registered in Amsterdam based on the current increase rate. Following scenario 1, compared to 2014, the total number of scooters will increase by 19% in 2020. From the total number of scooters in 2014, 45% was a regular-moped and 55% a light-moped. In 2020, this will change to 31% regular-moped and 69% light-moped.

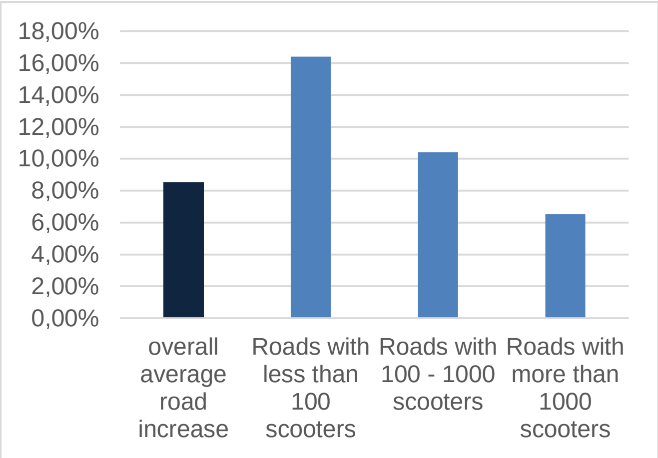
Figure 32: trend on scooter increase/decrease, subdivided into categories.



Due to an increase in elderly (baby boomers), the prognosis is that 13.9% of the total population will be retired by 2020. Although, unemployment is difficult to predict, it is expected that it will not increase/decrease much in the next few years, therefore the parameter for unemployment was kept equal to 2015.

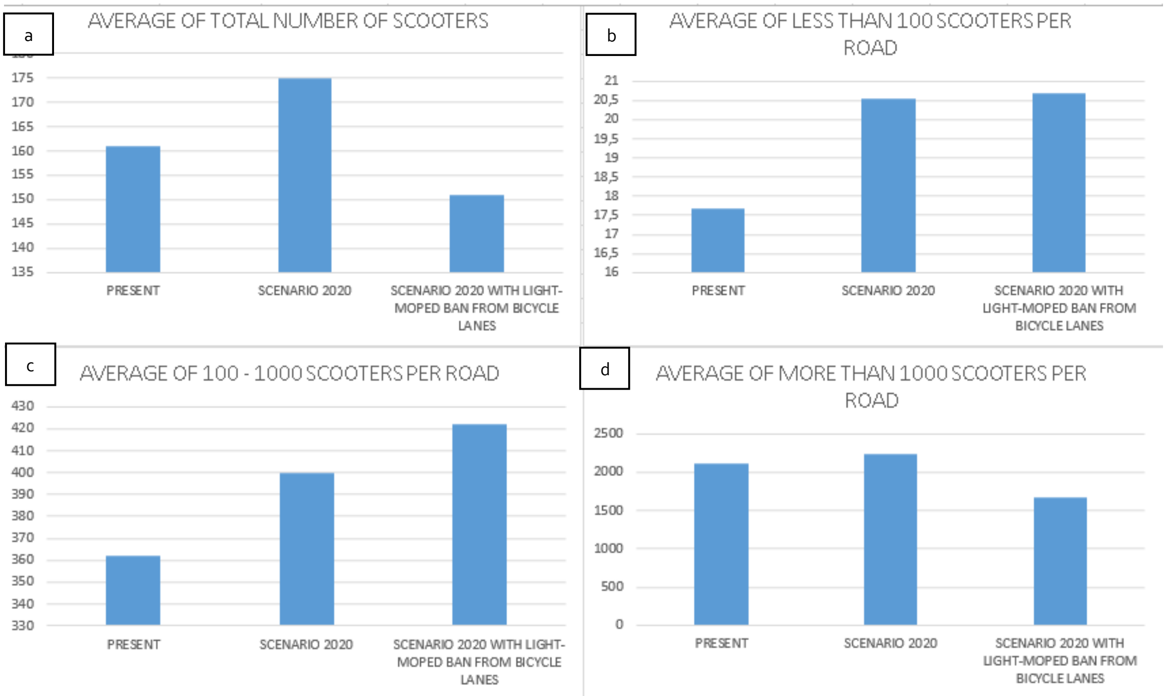
Simulation of scenario 1 show that although the number of scooters will increase by 19% compared to 2014, increase per road segment is less. Most of it is due to the fact that the percentage of elderly has increased drastically. Elders are a rather large group of scooter users. However, working activities have the largest impact on the overall intensity of travel, as was shown in the sensitivity analysis chapter 4.2. Most elderly are retired and are no part of the working society anymore. Average road intensity increases by 8.5%. Roads with less than 100 scooters in 2014 increase the most, by over 16% in 2020. However, in absolute numbers this is rather low (average of 4 scooters). Although roads with more than 1000 scooters increase the least in percentages (6,5%), in absolute numbers it is over 130 scooters on average. The logistic regression analysis on noise annoyance (chapter 4.3) showed that there is a higher chance of noise annoyance when there is an increase in scooters. This finding suggests that due to the increase in scooters in the next few years, the number of people that are seriously annoyed by scooter traffic may increase in areas where many scooters pass by per day (highly dense scooter streets). Furthermore it is expected that the less dense scooter roads will have less effect on seriously noise annoyance. Figure 33 shows categories of roads which have an increased risk of noise annoyance reports in 2020. Most of these roads are situated in Amsterdam Centrum and Noord, as the increase in scooters in these areas is expected to be largest.

Figure 33: Percentage increase per road type compared to 2014 and increased risk zones for serious annoyance



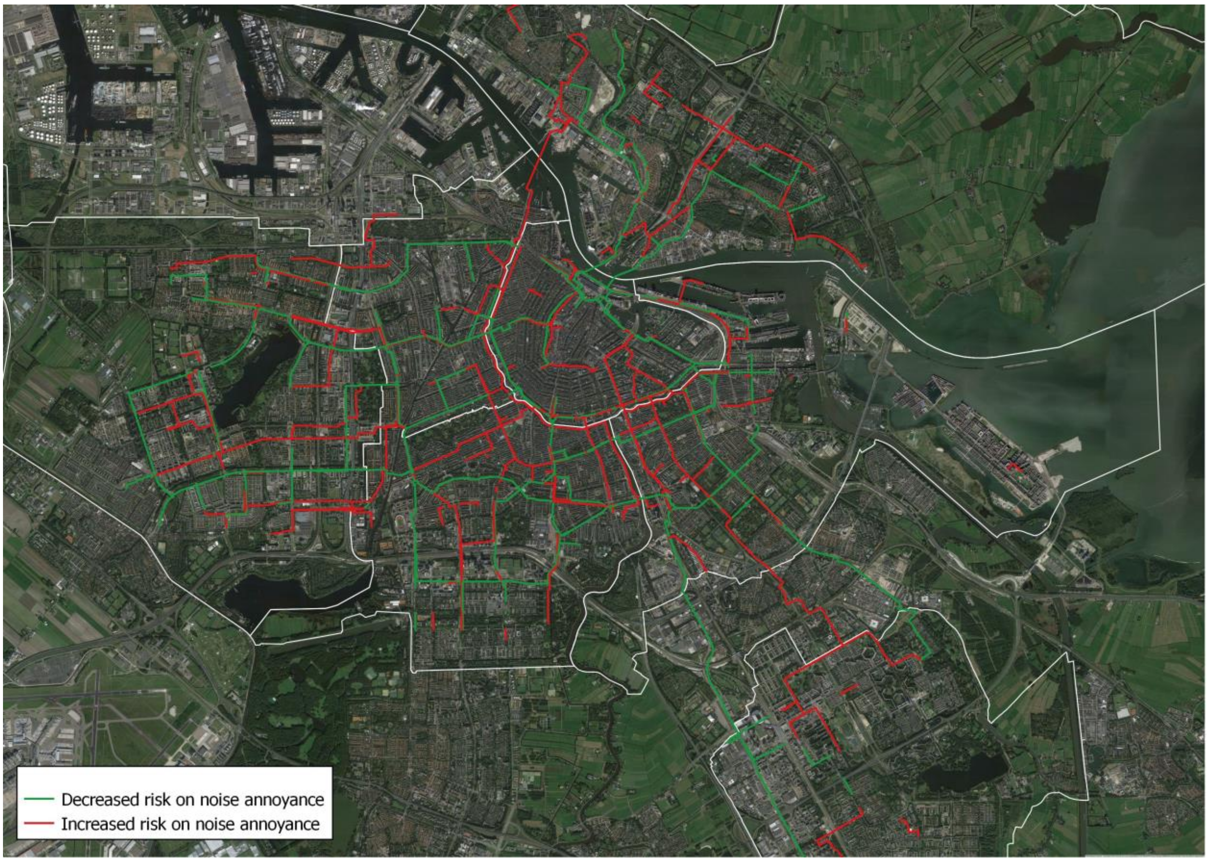
As mentioned in the introduction, a possible scenario might be that light-moped will be banned from bicycle lanes. Another model run with 2020 data has been done where this policy has been implemented (scenario 2). According to a research by the municipality of Amsterdam, this will give an impulse to regular-moped sales and a decrease in light-mopeds (1/3 decrease)(Amsterdam, 2014). All these parameters (increase in regular-moped, decrease in light-moped and restriction for light-mopeds on bicycle lanes) have been set in the ABM. Scenario 2 results in a 6% reduction of scooter traffic in general, compared to 2014. Furthermore, there is a 25.5% reduction of scooter density on roads with a bicycle lane. Scooters tend to choose a different (faster) route, now that they are banned from bicycle lanes and have to drive on normal roadways.

