Chapter 4

Residential Moving Intentions at Highway Locations:

The trade-off between Nuisances and Accessibility in the Netherlands

Abstract*

This study investigates how highway nuisances are traded off against accessibility gains and other residential characteristics in the moving intentions of people living near highways. It studies a potential mediating role for residential satisfaction and potential mitigating relationships with highway nuisance perceptions. Structural Equation Modelling was used to test a proposed framework based on survey data collected from 1,220 respondents living within 1,000 m from a highway in the Netherlands.

The results show that higher levels of perceived highway nuisances are associated with increased intentions to move, mediated by lower residential satisfaction. However, better perceived accessibility was (just) not associated with either lower moving intentions or lower highway nuisance perception. Highway usage/interest and other residential characteristics – such as satisfaction with buildings, traffic safety, and amount of greenery – seem to countervail perceived highway nuisances as they reduce moving intentions and reduce highway nuisance perception. Finally, the results show that some groups – for example home owners – were less inclined to move (direct effect), independently of their residential satisfaction.

From a practical perspective, a more inclusive perspective on highway planning, which accounts for accessibility and other residential characteristics as potential compensators and mitigators for highway nuisances, would be effective to reduce residential stress which could prevent protest and consequent cost overruns of projects.

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4.1 Introduction

The presence of highway infrastructure -inter-urban roads with at least two lanes in each direction- could impact residents negatively as well as positively. Negative highway externalities such as noise, air pollution or barrier-effects (i.e., visual and physical obstructions) can be perceived as highly undesirable and could in the most extreme cases even result in residential moving. Nevertheless, accessibility gains resulting from proximity to a highway access lane/on-ramp alongside other residential characteristics – such as neighbourhood aesthetics – could be highly valued: as such, they could at least partly countervail the stresses caused by highway annoyance.

Several studies touch upon the relevance of either nuisances (e.g., Osada et al., 1997; Lu, 1998; Nijland et al., 2007) or accessibility (e.g., Van Ommeren et al., 1999; Tillema et al., 2010) in relation to residential preferences. As far as we know there is only one study however that has investigated the relative importance of highway nuisances and accessibility gains to residential satisfaction near highways together, and to have confirmed the importance of accounting for these trade-offs (Hamersma et al., 2014). However, the consequences on moving intentions are still unknown.

This study extends this existing line of research and first of all aims to investigate to what extent highway nuisances, accessibility gains and other residential characteristics influence the intention to move. We study moving intentions instead of moving behaviour because we also wanted to include people who intend to move but who had not yet gone through with it. Research shows, for example, that the actual and perceived costs involved prevent some groups from moving (e.g., Lu, 1999). We also test the role of 'residential satisfaction' as potential mediator between nuisances, accessibility and other characteristics on the one hand, and moving intention on the other hand. Residential moving research indicates that residential satisfaction is a proxy for stress and consequent moving behaviour (Speare, 1974; Tillema et al., 2012). In addition, the second research objective is to investigate potential direct relationships with highway nuisance perception; research provides indications that accessibility gains and other residential characteristics may also affect the perceiving of nuisances (e.g., Miedema & Vos, 1999).

From a policy perspective, this study specifically provides insights on the extent to which accessibility gains and other residential characteristics – such as neighbourhood aesthetics – could compensate for or mitigate (i.e., relieve) perceived highway nuisance. In addition, it provides insight into groups of people or

types of areas, which may need a specific approach or additional attention (e.g., Tillema et al., 2012), for instance because of greater nuisance perception or a reduced ability to move. These insights allow actions that could to a certain extent relieve locational stress and prevent protests (NIMBY-ism), undesired relocations and the time and cost overruns of projects caused by the need for unforeseen mitigation (e.g., Tillema et al., 2012).

The outline of this article is as follows. The second Section outlines the theoretical model and the third Section describes the data and method. The results are discussed in the fourth Section, followed by conclusions in the last Section.