Figure 34: average absolute numbers of numbers of scooters passing by per road type, per scenario, per day



The average of the total number of scooters will decrease significantly per road when the light-moped regulation will be put in place (Figure 34a). However, in low density streets (residential areas) (figure 34b) numbers will not change much and have little effect on noise annoyance. Noise annoyance may decrease on road types with more than 1000 scooters passing by per day under scenario 2. Note that roads with an average of 100 – 1000 scooters per road (figure 34c) will have an increased number of scooters after implementing the policy on light-mopeds. This is because roads with bicycle lanes were also part of high density roads. Light-mopeds tend to choose different route paths. This may lead to a decreasing of highly dense scooter roads and an increase in middle dense scooter roads. An increase in middle dense roads may have a negative influence on noise annoyance for people living in or near these streets (see figure 35 for an overview). Therefore, although a policy change for light-mopeds may seem to have a positive effect, new risk zones of serious annoyance may arise.

Figure 35: increased and decreased risk zones after light-moped policy implementation compared to 2014



5. Discussion

Due to time pressure, there were some obstacles that could not be overcome during the research. A rather large part of the whole thesis was programming the model. Because of this, several issues were not doable within the time span and had to be shut out from the thesis. These are discussed below.

5.1 Discussion of ABM software and model

First, there were some problems with the ABM software GAMA. When loading the road network of Amsterdam, it creates a so-called graph. Nodes at the end of each road segment are connected with each other by vertices and stored with a hash code. Large datasets have numerous hash codes to store vertices of the network. There might be a chance two hash codes have an identical ID, which gives errors. Agents 'fall off' the edges of road segments with identical hash code ID's and start floating through the map. This was the case in the road network of Amsterdam. Modeling these roads as dead ends made sure agents stayed on the road, because they choose a different path, but it was not a real life representation of the network. This 'dirty trick' was used throughout the analysis, because the bug could not be fixed before the analysis. Although the number of road segments, which had the same hash code was very small, it could have had an effect on the model outcome. In future analysis with GAMA, one should have a closer look at the hash code generation.

GAMA also had problems handling large datasets. The number of agents during this analysis was over 50.000 for present analysis and over 60.000 for future scenarios. Scheduling activities for all agents was very time-consuming, and computation time of scheduling activities seemed to increase exponentially. It took over 24 hours to load the model and crashed while running the model. Even on computers with a large amount of RAM and CPU speed, the software only used 1GB of RAM at a maximum. Therefore, even on these computers, computation stayed slow. A solution was found by splitting the number of agents by city district (7 in total). In this case, each city district had its own dataset of agents, instead of one big dataset for the whole city. The model was run for each district and model outcomes were merged together for a final result. Software improvements are needed to optimize the computation speed of GAMA itself. Right now, GAMA is running on Java. In the future, it may be a solution to create a software package where it runs completely on itself, or choose another software program, like Repast.

Analyzing the model output was done by external shapefiles and csv files generated by the model. Specific visualization of data during a model run was not used at all. Although it was not necessary for this study, it might be for other research purposes. GAMA seems to fall short there. ABM with GAMA may be more effective on smaller datasets.

5.2 Discussion of results

Several factors may have had an effect on the outcome of the model. First, data obtained from CBS were for private scooter registrations and did not include company owned scooters. A small portion of the total number of scooters is used as delivery vehicles. Although this portion may be small, these scooters are used seven days a week and therefore use of road might be underestimated.. Although CBS was not able to provide this dataset, it may have been possible to obtain a total number of company registered scooters and distribute them randomly throughout takeaways in the city (a dataset which was available).

During the preparation phase, assumptions had to be made. These assumptions are a potential risk as they are not backed by literature. Chapter 3.2 describes that only the most popular destination types were programmed in the model. Programming other spare time activities were a possibility, but had to be fully based on assumptions. Possible outcome of the model would have been extra risky because of these assumptions. Also, due to time pressure, some solutions were chosen which could have been handled differently. Work destinations were, as mentioned in chapter 3.2, modeled by choosing a random location because there are only a few evident business districts in Amsterdam. There is however, data on city districts with its total number of jobs. This could have served as a weighted value for choosing a certain district for work. Furthermore, other assumptions were made for activities, which are not based on literature, but were used to calibrate the model (see table 13 for a complete list of decisions taken during preparation phase). This may have had an impact on the model and should always be considered as a possible risk of model output. Above mentioned assumptions may have led to estimation error. Nevertheless the model is assumed to give a reliable representation of reality. The model was validated and showed a strong correlation with reality. Analysis of the present situation was partly based on literature, and the same parameter settings were used for future analysis. This may also be a risk. Future analysis is therefore more strongly based on assumptions.

Table 13: list of decisions taken during the preparation phase.

Input	Decision	Source
Scooters	1.Scooters locations in the city 2. Scooter locations for new registrations in the future randomly distributed throughout the city	1. Literature 2. Assumption
Work destinations	1. Unemployment and retirement rates 1. Work destination is a random location in the city 2. Duration of work activities 3. Percentage of people not using scooter for their work activities 4. Future retirement and unemployment rates	1. Literature 2. Assumption 3. Assumption 4. Assumption 5. Literature
School destinations	1. Proportion of population actively following an education 2. People choose the closest school 3. Duration of school activities 4. Percentage of people not using scooter for school activities 5. All of the above unchanged in the future	1. Literature 2. assumption 3. Assumption 4. Assumption

		5. Assumption
Sport destinations	1. Proportion of people practicing a sport 2. Type of sport people practice 3. Average times per week, a sports activity is practiced 4. Duration of sport activity 5. People choose closest building of its sporting activity 6. Percentage of people not using scooter for sport activities 7. All of the above unchanged in the future	1. Literature 2. Literature 3. Literature 4. Assumption 5. Assumption 6. Assumption 7. Assumption
Shop destinations	1. Average times per week people shop 2. Shop duration 3. People rather shop in city district than closest shopping mall 4. Percentage of people not using scooter for sport activities 5. All of the above unchanged in the future	1. Literature 2. Literature 3. Assumption 4. Assumption 5. Assumption
Grocery destinations	1. Average number of times people do grocery shopping per week 2. people choose closest supermarket to do grocery shopping 3. Percentage of people not using scooter for sport activities 4. All of the above unchanged in the future	1. Literature 2. Assumption 3. Assumption 4. Assumption
Network	1. Light-moped users rather drive on bicycle lanes than roads without them 2. If small shortcuts through residential areas are possible, people often choose to stay on roads where speed limit is higher 3. Network is unchanged in the future	1. Assumption 2. Assumption 3. Assumption

6. Conclusion

The research objective of this thesis was to *Model the most likely routes for scooters in an urbanized area and evaluate current and future associated risks of noise annoyance***.** An ABM was built accounting for the scheduling of activities for each individual agent. This generated a map of Amsterdam where major routes of scooters were presented. One of the highest density areas was around Central Station and ferry routes to Amsterdam Noord. Other dense populated roads include Prins Bernhardplein and Marnixstraat. This is mainly because these roads serve as main transit routes from one city district to another. Validating the model using real scooter counts showed that the model outcome strongly correlates with reality.

Noise annoyance and sleep disturbance were associated with number of scooters. In single exposure models odds ratios for regular-mopeds were higher compared to light-moped users. Further analysis showed that light-moped were not associated to noise annoyance and sleep disturbance, independent of regular-mopeds. The odds for people experiencing serious noise annoyance is a 6% - 17% increase for every additional 100 regular-mopeds passing by per day. It is expected that scooters will increase by almost 19% in 2020 compared to present numbers, which may lead to an increased number of seriously annoyed people by scooter noise in the future. Although scooter registrations will increase by 19%, average road intensity is predicted to increase by 8.5%, mainly because there is a growing group of elderly in the next few years. This group uses their scooter for other purposes than to drive to work. Instead, they use the scooter for activities like shopping or other spare time activities. This has less effect on the road density because these activities are not practiced daily or are closer to their home.

As mentioned in chapter 1, there are plans to restrict light mopeds from bicycle lanes, which could lead to an increase in regular-mopeds and a decrease in light-mopeds (Amsterdam, 2014). Therefore the number of seriously annoyed people in urban cities might increase in the future. Analysis of this future scenario showed a decline in total number of scooters in the city. Also scooter density on roads is more distributed, because light-moped drivers will use main routes, since they are restricted from bicycle lanes. This may create new risk zones for noise annoyance, since an increased number of roads will get more scooters per day. On the contrary, high density scooter roads are expected to decrease.

7. Recommendations

It seems that we should expect a growing number of scooters over the next few years. The increasing popularity of light-mopeds will have its effect on regular-mopeds, which will start to decline. Implementing a policy on helmet obligation by light-mopeds and ban from bicycle lanes is expected to cause a decline in scooter numbers. This may lower the total number of scooters. Light-mopeds may choose diverse routes so that the extreme dense roads will decline the most in numbers. However, it should be noted that analysis showed that regular-mopeds had most impact on serious noise annoyance. These mopeds are expected to increase in numbers when this policy will be adopted. Also, although some roads will have lower chance of people experiencing serious noise annoyance, other risk zones emerge. The municipality of Amsterdam should be aware of the fact that a policy change like this may also cause new problems along other roads.

The municipality must therefore also look at extra measures to decrease possible noise annoyance. An e-scooter might help to solve the problem. An e-scooter is reported to be almost silent, which makes the highly annoying sound event of a passing scooter with a combustion engine disappear. Stimulating sales of e-scooters, perhaps with subsidies or additional driving rights, as well as other vehicle types that cause lower levels of serious noise annoyance (trams, busses, bikes) is recommended. Also, scooters used for work are considered to have the most impact on scooter numbers per street. If the municipality of Amsterdam wants to reduce these numbers, it should focus on the labor force group of Amsterdam and should stimulate alternatives vehicle types for them in particular.

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Appendix A: ABM script

```
/*
 *  Amsterdam
 *  Author: Thomas
 *  Description: Thesis
 */

model Amsterdam

global {    //all shapefiles
        file shape_file_roads               <- file("../includes/Samples/Wegennetwerk_met_bromsnorfiets_polyline.shp");
        file shape_file_scooter         <- file("../includes/Samples/Brom_Snor_Sample.shp");
        file shape_file_building        <- file("../includes/Samples/supermarkten.shp");
        file shape_file_vrijetijd       <- file("../includes/Samples/Vrije_Tijd.shp");
        file shape_file_school              <- file("../includes/Samples/Scholen.shp");
        file shape_file_winkels             <- file("../includes/Samples/Winkelstraten.shp");

        //This is where the results of the shapefile are stored
        string new_shape_file_roads         <- "../results/west_wegen_final.shp";
        string new_shape_file_roads_week    <- "../results/west_wegen_final_week.shp";

        //The boundaries of the city_display
        geometry shape                                  <- envelope(shape_file_roads);

        //percentage of scooters used. 100 is the standard amount from the shapefile. also a parameter
        int nb_scooters                         <- 100 min: 1 max: 1000;
        int nb_scooters_absolute            <- 100 min: 0 max: 200000;
        int unemployment                        <- 10 min: 0 max: 100;
        int sport_practicing                <- 0 min: 0 max: 100;
        int school_practicing               <- 0 min: 0 max: 100;
        int shop_participating              <- 0 min: 0 max: 100;
        int grocery_participating       <- 0 min: 0 max: 100;
        int days_per_week                       <- 0 min: 0 max: 7;

        //This is were time is initialized. Every cycle is 60 minutes. Variable time is in seconds.
        //current_day resets afters#hour is 24, current_day resets after 7 days and current_day_2weeks resets after 14 days
        float step                                      <- 60#mn;
        int current_hour update:        (time / #hour) mod 24;
        int current_day update:             (time / #days) mod 7;
        int current_day_2weeks update:  (time / #days) mod 14;

        //This is where the minimum, and maximum times are stored per destination type
        int min_work_start                      <- 6;
        int max_work_start                      <- 8;
        int min_work_end                        <- 16;
        int max_work_end                        <- 20;
        int min_school_start                <- 9;
        int max_school_start                <- 10;
        int min_school_end                      <- 15;
        int max_school_end                      <- 16;
        int min_trips                           <- 0;
        int max_trips                           <- 8;
        int min_sport_start                     <- 8;
```

```
int max_sport_start                         <- 22;
int min_shop_start                          <- 12;
int max_shop_start                          <- 18;
int min_grocery_start                 <- 8;
int max_grocery_start                 <- 21;

//the total duration of some destination types
int sport_duration                          <- 1;
int grocery_duration                  <- 1;
int shop_duration                           <- 2;

//the weight for a light-moped to choose a road with a bicycle (parameter)
int weight_bicycle                          <- 1;

//Graph is a built-in variabele. "The current topology (in the case it is a spatial graph)"
//two types of graphs. One for mopeds and the other for light_moped (they have different weights)
graph graph_snorfiets;
graph graph_bromfiets;

map weights_normal;

//creates a list of buildings for each destination type. Some destination types are seperated per category
list<building> supermarket_buildings;
list<sport> fitness_buildings;
list<sport> football_buildings;
list<sport> tennis_buildings;
list<school> hbowo_buildings;
list<school> vombo_buildings;
list<shops> shop_buildings_centrum;
list<shops> shop_buildings_else;

//everything is initialized here.
init {
		//all shapefiles get a variable for GAMA and take some attributes from the shapefile with it and creates a GAMA varibale for them
		create building from: shape_file_building with: [type::string(read ("KLASSE1_ID"))];
		create school from: shape_file_school with: [schooltype::string(read ("KLASSE3"))];
		create sport from: shape_file_vrijetijd with: [sporttype::string(read ("KLASSE3"))];
		create shops from: shape_file_winkels with: [winkelstr::string(read ("WINKELSTR")),stadsdeel::string(read("STADSDEEL"))];
	create road from: shape_file_roads with: [maxspeed::float(get ("Snelheid")),has_bicycle::string(get ("Met_Fietsp")),kilometers::float(get ("AantalKM"))];

	//With a query, all buildings are placed in the correct category.
	supermarket_buildings <- building  where (each.type="D") ;
	fitness_buildings <- sport where (each.sporttype="Fitness-centrum - Yogaruimte - Niet-gespecialiseerde sportschool");
	football_buildings <- sport where (each.sporttype="Sportvelden - Kleinschalige sportveldbebouwing");
	tennis_buildings <- sport where (each.sporttype="Tennisaccommodatie");
	hbowo_buildings <- school where (each.schooltype="Hogeschool en Universiteit");
	vombo_buildings <- school where (each.schooltype="Voortgezet onderwijs");
	shop_buildings_centrum <- shops where (each.stadsdeel="Centrum");
	shop_buildings_else <- shops where (each.stadsdeel!="Centrum");

	//The scooter initialization. It gives the correct location per scooter and identifies when an agent needs to do
```

```
//an activity. It starts with initializing its school or work time for the day and continues with the other activities
//if they are not doing something
create scooter from: shape_file_scooter with:[typescoot::string(get("Type")),gaatschool::string(get ("GaatSchool")),gaatsport::string(get ("Sport")),Postcodescoot::string(get ("Postcode"))];

//makes sure that the nb_scooters are first the ones from the shapefile
int nb_scooter_data <-  length(scooter);

//if the parameter is set on a lower number than 100%, then let a certain percentage of agents die
if (nb_scooters < 100) {
   ask ((((100 - nb_scooters)/100)*nb_scooter_data) among scooter) {do die;}
}

//if the parameter is set above 100%, the model will randomly set extra agents on a road and gives them a number for
//gaatschool or gaatsport etc.
    else if (nb_scooters > 100){
        create scooter number: (((nb_scooters - 100)/100)*nb_scooter_data){
                location <- any_location_in(one_of(road));
        }
        ask (nb_scooters among scooter) where (each.gaatschool = nil) {do flip_activity_school;}
        ask (nb_scooters among scooter) where (each.gaatsport = nil) {do flip_activity_sport;}
        ask (nb_scooters among scooter) where (each.typescoot = nil) {do flip_activity_type;}
    }

//here are the percentages created and furthermore modelled as a parameter to stop scooters from driving
ask (((unemployment/100)*(length(scooter))) among scooter where (each.gaatschool = "0")) {do parameter_activity;}
ask (((school_practicing/100)*(length(scooter))) among scooter where (each.gaatschool = "1")) {do parameter_activity;}
ask (((sport_practicing/100)*(length(scooter))) among scooter where (each.gaatsport = "1")) {do parameter_activity_sport;}
ask (((shop_participating/100)*(length(scooter))) among scooter) {do parameter_activity_shop;}
ask (((grocery_participating/100)*(length(scooter))) among scooter) {do parameter_activity_grocery;}

//the parameter which makes sure average number of scooters are driving on a certain day.
ask (((1-(days_per_week/7))*(length(scooter))) among scooter) {do parameter_activity_all;}

    ask scooter{
        living_place <- location;
        activity work_or_school<- create_work_school_activity();
            if (work_or_school != nil) { activities<<work_or_school; }
        activity sport_actvity<- create_sport_activity();
        if (sport_actvity != nil) { activities<<sport_actvity; }
        activity shop_activity <- create_shop_activity();
        if (shop_activity != nil) { activities<<shop_activity; }
        do create_grosary_activity;
        objective <- "resting";
    }

    //The road shapefile had some problems. With the method below, lines are connected to each other if it was not the case.
                graph_bromfiets <- as_edge_graph(road);
                loop e over: graph_bromfiets.edges {
                    point e_start <- first(road(e).shape.points);
                    point e_last <- last(road(e).shape.points);
                    if (not (e_start in graph_bromfiets.vertices) or (not (e_last in graph_bromfiets.vertices))) {
                    ask road(e) {do die;}
```

```
}
}

//The weights of a moped and a light moped. Both take speed limit into account, but extra weight has been given to
// the light-mopeds. They are likely to choose roads which has a bicycle lane.
weights_normal <- road as_map (each::(each.shape.perimeter / (each.maxspeed #km/#h)));
map weights_snorfiets <- road as_map (each::(each.shape.perimeter / (each.maxspeed #km/#h) / ((each.has_bicycle = "J") ? weight_bicycle : 1)));

//Scooters get the restriction to drive only on roads which they have permission to. Not on roads over 70km/h or below 25
graph_bromfiets <- as_edge_graph(road where ((each.maxspeed > 24) and (each.maxspeed < 70))) with_weights weights_normal;
graph_snorfiets <-copy(graph_bromfiets) with_weights weights_snorfiets;

}

//The simulation will stop after 2 weeks by itself
 reflex stop_simulation when: time / #day = 14 {
    do pause;
 }


//A few save statements. One for the shapefile which counts scooter numbers on the streets. The other is a CSV file of the countings of scooters.
//the last one is a csv where the number of trips per day and its kilometers are counted and presented in an csv
    reflex save_data when: cycle = 24 {
        save road to: new_shape_file_roads type:"shp" with:[name::"name",bromsnornr::"bromsnornr",brommernr::"bromfietsnr",snorfietsnr::"snorfietsnr",maxspeed::"Snelheid",has_bicycle::"Met_Fietspad"];
    }

    reflex save_data_week when: cycle = 168 {
        save road to: new_shape_file_roads_week type: "shp" with:[bromsnornr::"bromsnornr",brommernr::"bromfietsnr",snorfietsnr::"snorfietsnr",maxspeed::"Snelheid",has_bicycle::"Met_Fietspad"];
    }

    reflex save_csv when: cycle = 24 or cycle = 48 or cycle = 72 or cycle = 96 or cycle = 120 or cycle = 144 or cycle = 168 {
        ask scooter{
        save [name, current_day, typescoot, tot_kilometer, trips] to: "new_scooter.csv" type: "csv";
        }

    }
}

//A species of the activity. It has a start and end time, which day, and which target
species activity {
    int start;
    int end;
    list<int> days;
    list<point> target_locs;
    list<float> proba_targets;
```

```
}

//variables of building, school, sport, road and shops with the types of vaiables, color of the species and shape.
species building {
	string type;
	rgb color <- #red;

	aspect base {
		draw shape color: color ;
	}
}

species school {
			string schooltype;
			rgb color <- #lightblue;

			aspect base {
					draw shape color: color;
			}
}

species sport {
			string sporttype;
			rgb color <- #lightgreen;

			aspect base {
					draw shape color: color;
			}
}

species shops {
			string winkelstr;
			string stadsdeel;
			rgb color <- #orangered;

			aspect base{
					draw shape color: color;
			}
}

species road  {
	rgb color								<- #black;
	int brommernr							<- 0;
	int snorfietsnr							<- 0;
	int bromsnornr							<- 0;
	float maxspeed;
	float kilometers;
	string has_bicycle;

	aspect base {
		draw shape color: color ;
	}
}
```

```
//The scooter species. Here every activity is logged and activitated at a certain time.
species scooter skills:[moving] {

			//The boolean variables to let agents drive or not when parameters are set.
			bool do_not_drive				<- false;
			bool do_not_drive_sport			<- false;
			bool do_not_drive_all			<- false;
			bool do_not_drive_shop			<- false;
			bool do_not_drive_grocery		<- false;

	//color of the scooter
	rgb color						<- #yellow;

	//a few variables which are from the shapefile of scooters
	string typescoot;
	string gaatschool;
	string gaatsport;
	string Postcodescoot;

	//a calculation to use the speed limits of a road
	float respect_to_speed_limit	<- 1.0;

	//the coordinates of the starting location of the scooter
	point living_place				<- nil;

	//flip variables to let the agent choose for a certain destination.
	bool flip_value_sport_extra;
	bool flip_value_school;
	bool flip_value_shop;
	bool flip_value_grocery;

	//string variable which stores the decision of the agent. Which sport (tennis, fitness, football), and which