4.2 Theoretical framework

4.2.1 Highway nuisances, accessibility and residential moving intentions

Our first aim was to study the impact of highway nuisance against accessibility gains alongside other residential characteristics in residential moving intentions, accounting for a mediating role for residential satisfaction. First, we discuss the literature on the relationship between residential satisfaction and residential moving (see Section ‘‘Residential moving intentions research: the role of residential satisfaction’’). Second, literature pointing to the relevance of trade-offs between highway nuisances, accessibility gains and other residential characteristics is reviewed (see Section ‘‘Combined research on nuisances and accessibility’’).

Residential moving intentions research: the role of residential satisfaction

Many studies emphasize the relevance of residential satisfaction as a proxy for residential coping behaviour in understanding why people move (e.g., Speare, 1974; Wong, 2002; Tillema et al., 2012). Within this literature, residential dissatisfaction is often seen as a sign of stress (Speare, 1974) and residential moving as a way of relieving residential stress. Rossi (1955) describes the decision to move as a reaction to stress caused by a “change in needs, aspirations or satisfaction” (Rossi, 1955, pp. 225–226). This stress could be caused by internal factors, such as lifecycle events, and external household factors, such as highway nuisances or a bad accessibility (e.g., Tillema et al., 2012). In this conceptualization residential satisfaction can be regarded as a mediator between contextual factors and residential moving considerations (e.g., Speare, 1974), which is empirically confirmed by several studies (Speare, 1974; Wong, 2002; Lu, 1998).

Nevertheless, some studies have found that certain groups have higher or lower moving intentions despite residential satisfaction. Wong (2002) argues that a household's level of dissatisfaction is evaluated against its stress threshold: stress thresholds can differ by household based on the perceived costs of moving (e.g., Coulombel, 2010; Wong, 2002). Aspects such as home ownership, longer duration of residence, increasing age, relatively low income, relatively low educational level and larger family size are frequently found to reduce moving intentions regardless of satisfaction (e.g., Deane, 1990; Landale & Guest, 1985; Lu, 1998; McHugh et al., 1990). Furthermore aspects such as proximity to friends and family (Landale & Guest, 1985), neighbourhood problems and environmental quality are sometimes found to have a direct impact (Lee et al., 1994; Osada et al., 1997; Lu, 1998).

Combined research on nuisances and accessibility

Nuisances and accessibility have to our knowledge never been jointly studied in relation to residential moving intentions in a highway context. Nevertheless, scientific literature offers indications of their relative importance alongside other characteristics in other research contexts. For example, Nijland et al. (2007) studied residential self-selection of noise sensitive people to lower noise exposure areas in the town of Maarssenbroek in the Netherlands, but did not find proof of the occurrence of this phenomenon. Although not empirically confirmed, one of their explanations is that other neighbourhood amenities, among which could be low house prices, neighbourhood quality and accessibility, are more important in residential relocation decisions. In the same line, studies conclude that the relationship between the occurrence of environmental hazards (such as air pollution) and moving is not straightforward (e.g., Hunter, 2005). Based on data from the residents of Darmstadt city and its suburbs, Rohrmann (1991) concludes that noise and smell effects are outweighed by factors relating to housing type, neighbourhood aesthetics and distance to work in moving decisions.

Other studies focus more on the importance of accessibility in residential moving. Most of them argue that in general the impact of accessibility on residential moving is limited and seems to have decreased in recent years (e.g., Giuliano, 1989). For example, based on stated preference research, Molin and Timmermans (2002) conclude that house and neighbourhood aspects are more important than accessibility considerations in residential preferences. However, other studies found that groups of people can still value travel costs and time in their residential location decisions (e.g., Tillema et al., 2010; Van Ommeren et al., 1999). Tillema et al. (2012) argue that although accessibility may not be the main reason for residential relocation, it can still influence the final residential location choice.