	//level of education (high school or HBO/WO)
	string welke_sport;
	string opleiding_niveau;

	//A list of activities planned by the agent
	list<activity> activities;
	activity current_activity;

	//Varibales to keep track of the total amount of kilometers and the number of trips per day per dagent.
	int tot_kilometer				<- 0;
	int trips						<- 0;

	//The objective of the agent (which activity is he doing)
	string objective;

	//This varibale will fill with a coordinate of the destination the agent has and is moving towards
	point the_target				<- nil;

	//The grocary activity with a bolean variable if he is planning to do groceries that day or not
	activity grocery_actvity		<- nil;
	bool grocery_to_do				<- false;
```

```
//the actions where scooters get a value of true, which makes them not move for a particular activity
action parameter_activity_all{
		do_not_drive_all <- true;
	}

action parameter_activity{
		do_not_drive <- true;
	}

	action parameter_activity_sport{
		do_not_drive_sport <- true;
	}

	action parameter_activity_shop{
		do_not_drive_shop <- true;
	}

	action parameter_activity_grocery{
		do_not_drive_grocery <- true;
	}

	//actions that make sure new agents get the correct number (school/work, sport/nosport etc.)
	action flip_activity_school{
		if flip(0.24){
			gaatschool <- "1";
		}
		else{
			gaatschool <- "0";
		}
	}

	action flip_activity_sport{
		if flip(0.68){
			gaatsport <- "1";
		}
		else{
			gaatsport <- "0";
		}
	}

	action flip_activity_type{
		if flip(0.45){
			typescoot <- "Bromfiets";
		}
		else{
			typescoot <- "Snorfiets";
		}
	}

//The first activity, work or school.
activity create_work_school_activity{
	activity work_or_school <- nil;
	if (gaatschool = "0" and do_not_drive = false and do_not_drive_all = false)	{		//if gaatschool = 0, they work
		create activity{
```

```
                name <- "work";
                loop i from: 0 to: 11 {
                                //from day 0 (monday to day 11 frday
                        if (not (i in [5, 6])){days << i;}
            //but not in day 5 and 6 (weekend)
                }
                start <- min_work_start + rnd(max_work_start - min_work_start);                    //start work is
generated
                end <- min_work_end + rnd(max_work_end - min_work_end);
        //end work is generated
                target_locs << any_location_in(one_of(road)) ;
        //location of work is anywhere in the city
                proba_targets << 1.0;
                work_or_school <- self;
            }
        } else if (gaatschool = "1" and do_not_drive = false and do_not_drive_all = false) {//if gaatschool = 1, they go to school
            create activity{
                name <- "school";
                loop i from: 0 to: 11{
                        if (not (i in [5, 6])){days << i;}
                }
                start <- min_school_start + rnd(max_school_start - min_school_start);
                end <- min_school_end + rnd(max_school_end - min_school_end);
                if flip(0.38) {
                                    //flip variable that it is 38% chance that they go to high school
                myself.opleiding_niveau <- "vombo";
                target_locs << (vombo_buildings closest_to myself.living_place).location ;
                proba_targets << 1.0;
            }
            else{
                myself.opleiding_niveau <- "hbowo";
        //otherwise they go to HBO/WO
                target_locs << (hbowo_buildings closest_to myself.living_place).location ;
                proba_targets << 1.0;
            }
                work_or_school <- self;
            }
        }
        return work_or_school;
    }

    //the sport activity
    activity create_sport_activity
    {
        activity sport_actvity <- nil;
        if (gaatsport = "1" and do_not_drive_sport = false and do_not_drive_all = false)  //gaatsport should be 1, otherwise they dont sport
        {
            list<list<int, int>> free_slots <- [];
            //list the number of free slots available during the week
            loop i from: 0 to: 6
                        //for possible new activities
            {
                list<int> slots_day <- list_of_free_slots(i, min_sport_start, max_sport_start, sport_duration);
                loop sl over: slots_day
```

```
				{
					free_slots << [i, sl];
				}

			}

			list<int> slot_chosen <- one_of(free_slots);
			create activity
			{
				days <- [slot_chosen[0], slot_chosen[0] + 7];
		//the day the sport activity will be played (column 1)
				name <- "sport";
				start <- slot_chosen[1];
					//the start time of the activity (column 2)
				end <- slot_chosen[1] + sport_duration;
			//end time
				if flip(0.5)
						//flip variable to choose an activity
				{
					myself.welke_sport <- "fitness";
					target_locs << any_location_in(fitness_buildings closest_to myself.living_place);
				} else if flip(0.7)
				{
					myself.welke_sport <- "football";
					target_locs << any_location_in(football_buildings closest_to myself.living_place);
				} else
				{
					myself.welke_sport <- "tennis";
					target_locs << any_location_in(tennis_buildings closest_to myself.living_place);
				}

				proba_targets << 1.0;
				sport_actvity <- self;
			 }

		}
		return sport_actvity;
	}

	//make the hypothesis that if the sport day is during week, the shopping day is different
	activity create_shop_activity {
			activity shop_actvity <- nil;
			if (do_not_drive_all = false and do_not_drive_shop = false){
			list<list<int,int>> free_slots <- [];
			loop i from: 0 to: 13 {
				list<int> slots_day <-list_of_free_slots(i,min_shop_start,max_shop_start, shop_duration);
				loop sl over: slots_day {free_slots << [i, sl];}
			}
			list<int>  slot_chosen <- one_of(free_slots);
			create activity {
					days <- [slot_chosen[0]];
				name <- "shop";
				start <- slot_chosen[1];
					end <-slot_chosen[1] + shop_duration;
```

```
target_locs << any_location_in(one_of(empty(shop_buildings_centrum) ? shop_buildings_else : shop_buildings_centrum));
                proba_targets << 0.7;
                target_locs << any_location_in(shop_buildings_else with_min_of (each distance_to myself.living_place));
                proba_targets << 1.0;
            shop_actvity <- self;
            }

            }
            return shop_actvity;
    }

    //grocery activity if there is time left in the day
    action create_grosary_activity {
        create activity {
            name <- "grocery";
            target_locs << any_location_in(supermarket_buildings closest_to myself.living_place) ;
            proba_targets << 1.0;
            myself.grocery_actvity <- self;
        }

    }

    list<int> list_of_free_slots(int day_2_weeks, int min_start, int max_start, int act_duration) {
        list<int> free_slots <- [];
        loop i from: min_start to: (max_start - act_duration) {free_slots<<i;}
        loop act over: activities {
        if (day_2_weeks in act.days) {
            loop i from: act.start - act_duration + 1  to: (act.end) {free_slots>>i;}
        }
      }
      return free_slots;
    }

    action update_grocery_activity {
        list<int> free_slots <- list_of_free_slots(current_day_2weeks,min_grocery_start,max_grocery_start, grocery_duration);
        if (not empty(free_slots)) {
            grocery_actvity.start <- one_of(free_slots);
            grocery_actvity.end <- grocery_actvity.start + grocery_duration;
            grocery_actvity.days <- [current_day_2weeks ];
        }
        activities << grocery_actvity;

    }

    //reflex variable to reset the kilometers and number of trips after 24 hours. Also a grocery activity is present. 37% chance to do groceries on
    //that day. set grocery_to_do at false again to reset value.
        reflex reset_km_trip when: ((time /#h) mod 24) = 0 {
            tot_kilometer <-0;
            trips <-0;
            activities >> grocery_actvity;
            grocery_to_do <- grocery_to_do or flip(0.37);
            if (grocery_to_do) and do_not_drive_all = false and do_not_drive_grocery = false{
                do update_grocery_activity;
```

```
            }
            grocery_to_do <- false;
    }

        //choose an activity from the activity log. do this when day and hour are from activity
    reflex choose_new_activity {
        bool new_activity <- false;
        loop act over: activities {
            if (act.start = current_hour) and (current_day_2weeks in act.days) {
                current_activity <- act;
                objective <- act.name ;
                new_activity <- true;
            trips  <- trips + 1;
            loop i from: 0 to: length(act.target_locs) - 1 {
                if flip(act.proba_targets[i]) {
                    the_target <- act.target_locs[i];
                    break;
                }
            }
                break;
            }
        }
    }

    //a reflex to end the current activity and head back to living_place
    reflex end_of_activity when: (current_activity != nil) and (current_hour = current_activity.end){
         objective <- "resting" ;
       the_target <- living_place;
    }


    //a drive reflex to make sure light mopeds use graph_snorfiets and mopeds use graph_bromfiets
    //Also, if an agent crosses a road, a plus 1 will be added to that road.
    reflex drive when: the_target != nil  {
             path path_followed <- nil;
            if (typescoot = "Snorfiets") {
                path_followed  <-  goto(target:the_target,  on:  graph_snorfiets,  move_weights:  weights_normal,  return_path:  true,
speed: respect_to_speed_limit);
            } else {
                path_followed <- goto(target:the_target, on: graph_bromfiets, return_path: true, speed: respect_to_speed_limit);
            }
        list<geometry> segments <- path_followed.segments;
        loop line over: segments {
            if (line.perimeter > 0) {
                tot_kilometer <- (int(tot_kilometer + line.perimeter));
                road the_road <- road(path_followed agent_from_geometry line);
              if (line overlaps first(the_road.shape.points)) {
                ask the_road {
                    if (myself.typescoot = "Bromfiets" ) {
                        brommernr  <- brommernr + 1;
                        } else if (myself.typescoot = "Snorfiets"){
                            snorfietsnr  <- snorfietsnr + 1;
                        }
                        bromsnornr <- bromsnornr + 1;
```

```
                    }
                }
            }
        }
        if the_target = location {
            the_target <- nil ;
        }
    }

    aspect base {
        draw circle(5) color: color;
    }
}

//the parameters of the model
experiment road_traffic type: gui {
    parameter "Percentage of scooters based on total number 2014" var: nb_scooters category: "People" min: 1 max: 200000;
    parameter "Unemployment percentage" var: unemployment category: "People" min: 0 max: 100;
    parameter "percentage not going to school with a scooter" var: school_practicing category: "People" min: 0 max: 100;
    parameter "percentage  not practicing sport with a scooter" var: sport_practicing category: "People" min: 0 max: 100;
    parameter "The weight for light-moped drivers to choose a bicycle road" var: weight_bicycle category: "Scooter" min: 0 max: 200;
    parameter "percentage not doing shopping with a scooter" var: shop_participating category: "People" min: 0 max: 100;
    parameter "percentage not doing grocery shopping with a scooter" var: grocery_participating category: "People" min: 0 max: 100;
    parameter "Average days per week the scooter is used" var: days_per_week category: "People" min: 0 max: 7;

    //the output. A city display, but also a piechart and a line chart to keep track of the activities
    output {
        display city_display type:opengl {
            species scooter aspect: base ;
            species road aspect: base ;
            species building aspect: base;
            species school aspect: base;
            species sport aspect: base;
            species shops aspect: base;
        }

        display activity_display {
                chart activities type:series {
                        data "working" value: scooter count (each.objective = "work") color: #red;
                        data "school" value: scooter count (each.objective = "school") color: #orange;
                        data "sport" value: scooter count (each.objective = "sport") color: #black;
                        data "shop" value: scooter count (each.objective = "shop") color: #violet;
                        data "grocery" value: scooter count (each.objective = "grocery") color: #blue;
                        data "resting" value: scooter count (each.objective = "resting") color: #green;
                }
        }
          display activity_display2 {
                chart activities type:pie {
                        data "working" value: scooter count (each.objective = "work") color: #red;
                        data "school" value: scooter count (each.objective = "school") color: #orange;
                        data "sport" value: scooter count (each.objective = "sport") color: #black;
                        data "shop" value: scooter count (each.objective = "shop") color: #violet;
                        data "grocery" value: scooter count (each.objective = "grocery") color: #blue;
                        data "resting" value: scooter count (each.objective = "resting") color: #green;
```

```
                }
            }

        }
    }
```

Appendix B: questionnaire ROAM

LEES DIT EERST

- Het is de bedoeling dat de vragenlijst wordt ingevuld door de persoon aan wie de vragenlijst is gericht.
- Als u de vragen niet zelf kunt lezen of invullen, kunt u iemand vragen om te helpen. De antwoorden moeten wel op u betrekking hebben.
- Neemt u rustig de tijd voor het doorlezen van een vraag. Als u twijfelt over het antwoord op de vraag, probeer dan het antwoord te geven dat het meest op u van toepassing is. Het is belangrijk dat u alle vragen invult.
- Er zijn geen 'goede' of 'foute' antwoorden, maar het is wel belangrijk dat u eerlijk antwoord geeft.

- Vul de vragenlijst in met een zwarte of blauwe pen (geen viltstift).
- Bij iedere vraag maar één antwoord aankruisen! Wanneer u meerdere antwoorden mag aankruisen, staat dit apart vermeld.
- Zet een duidelijk kruis in het antwoordvakje (zie voorbeeld 1).

Voorbeeld 1

V1 Welke plaats ligt in Zuid-Holland?

☒ Utrecht
☐ Rotterdam

→ U hebt nu 'Utrecht' ingevuld.

- Als u zich heeft vergist met aankruisen, laat dan het verkeerde kruisje staan en maak het juiste vakje helemaal **zwart** (zie voorbeeld 2).

Voorbeeld 2

V2 Welke plaats ligt in Zuid-Holland?

☒ Utrecht
■ Rotterdam

→ U hebt nu 'Rotterdam' ingevuld.

- Het kan zijn dat u bepaalde vragen niet hoeft in te vullen. Er staat dan aangegeven naar welke vraag u moet gaan (bijvoorbeeld → GA NAAR VRAAG 100).
- Soms wordt u gevraagd zelf iets op te schrijven. Het is belangrijk dat u binnen de lijnen blijft. Als er gevraagd wordt een cijfer in te vullen moet u één cijfer per hokje invullen (zie voorbeeld 3).

Voorbeeld 3

Goed [1] [9]   Fout [19] [ ]

+ +

Alvast hartelijk dank voor het invullen van deze vragenlijst. We willen u er nog eens op attenderen dat de gegevens uit de vragenlijst vertrouwelijk worden behandeld.

+ +

A ALGEMENE VRAGEN

A1 Wat is uw geslacht?

- ☐ man
- ☐ vrouw

A2 Wat is uw geboortejaar?

1 9 ☐ ☐

A3 Hoe lang bent u? (zonder schoenen)

1 ☐ ☐ centimeter

A4 Hoeveel kilo weegt u? (zonder kleren)

☐ ☐ ☐ kilogram

A5 Wat is uw hoogst voltooide opleiding? (een opleiding afgerond met diploma of voldoende getuigschrift)
Kruis één antwoord aan.