Although not studying residential moving, some studies of residential satisfaction give indications on the relative importance of nuisance and accessibility alongside other residential characteristics. Hamersma et al. (2014) investigated residential satisfaction close to highways in the Netherlands. They conclude that accessibility measures (perception and actual highway use) and other residential aspects could – at least partly – counterbalance highway (noise, air and barrier- effect) nuisances in residential satisfaction. Furthermore, studies of residential satisfaction focusing less specifically on highway locations also show comparable results (e.g., Buys & Miller, 2012; Hur & Morrow-Jones, 2008). Nevertheless, compared to perceived measures, studies including actual levels of nuisance or accessibility generally found much weaker relationships with residential satisfaction or subjective well-being (e.g., Hamersma et al., 2014; Morris, 2013), which could partly concern residential self-selection (e.g., Morris, 2013). For example, people living further away from an access lane might find access lane proximity less relevant in their residential satisfaction.

Finally, studies jointly including accessibility and nuisances in analysing house prices close to transport infrastructure generally conclude that both have an impact (e.g., Theebe, 2004; Iacano & Levinson, 2011; Chen et al., 1997). While nuisances lower the price of a house, proximity to an access lane or a train station create a countervailing increase. However, the relationships with house prices might not be directly comparable with residential satisfaction or moving intentions, for example because people may be willing to accept more nuisances if they can pay less for their home (e.g., Nijland et al., 2007).

4.2.2 Direct relationships between accessibility and perceived highway nuisance

Our second aim was to explore whether accessibility gains and residential characteristics also directly influence (i.e., reduce) the way highway nuisances are perceived. Theories of environmental perception emphasize the difference between the objective environment that people encounter and the way this environment is perceived (e.g., Kirk, 1963). With respect to nuisance perception, studies conclude that there is no one-to-one relationship between actual exposure and perceptions (e.g., Schreckenberg et al., 2010); several other factors could influence the way nuisance is perceived. This also helps to explain why studies find that subjective measures outweigh objective exposure measures in explaining wellbeing (e.g., Van Praag & Baarsma, 2005) or moving considerations (e.g., Osada et al., 1997). It is possible that better accessibility as a consequence of

highway access-lane proximity reduces the stress caused by the highway. We are not aware of studies of these relationships. There is evidence, however, that users of a polluting source and people dependent on a polluting source seem to be less annoyed by its negative effects (e.g., Kroesen et al., 2010; Miedema & Vos, 1999).

Furthermore, some studies give indications about relationships between other residential characteristics and nuisance perception. Although the relationship with neighbourhood characteristics, such as neighbourhood aesthetics, has not been studied much, we know that in general, greenery is found to reduce annoyance (e.g., Gidlöf-Gunnarsson & Öhrström, 2007; Li et al., 2010). Somewhat in contrast, it was also found that green noise barriers, despite being more appealing, are perceived to be less helpful in reducing noise compared to opaque ones (Joing & Kang, 2010). The effect of socioeconomics (see Miedema & Vos, 1999 for an overview) on perceived noise nuisance, on the other hand, has been widely studied. Studies show that differences in nuisance perception are at least partly explained by aspects such as fear and noise sensitivity, being middle-aged and house ownership.

4.2.3 Conceptual model: moving intentions at highway locations

Figure 4.1 presents our conceptual model, in which we propose analysing the impact of a highway on moving intentions from a broader perspective. To do so, we study the influence of highway nuisances against accessibility gains alongside other residential characteristics in residential moving intentions, while accounting for a mediating role for residential satisfaction (see number 1, Figure 4.1). To measure highway nuisances, following Tillema et al. (2012), we distinguish between perceived noise, air-pollution and barrier-effect nuisances, which are expected to increase moving intentions. Regarding accessibility gains, we argue that highway access lane proximity could contribute to a better accessibility level, the latter defined by Geurs and Van Wee (2004) as the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s). Accessibility in relation to highways mainly refers to regional accessibility i.e., good transportation links to regionally oriented concentration of activity (Handy, 1993). Good accessibility may be appreciated by people in their residential preferences (e.g., Tillema et al., 2010; Van Ommeren et al., 1999) and may as such at least partly countervail highway nuisances. In addition, highway interest/use is included; literature indicates that users of polluting transport modes are less stressed by its nuisances (e.g., Kroesen et al., 2010; Miedema & Vos, 1999; Hamersma et al.,

2014). Both a better accessibility level and highway interest/use (to the left of Figure 4.1), are expected to decrease moving intentions. Furthermore, nuisances and accessibility are expected to be traded off with other characteristics. Therefore (to the right of Figure 4.1), actual highway exposure, other residential characteristics and socioeconomic controls are included and expected to influence residential moving intentions as well.

An important role for residential satisfaction is expected in mediating the relationship between the highway context and residential moving intentions (e.g., Speare, 1974). Nevertheless, existing research also shows that some contextual aspects seem to influence moving intentions directly independent of residential satisfaction (e.g., Osada et al., 1997; Lu, 1998). Therefore, no prior conclusions are drawn on the relationship between contextual factors and moving intentions; contextual factors are enabled to impact moving intentions indirectly through their effect on residential satisfaction, but also directly, independently of residential satisfaction. Furthermore, as a second aim, it is anticipated that accessibility gains alongside other factors could also influence highway nuisance perception (see Figure 4.1, number 2).

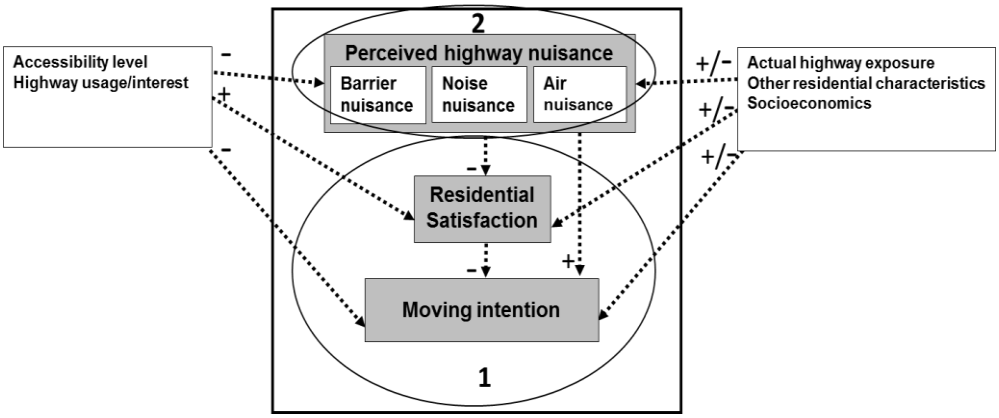


Figure 4.1 Hypothesized conceptual model.

4.3 Data and method

4.3.1 Data collection

Data were collected at seven highway locations in the Netherlands – a population-dense country with a well-developed transport network – using a questionnaire devised in 2011. The locations selected are geographically distributed throughout

the country and are all within a one-kilometre range of a highway. This radius was chosen because studies indicate that noise effects appear to fade at a distance of 300–600 m from a highway (Eliasson, 2005; Nelson, 1982). To ensure sufficient variation in exposure levels, we extended the research's catchment area to 1000 m. Although all the respondents lived within 1,000 m of the highway, there was substantial variation in access lane proximity (residential locations ranging from 25 to 3,500 m from an access lane). A total of 5,500 questionnaires were manually distributed, 1,396 of which were returned, a response rate of 25%. The response rate was found to be consistent with respect to distance from the highway (22.7% at 0–300 m; 27.2% at 300–600 m and 23.1% at 600–1,000 m from the highway) and neighbourhood composition based on gender, household composition and age. Respondents with incomplete data were excluded (n = 176). A total of 1,220 valid questionnaires were analysed.

The questionnaire collected data on subjective evaluations of the neighbourhood, residential satisfaction and moving intentions, supplemented with background characteristics about the respondent, the house and the exact residential location. Based on the latter, straight line distances between the 6-digit postal code and the highway and highway access lane were calculated using Geographical Information Systems (GIS). Noise and air exposure levels which were obtained from the Dutch Ministry of Infrastructure and the environment were also linked to each 6-digit residential location. Finally, the average house price in the neighbourhood in 2011 was obtained from Statistics Netherlands.