- ☐ geen opleiding (lager onderwijs niet afgemaakt)
- ☐ lager onderwijs (basisschool, speciaal basisonderwijs)
- ☐ lager of voorbereidend beroepsonderwijs (zoals LTS, LEAO, LHNO, VMBO)
- ☐ middelbaar algemeen voortgezet onderwijs (zoals MAVO, (M)ULO, MBO-kort, VMBO-t)
- ☐ middelbaar beroepsonderwijs en beroepsbegeleidend onderwijs (zoals MBO-lang, MTS, MEAO, BOL, BBL, INAS)
- ☐ hoger algemeen en voorbereidend wetenschappelijk onderwijs (zoals HAVO, VWO, Atheneum, Gymnasium, HBS, MMS)
- ☐ hoger beroepsonderwijs (zoals HBO, HTS, HEAO, HBO-V, kandidaats wetenschappelijk onderwijs)
- ☐ wetenschappelijk onderwijs (universiteit)
- ☐ anders, namelijk

A6 Wat is uw burgerlijke staat?
Kruis één antwoord aan.

- ☐ gehuwd/geregistreerd partnerschap
- ☐ samenwonend
- ☐ ongehuwd, nooit gehuwd geweest
- ☐ gescheiden, gescheiden levend
- ☐ weduwe, weduwnaar

A7 Uit hoeveel personen bestaat het huishouden waartoe u behoort, uzelf meegerekend? ☐☐ personen

A8 Met welke personen woont u momenteel samen?

Kruis op iedere regel één antwoord aan.	ja	nee
a. met een partner	☐	☐
b. woon niet samen met een partner, maar heb een duurzame relatie	☐	☐
c. met kind(eren) t/m 18 jaar	☐	☐
d. met mijn kinderen/andere familieleden	☐	☐
e. met andere volwassene(n) dan een partner	☐	☐

A9 Wat is ongeveer het netto maandinkomen van uw **huishouden**? Netto is het bedrag dat uw huishouden maandelijks op de bank- of girorekening krijgt. Dit zijn inkomsten uit arbeid, pensioen, uitkering of alimentatie. Eventuele vakantie-uitkering etc. a.u.b. niet meerekenen. **Kruis één antwoord aan.**

☐ beneden modaal
☐ rond modaal (1.300 t/m 1.900 € netto per maand)
☐ boven modaal

A10 Welke van de onderstaande situaties is op u van toepassing? **U kunt meerdere antwoorden aankruisen.**

	ja	nee	
a. ik werk (betaald of als vrijwilliger), 32 uur of meer per week	☐	☐	
b. ik werk (betaald of als vrijwilliger), 12 tot 32 uur per week	☐	☐	
c. ik werk (betaald of als vrijwilliger), minder dan 12 uur per week	☐	☐	
d. 1) ik ben met pensioen	☐	☐	d. 2) Sinds welk jaar: ☐☐☐☐
e. ik ben werkloos/werkzoekend (geregistreerd bij arbeidsbureau)	☐	☐	
f. ik ben arbeidsongeschikt (WAO, AAW, WAZ)	☐	☐	
g. ik heb een bijstandsuitkering	☐	☐	
h. ik ben fulltime huisvrouw/huisman	☐	☐	

A11 Deze vraag gaat over het soort werk dat u doet/deed. Als u al met pensioen bent beantwoordt u de vraag voor het werk dat u vroeger deed. Heeft u of had u een baan waarbij u het grootste gedeelte van de tijd bureauwerk doet/deed?

☐ ja
☐ nee

+ +

A12 In welk land bent u geboren? En uw vader en uw moeder? **Vul in alle drie de kolommen uw antwoord in.**

	a. uzelf	b. uw vader	c. uw moeder
Nederland	☐	☐	☐
Turkije	☐	☐	☐
Marokko	☐	☐	☐
Suriname	☐	☐	☐
Nederlandse Antillen	☐	☐	☐
overig Westers land	☐	☐	☐
overig niet-Westers land	☐	☐	☐

B UW WONING

B1 In welk type woning woont u? **Kruis één antwoord aan.**

☐ appartement zonder lift
☐ appartement met lift
☐ groepswoning
☐ eengezinswoning
☐ serviceflat
☐ aanleunwoning
☐ verzorgingshuis
☐ verpleeghuis
☐ ander type woning

B2 Op welke verdieping (etage) woont u? Begane grond of woonhuis kunt u invullen als verdieping ‘0’.

Ik woon op verdieping ☐☐

B3 Woont u in een huurwoning of in een koopwoning?

☐ huurwoning
☐ koopwoning

B4 Welke van de onderstaande uitspraken over uw woning zijn op u van toepassing?

Kruis op iedere regel één antwoord aan.	ja	nee
a. mijn woning is (deels) voorzien van dubbel glas	☐	☐
b. mijn woning heeft een buitenruimte (dakterras/tuin)	☐	☐
c. de buitenruimte van mijn woning bevindt zich aan de straatkant	☐	☐
d. mijn slaapkamer bevindt zich aan de straatkant	☐	☐
e. in mijn woning wordt op gas gekookt	☐	☐

+ +

B5 Neem de meest gebruikte ruimte in uw woning in gedachten (bijvoorbeeld de woonkamer, eetkamer, woonkeuken). Wat is uw uitzicht vanuit deze ruimte? **U kunt meerdere antwoorden aankruisen.**

- ☐ een (dak)tuin
- ☐ bomen in de straat
- ☐ grasveld
- ☐ park/plantsoen
- ☐ bos/natuurgebied
- ☐ weiland/akker
- ☐ water (bijv. vijver, kanaal, rivier)
- ☐ geen van bovenstaande

B6 Neem een normale dag in de afgelopen weken in gedachten. Wilt u aangeven hoeveel tijd u gemiddeld per dag thuis was (inclusief de nacht)?

Gemiddeld aantal uren thuis per dag+nacht:

± ☐ ☐ uur

C VERHUIZEN EN WOONWENSEN

C1 Sinds welk jaar woont u op dit adres?

☐ ☐ ☐ ☐ (jaartal)

C2 Bent u van plan om binnen 2 jaar te verhuizen? **Kruis één antwoord aan.**

- ☐ beslist niet → GA NAAR VRAAG D1
- ☐ eventueel wel, misschien
- ☐ zou wel willen, maar kan niets vinden
- ☐ beslist wel
- ☐ ik heb reeds andere huisvesting/woning gevonden
- ☐ weet niet → GA NAAR VRAAG D1

C3 Wat is de reden van uw verhuiswens? **Kruis één antwoord aan.**

- ☐ gezondheid of behoefte aan zorg → GA NAAR VRAAG D1
- ☐ studie en/of werk → GA NAAR VRAAG D1
- ☐ familie/kinderen → GA NAAR VRAAG D1
- ☐ ontevreden met huidige woning → GA NAAR VRAAG D1
- ☐ ontevreden met de woonomgeving
- ☐ anders → GA NAAR VRAAG D1

C4 Als uw woonomgeving een reden is om te verhuizen, is dat dan vanwege:
U kunt meerdere antwoorden aankruisen.

- ☐ (woonomgeving is geen reden)
- ☐ onderhoud van de buurt
- ☐ veiligheid van de buurt als gevolg van criminaliteit
- ☐ mensen in de buurt
- ☐ milieusituatie (overlast van geluid, stank, stof enz.)
- ☐ voorzieningen in de buurt
- ☐ gebrek aan groen in de buurt
- ☐ verkeersveiligheid in de buurt

+ +

D WAARDERING VAN DE WONING EN LEEFOMGEVING

D1 Hoe tevreden bent u met uw:

Kruis op iedere regel één antwoord aan.	1 (zeer ontevreden)	2	3	4	5	6	7	8	9	10 (zeer tevreden)
a. woning	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. woonomgeving	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

D2 Hoe zou u uw buurt typeren? Hieronder staan enkele stellingen over uw buurt. Kunt u aangeven in hoeverre u het met de stellingen eens bent?

Kruis op iedere regel één antwoord aan.	helemaal oneens	beetje oneens	neutraal	beetje mee eens	helemaal mee eens
a. ik woon in een veilige buurt	☐	☐	☐	☐	☐
b. ik woon in een lawaaiige buurt	☐	☐	☐	☐	☐
c. ik woon in een buurt met vieze lucht	☐	☐	☐	☐	☐
d. ik woon in een groene buurt	☐	☐	☐	☐	☐
e. het groen in mijn buurt is op loopafstand	☐	☐	☐	☐	☐

D3 Hieronder wordt een aantal aspecten van **uw buurt** genoemd. Hoe tevreden bent u met elk van deze aspecten?

Kruis op iedere regel één antwoord aan.	zeer ontevreden	ontevreden	neutraal	tevreden	zeer tevreden
a. sportvoorzieningen	☐	☐	☐	☐	☐
b. fiets- en wandelmogelijkheden	☐	☐	☐	☐	☐
c. speelmogelijkheden voor kinderen	☐	☐	☐	☐	☐
d. de hoeveelheid groen	☐	☐	☐	☐	☐
e. de kwaliteit van het groen	☐	☐	☐	☐	☐
f. onderhoud van de buurt	☐	☐	☐	☐	☐
g. veiligheid van de buurt als gevolg van criminaliteit	☐	☐	☐	☐	☐
h. de mensen in de buurt	☐	☐	☐	☐	☐
i. de milieusituatie (overlast van geluid, stank, stof enz.)	☐	☐	☐	☐	☐
j. de luchtkwaliteit	☐	☐	☐	☐	☐
k. de verkeersveiligheid	☐	☐	☐	☐	☐

D4 Hieronder worden een aantal milieuaspecten genoemd. In de eerste kolom geeft u aan of u denkt dat deze punten **in uw buurt** een probleem vormen (ja of nee). Als u 'ja' heeft geantwoord, kunt u in de tweede kolom aangeven of u bezorgd bent dat deze **in uw buurt** ook tot gezondheidsklachten kunnen leiden. Als u helemaal niet bezorgd bent, kiest u de 0, als u extreem bezorgd bent, kiest u de 10. Als u daar ergens tussenin zit, kiest u een getal tussen 0 en 10.