4.3.2 Method

We applied a Structural Equation Modelling (SEM) approach to test the proposed model. SEM is particularly useful in testing theories that contain multiple equations involving dependence relationships (Hair et al., 2006). In other words, SEM permits the estimation of a theoretical model with more than one dependent variable, as in our proposed theoretical model where we simultaneously study relationships with perceived highway (noise, air and barrier-effect) nuisance, residential satisfaction and moving intentions. LISREL was used to estimate the models and we applied a covariance method based on Maximum Likelihood (ML) estimation. Maximum likelihood (ML) is the most widely used estimation method for Structural Equation Modelling and has been shown to be relatively robust under moderate departures from normality (e.g., Boomsma & Hoogland, 2001), which is the case for some variables in our model. A confirmatory modelling strategy was used, as our goal was not to find the best fitting model but to test the proposed model presented in Figure 4.1. As existing research is inconclusive on the role of satisfaction in

mediating the relationship between contextual variables and moving intentions, both direct and indirect relationships between contextual variables and moving intentions are tested. Moreover, in addition to the full saturated model, we tested how the model fit could be improved by excluding insignificant links and by adding paths as suggested by LISREL. In assessing the model fit, we will focus on the Root Mean Square Error of Approximation (RMSEA) and the Comparative Fit Index (CFI), following Ullman and Bentler (2003).

4.3.3 Variables

A SEM model consists of Endogenous and Exogenous variables (Hair et al. 2006). The Endogenous variables are the dependent variables explained by other factors in the model. Exogenous variables are independent variables; they are not influenced by any other variable or construct in the model. Furthermore, a SEM model permits the inclusion of observed variables and latent constructs: while the former are based on one indicator (one variable), the latter are unobserved constructs or factors and based on two or more indicators (Ullman & Bentler, 2003). The indicators as input for the latent constructs were chosen based on theoretical reasoning. Construct validity checks were performed and violations are reported. Table 4.1 and Figure 4.2 present a descriptive overview of the variables included, distinguishing between endogenous and exogenous variables and indicating the number of indicators for each variable.

Endogenous variables

As per Figure 4.2, moving intentions, residential satisfaction, and perceived highway noise, air pollution and barrier-effect nuisances are endogenous variables, as they can be explained by other factors in the model. All endogenous variables are included as latent (built up by several indicators measured on a 7-point scale, see also Table 4.1) constructs. “Moving intention” was formed from two indicators, i.e. one regarding the intention to move within two years, and one regarding a willingness to move in general (Table 4.1; 1.1). The “Residential satisfaction” construct was built up from the house and neighbourhood satisfaction indicators (Table 4.1; 1.2). Construct validity checks showed an indication of a violation on discriminant validity between the construct “Residential satisfaction” and “Moving intentions”[8], but a robustness check by removing the indicator most correlating on

[8]According to Hair et al. (2006), discriminant validity is evidenced when the percentages of variance extracted for both constructs are higher than the squared correlation between both constructs. The percentages of variance extracted are 39.7% and 47.1% for the constructs ‘Residential satisfaction’ and ‘Moving intentions’ respectively, whereas the squared correlation of both constructs is 0.57, which is an indication of a violation on discriminant validity.

both constructs showed that results are generally stable. With respect to highway nuisance, factor analysis was performed prior to the analysis to check the reliability of the hypothesized latent constructs and confirmed that “perceived air pollution”, “perceived noise” and “perceived barrier-effect” nuisance were found to be separate constructs, formed from four (Table 4.1; 1.3), four (Table 4.1; 1.4) and three indicators (Table 4.1; 1.5), respectively. Although the latent construct “perceived barrier-effect” has relatively low estimates (see Table 4.1), it was decided to include these indicators based on the model fit.

Exogenous variables

Actual highway exposure, accessibility gains, residential characteristics and socioeconomics are included as exogenous variables (Figure 4.2). Actual highway exposure variables are included in addition to the perceived highway nuisances (being endogenous in the model). More specifically, the actual distance from the highway (calculated by use of GIS), the level of noise exposure (in decibels) and air-pollution exposure (NO_2 in µg/m3) generated by highway traffic were included (obtained from Rijkswaterstaat, Ministry of Infrastructure and the Environment, 2014), based on the six-digit postcode of the residential location (Table 4.1; 2.1). Both noise and air pollution exposure levels are based on yearly calculations. With respect to accessibility gains, both the accessibility level and highway use/interest related variables are tested. The accessibility level (Table 4.1; 2.2) was operationalized by three measures while using to the definition of accessibility by Geurs and Van Wee (2004) i.e. the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s). The first included measure is the actual distance between the home and the nearest highway access lane, calculated using GIS. This measures the ease of reaching the ‘transport system’ i.e., the highway in itself. Second, we included a measure of satisfaction with overall accessibility: ‘‘I am satisfied with accessibility of the residential location’’, measured on a 1–7 scale (“1” ‘totally disagree’ and “7” ‘totally agree’). The highway could contribute to the overall ease of reaching activities/destinations from the residential location. Third, more related to regional accessibility, the level of ‘‘satisfaction with the car-commute’’ was included, measured on a 1–7 scale. Highway access lane proximity could contribute to regional accessibility i.e., reaching activities in a regional context; work accessibility is one of the important activities to be reached from the home in a regional context and considered to be relevant to the residential location choice (e.g., Tillema et al., 2010; Van Ommeren et al., 1999). An additional model for working respondents is therefore estimated. More highway use/interest related (Table 4.1; 2.3), a variable indicating whether people had a prior ‘preference to live

near a highway' was included, which was measured on a scale of "1" (no preference) to "7" (strong preference). Furthermore, we added traffic jam frequency as a dummy, scored "1" when the respondent indicated being stuck in traffic jams more than once a week and "0" otherwise. Finally, we included a latent construct "attitude towards car driving" on a 1–7 scale ("1" indicating a negative attitude and "7" a very positive attitude). Another group of exogenous variables included in the model are the residential characteristics (Table 4.1; 2.4). We included the average house price in the neighbourhood (obtained from Statistics Netherlands), as well as people's subjective evaluations of traffic safety, attractiveness of buildings, number of social contacts, amount of greenery, facilities and the number of parking spaces in the neighbourhood. Subjective neighbourhood variables were all measured on a "1" (very negative) to "7" (very positive) scale. Finally, we control for socioeconomics (Table 4.1; 2.5). In line with other studies looking into the relationships between context, satisfaction and moving (e.g., Speare, 1974; Lu, 1999; Lee et al., 1994), we included age, gender, household composition, education, income, house ownership and duration of residence.

Table 4.1 Descriptive statistics and factors scores constructs.

Construct	Statement/Variable	Mean/ pct_d	St. dev_e	R-square
1.Endogenous				
1.1 Moving intention (2x)	*I would like to move in the next two years$_a$	2.6	2.0	0.50
	*If possible, I will move out of this neighbourhood$_a$	2.3	1.8	0.90
1.2 Residential satisfaction (2x)	*I am satisfied with my house$_a$	5.9	1.1	0.51
	*I am satisfied with my neighbourhood$_a$	5.7	1.3	0.74
1.3 Perception Air nuisance (4x)	*The air quality in my neighbourhood is poor$_a$	3.3	1.8	0.71
	*I am concerned about the possible effect of pollution on my health$_a$	3.5	2.0	0.78
	*I am annoyed by highway traffic pollution when I am inside my house$_a$	2.1	1.5	0.79
	*I have health problems because of the highway traffic pollution$_a$	2.1	1.6	0.76
1.4 Perception Noise nuisance (4x)	*I can hear noise from the highway when I am inside my house$_a$	2.6	2.0	0.80
	*I am concerned about the effect of highway traffic noise on my health$_a$	2.6	1.9	0.54
	*I am annoyed by highway traffic noise when I am inside my house$_a$	2.1	1.7	0.93
	*I have health problems as a result of highway traffic noise$_a$	1.7	1.4	0.75
1.5 Perception Barrier-effect nuisance (3x)	*The highway is a barrier: it is difficult to reach the other side$_a$	1.9	1.6	0.16
	*The highway is not sufficiently integrated into the landscape$_a$	4.3	1.7	0.38
	*The highway is ugly$_a$	4.2	1.9	0.56
2.Exogenous				
2.1 Actual highway exposure				
Decibel level (DB) for each 6-digit postal code	*=<39.5 DB	5.4%		
	*39.5-44.5 DB	20.8%		
	*44.5-49.5 DB	37.2%		
	*49.5-54.5 DB	22.8%		