Kruis op iedere regel uw antwoord aan.	1. Is dit in uw buurt een probleem?			2. Bent u bezorgd dat deze situatie **in uw buurt** tot gezondheidsklachten kan leiden? helemaal niet bezorgd ←→ extreem bezorgd										
	nee	ja		0	1	2	3	4	5	6	7	8	9	10
a. geluidsoverlast	☐	☐	→	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. geuroverlast	☐	☐	→	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. luchtverontreiniging	☐	☐	→	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. risico's door industriële bedrijven	☐	☐	→	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. slecht onderhoud van wegen	☐	☐	→	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. slecht onderhoud van groen	☐	☐	→	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
g. te weinig groen	☐	☐	→	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

D5 Welke van onderstaande activiteiten onderneemt u in de groene gebieden **in uw buurt** en hoe vaak? Het gaat hier om groene gebieden op loopafstand van uw woning. *Groene gebieden zijn bijvoorbeeld parken, plantsoenen, grasstroken, groenstroken, speelplaatsen.*

Kruis op iedere regel één antwoord aan.	niet	1-4 x per jaar	4-12 x per jaar	1-4 x per maand	1-4 x per week	vaker dan 4 x per week
a. zitten/liggen/luieren/zonnen	☐	☐	☐	☐	☐	☐
b. natuur bekijken/luisteren (planten en dieren)	☐	☐	☐	☐	☐	☐
c. wandelen/joggen/trimmen	☐	☐	☐	☐	☐	☐
d. hond uitlaten	☐	☐	☐	☐	☐	☐
e. met (klein)kinderen spelen	☐	☐	☐	☐	☐	☐
f. sport of spel met anderen	☐	☐	☐	☐	☐	☐
g. fietsen/skeeleren e.d.	☐	☐	☐	☐	☐	☐
h. picknicken/barbecueën	☐	☐	☐	☐	☐	☐
i. tot rust komen/ontstressen	☐	☐	☐	☐	☐	☐
j. buurtgenoten ontmoeten	☐	☐	☐	☐	☐	☐

+ +

D6 Bij onderstaande vraag kunt u aangeven in welke mate geluid u hindert, stoort of ergert als u **thuis** bent. Als u helemaal niet gehinderd wordt kiest u de 0. Als u extreem gehinderd wordt kiest u de 10. Als u daar ergens tussenin zit, kiest u een getal tussen 0 en 10. Als een geluid bij u thuis niet hoorbaar is, kunt u dit in de laatste kolom aangeven.

"Als u denkt aan de **afgelopen 12 maanden**, welk getal van 0 tot 10 geeft het beste aan hoeveel u gehinderd, gestoord of geërgerd wordt door geluid van ………(geluidsbron) als u **thuis** bent?"

Kruis op iedere regel één antwoord aan.	0 helemaal niet gehinderd	1	2	3	4	5	6	7	8	9	10 extreem gehinderd	niet hoorbaar
a. wegverkeer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. buren	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. treinen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. vliegtuigen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. bedrijven/industrie	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. bromfietsers/bromscooters	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
g. horeca	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
h. bouw- en sloopactiviteiten	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

D7 In welke mate wordt uw SLAAP verstoord als u **thuis** bent door het geluid van de volgende bronnen. Denkt u hierbij aan de **afgelopen 12 maanden**. Als een geluid bij u thuis niet hoorbaar is, kunt u dit in de laatste kolom aangeven.

Kruis op iedere regel één antwoord aan.	0 helemaal niet verstoord	1	2	3	4	5	6	7	8	9	10 extreem verstoord	niet hoorbaar
a. wegverkeer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. buren	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. treinen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. vliegtuigen	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
e. bedrijven/industrie	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
f. bromfietsers/bromscooters	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
g. horeca	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
h. bouw- en sloopactiviteiten	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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D8 Nu volgt een aantal algemene uitspraken over geluid in uw woonomgeving. Als u het helemaal oneens bent kiest u 1. Als het er helemaal mee eens bent kiest u 6. Als u ergens in het midden zit, kiest u een getal tussen 1 en 6.

Kruis op iedere regel één antwoord aan.	1 (helemaal mee oneens)	2	3	4	5	6 (helemaal mee eens)
a. Niemand zou zich er wat van aan moeten trekken als iemand de muziekinstallatie af en toe hard aanzet.	☐	☐	☐	☐	☐	☐
b. Ik word snel wakker door geluid.	☐	☐	☐	☐	☐	☐
c. Ik word gehinderd wanneer mijn buren lawaaierig zijn.	☐	☐	☐	☐	☐	☐
d. Ik raak zonder al te veel moeilijkheden aan de meeste geluiden gewend.	☐	☐	☐	☐	☐	☐
e. Soms werkt geluid op mijn zenuwen en raak ik geïrriteerd.	☐	☐	☐	☐	☐	☐
f. Muziek waar ik normaal gesproken van houd, stoort me wanneer ik me probeer te concentreren.	☐	☐	☐	☐	☐	☐
g. Ik vind het moeilijk om te ontspannen op een plaats waar het lawaaierig is.	☐	☐	☐	☐	☐	☐
h. Het maakt niet uit wat er om mij heen gebeurt; ik kan me altijd goed concentreren.	☐	☐	☐	☐	☐	☐
i. Ik word boos op mensen die geluid maken waardoor ik niet kan slapen of werken.	☐	☐	☐	☐	☐	☐
j. Ik ben gevoelig voor geluid.	☐	☐	☐	☐	☐	☐

D9 Als u denkt aan de **afgelopen 12 maanden**, welk getal van 0 tot 10 geeft het beste aan in welke mate u wordt gehinderd, gestoord of geërgerd door stof, roet en/of rook van de onderstaande bronnen als u **thuis** bent?

Kruis op iedere regel één antwoord aan.	0 (helemaal niet gehinderd)	1	2	3	4	5	6	7	8	9	10 (extreem gehinderd)	niet merkbaar
a. wegverkeer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
b. bedrijven/industrie	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
c. open haarden, allesbranders, vuurkorven in de buurt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
d. bouw- en sloopactiviteiten (ook renovaties, saneringen)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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E WELBEVINDEN EN GEZONDHEID

E1 Hoe zou u over het algemeen uw gezondheid noemen?

- ☐ uitstekend
- ☐ zeer goed
- ☐ goed
- ☐ matig
- ☐ slecht

De volgende vragen gaan over bezigheden die u zou kunnen doen op een doorsnee dag. Wilt u bij iedere bezigheid aangeven of u op dit moment door uw gezondheid ernstig, een beetje of helemaal niet beperkt wordt bij deze bezigheden.

Kruis op iedere regel één antwoord aan.		nee, helemaal niet beperkt	ja, een beetje beperkt	ja, ernstig beperkt
E2	matige inspanning, zoals het verplaatsen van een tafel, stofzuigen, fietsen.	☐	☐	☐
E3	een paar trappen oplopen	☐	☐	☐

De volgende vragen gaan over uw dagelijkse activiteiten en uw lichamelijke gezondheid en emotionele problemen.

Kruis op iedere regel één antwoord aan.		ja	nee
E4	Heeft u gedurende de afgelopen 4 weken minder bereikt dan u zou willen ten gevolge van uw lichamelijke gezondheid?	☐	☐
E5	Was u gedurende de afgelopen 4 weken beperkt in het soort werk of andere bezigheden ten gevolge van uw lichamelijke gezondheid?	☐	☐
E6	Heeft u gedurende de afgelopen 4 weken minder bereikt dan u zou willen ten gevolge van emotionele problemen (zoals depressieve of angstige gevoelens)?	☐	☐
E7	Deed u gedurende de afgelopen 4 weken uw werk of andere bezigheden niet zo zorgvuldig als gewoonlijk ten gevolge van emotionele problemen (zoals depressieve of angstige gevoelens)?	☐	☐

E8 In welke mate bent u de afgelopen 4 weken door pijn gehinderd in uw normale werk, zowel werk buitenshuis als huishoudelijk werk?

- ☐ helemaal niet
- ☐ een klein beetje
- ☐ nogal
- ☐ veel
- ☐ heel erg veel

+ +

De volgende vragen gaan over hoe u zich voelt en hoe het met u ging de afgelopen 4 weken. Wilt u bij elke vraag het antwoord geven dat het best benadert hoe vaak u zich zo voelde?

	Kruis op iedere regel één antwoord aan.	nooit	zelden	soms	vaak	meestal	altijd
E9	Hoe vaak voelde u zich gedurende de afgelopen 4 weken kalm en rustig?	☐	☐	☐	☐	☐	☐
E10	Hoe vaak had u gedurende de afgelopen 4 weken veel energie?	☐	☐	☐	☐	☐	☐
E11	Hoe vaak voelde u zich gedurende de afgelopen 4 weken somber en neerslachtig?	☐	☐	☐	☐	☐	☐
E12	Hoe vaak hebben uw lichamelijke of emotionele problemen u gedurende de afgelopen 4 weken gehinderd bij uw sociale activiteiten (zoals vrienden of familie bezoeken)?	☐	☐	☐	☐	☐	☐

E13 Wilt u bij de volgende ziekten en aandoeningen aangeven of u die heeft of in de **afgelopen 12 maanden** heeft gehad?

Kruis op iedere regel één antwoord aan.	nee	ja, niet door arts vastgesteld	ja, door arts vastgesteld
a. diabetes mellitus/suikerziekte	☐	☐	☐
b. beroerte, hersenbloeding, herseninfarct of TIA	☐	☐	☐
c. hartinfarct	☐	☐	☐
d. een andere ernstige hartaandoening (zoals hartfalen of angina pectoris)	☐	☐	☐
e. een vorm van kanker (kwaadaardige aandoening)	☐	☐	☐
f. migraine of regelmatig ernstige hoofdpijn	☐	☐	☐
g. vernauwing van de bloedvaten in de buik of benen (geen spataderen)	☐	☐	☐
h. astma	☐	☐	☐
i. longemfyseem, chronische bronchitis, CARA/COPD	☐	☐	☐
j. ernstige of hardnekkige darmstoornissen langer dan 3 maanden	☐	☐	☐
k. psoriasis	☐	☐	☐
l. chronisch eczeem	☐	☐	☐
m. onvrijwillig urineverlies (incontinentie)	☐	☐	☐
n. ernstige of hardnekkige aandoening van de rug (incl. hernia)	☐	☐	☐
o. gewrichtsslijtage (artrose, slijtagereuma) van heupen of knieën	☐	☐	☐
p. chronische gewrichtsontsteking (ontstekingsreuma, chronische reuma, reumatoïde artritis)	☐	☐	☐

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Kruis op iedere regel één antwoord aan.	nee	ja, niet door arts vastgesteld	ja, door arts vastgesteld
q. andere ernstige of hardnekkige aandoening van de nek of schouder	☐	☐	☐
r. andere ernstige of hardnekkige aandoening van elleboog, pols of hand	☐	☐	☐
s. andere langdurige ziekte of aandoening	☐	☐	☐

Gezondheid ademhalingsstelsel

E14 Heeft u **in de laatste 12 maanden** wel eens last gehad van piepen op de borst?
☐ ja
☐ nee → GA NAAR VRAAG E17

E15 Was u kortademig tijdens dit piepen op de borst?
☐ ja
☐ nee

E16 Heeft u dit piepen op de borst gehad terwijl u **niet** verkouden was?
☐ ja
☐ nee

E17 Bent u **in de afgelopen 12 maanden** wel eens wakker geworden met een gevoel van beklemming op de borst?
☐ ja
☐ nee

E18 Bent u **in de afgelopen 12 maanden** wel eens wakker geworden door een aanval van kortademigheid?
☐ ja
☐ nee

E19 Bent u **in de afgelopen 12 maanden** wel eens wakker geworden door een hoestbui?
☐ ja
☐ nee

E20 Heeft u **in de afgelopen 12 maanden** een astma-aanval gehad?
☐ ja
☐ nee

E21 Gebruikt u momenteel medicijnen (bijvoorbeeld inhalatoren, aerosols of tabletten) tegen astma?
☐ ja
☐ nee

E22 Heeft u enige vorm van neusallergieën, inclusief hooikoorts?
☐ ja
☐ nee

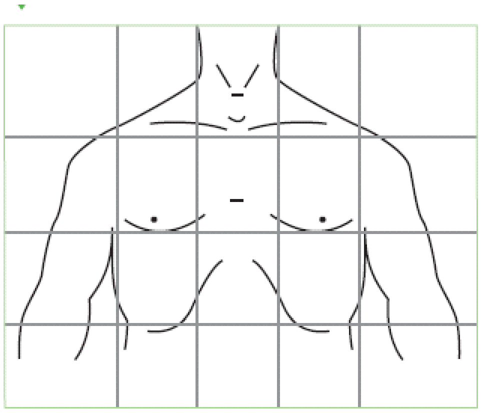
\+ +

Gezondheid hart en bloedvaten

E23 Heeft u wel eens last van pijn of druk op de borst?

- ☐ ja
- ☐ nee → GA NAAR VRAAG E30

E24 Kunt u in het figuur hiernaast met één of meer kruisjes aangeven waar u deze pijn dan voelt?



E25 Krijgt u er last van als u op een gewoon tempo loopt op een gelijke ondergrond?

- ☐ ja
- ☐ nee

E26 Krijgt u er last van als u omhoog (heuvel op) loopt of als u zich haast?

- ☐ ja
- ☐ nee
- ☐ ik heb nooit haast/loop nooit een heuvel op

E27 Wat doet u als u er last van krijgt tijdens het lopen?

- ☐ stoppen
- ☐ langzamer lopen
- ☐ (in het zelfde tempo) doorlopen

E28 Als u stilstaat, wat gebeurt er dan met de pijn?

- ☐ verdwijnt
- ☐ verdwijnt niet

E29 Hoe lang duurt het voordat de pijn verdwijnt?

- ☐ binnen 10 minuten of minder
- ☐ meer dan 10 minuten

E30 Hebt u ooit last gehad van pijn op de borst die een half uur of langer aanhield?

- ☐ ja
- ☐ nee

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E31 Krijgt u last van pijn of ongemak in uw been/benen als u loopt?

- ☐ ja
- ☐ nee → GA NAAR VRAAG E37
- ☐ ik ben niet in staat om te lopen → GA NAAR VRAAG E37

E32 Begint deze pijn wel eens als u stilstaat of als u zit?

- ☐ ja
- ☐ nee

E33 Krijgt u er last van als u omhoog (heuvel op) loopt of zich haast?

- ☐ ja
- ☐ nee

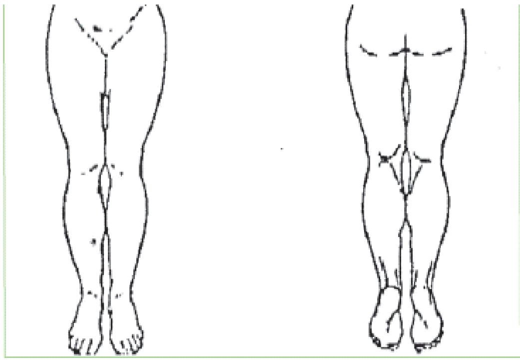
E34 Krijgt u er last van als u op een gewoon tempo loopt op een gelijke ondergrond?

- ☐ ja
- ☐ nee

E35 Als u stilstaat, wat gebeurt er dan met de pijn?

- ☐ verdwijnt
- ☐ verdwijnt niet

E36 Waar krijgt u deze pijn/dit ongemak?
Markeer de plaats in het figuur hiernaast.



Voorkant
Rechts Links

Achterkant
Links Rechts

E37 Heeft u ooit een hartinfarct gehad?

- ☐ ja
- ☐ nee → GA NAAR VRAAG E40

E38 Hoe vaak heeft u een hartinfarct gehad?

☐ ☐ keer

E39 In welk(e) jaar/jaren?

a. ☐☐☐☐ (jaartal)

b. ☐☐☐☐ (jaartal)

c. ☐☐☐☐ (jaartal)

E40 Heeft u **in de afgelopen 12 maanden** medicijnen gebruikt voor uw hart, bloedvaten of bloeddruk?

☐ ja
☐ nee

Leefstijl

E41 Rookt u?

☐ ja, ik rook op dit moment
☐ ik heb ooit gerookt, maar ben gestopt (langer dan 2 maanden)
☐ nee, ik heb nooit gerookt

E42 Hoeveel en wat rookt(e) u gemiddeld per dag? (ook in te vullen door ex-rokers)

☐ ☐☐☐ sigaretten per dag
☐ ☐☐☐ sigaren per dag
☐ ☐☐☐ gram tabak (pijprokers) per dag

E43 Hoe oud was u toen u regelmatig sigaretten/sigaren/pijp begon te roken?

☐☐ jaar

E44 Als u gestopt bent met roken, op welke leeftijd bent u dan gestopt?

☐☐ jaar

E45 Hoeveel uur per dag zit u gemiddeld in een rokerige ruimte?

☐☐ uur per dag

E46 Wordt er bij u thuis binnenshuis gerookt?

☐ ja
☐ nee
☐ soms

+ +

TOT SLOT

Tenslotte willen we u nog vragen of we u in de toekomst nogmaals mogen benaderen voor vervolgonderzoek? Natuurlijk kunt u, op het moment dat u nog eens wordt benaderd, altijd nog besluiten of u wel of niet mee wilt doen.

☐ ja
☐ nee

Onder de deelnemers worden 10 staatsloten verloot. Wilt u ook kans maken op een staatslot?

☐ ja
☐ nee

Heeft u nog opmerkingen naar aanleiding van deze vragenlijst?

☐ ja, namelijk:

Hartelijk dank voor uw medewerking. U kunt de vragenlijst en het toestemmingsformulier terugsturen in de bijgesloten retourenvelop. U hoeft hierop géén postzegel te plakken.