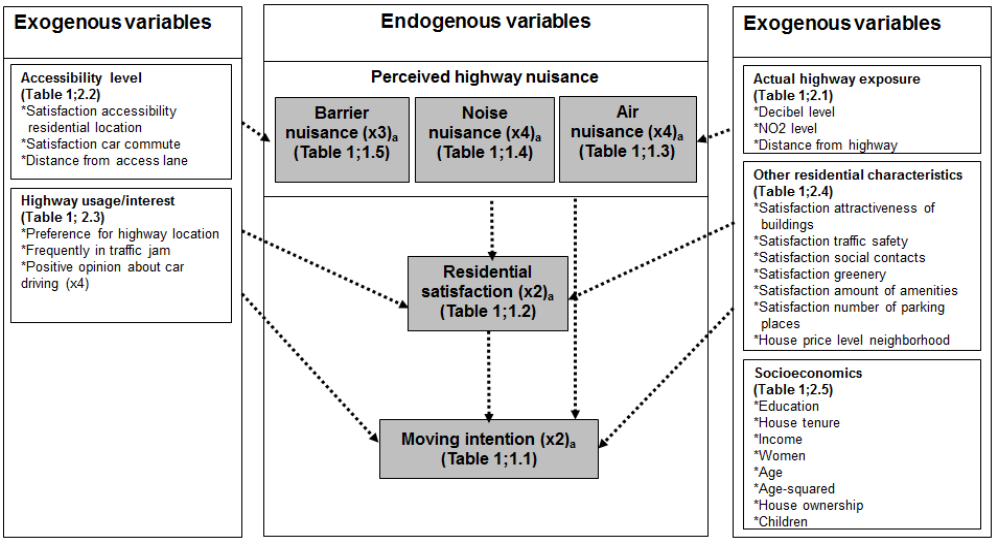
	*54.5-59.5 DB	10.3%		
	*59.5-64.5 DB	2.4%		
	*=>64.5 DB	1.1%		
NO_2 level derived from highway for each 6-digit postal code	*ug-m^3	2.9	2.1	
Distance from highway (metres)	*The actual distance between the residential location and the nearest highway	431.5	236.6	
2.2 Accessibility level				
Distance from access lane (metres)	*The actual distance between the residential location and the nearest highway access lane	1,059.2	977.8	
Satisfaction accessibility of the residential location	*I am satisfied with the accessibility of my residential location$_a$	6.3	1.0	
Satisfaction car commute$_b$	*I am satisfied with my home to work accessibility by car$_a$	5.7	1.7	
2.3 Highway usage/interest				
Preference to live near highway	*The highway was important in the location decision$_a$	2.6	1.8	
Frequently in traffic jam	*In traffic jams twice a week or more	6.1%		
Attitude car driving (4x)	*I think driving is enjoyable$_a$	5.3	1.7	0.83
	*I think driving is good$_a$	4.5	1.6	0.34
	*I think driving is pleasant$_a$	5.2	1.7	0.85
	*I think driving is positive$_a$	3.2	1.7	0.26
2.4 Other residential characteristics				
Average house price neighbourhood (euro's x1,000)	*Average residential property value in the neighbourhood(x1,000)	€255.5	105.7	
Satisfaction attractiveness of buildings	*The infrastructure in this neighbourhood is attractive$_a$	5.4	1.4	
Satisfaction traffic safety	*I live in a traffic-safe environment$_a$	5.2	1.4	
Satisfaction greenery	*I live in a green environment$_a$	5.6	1.4	
Satisfaction facilities	*There are enough facilities in the neighbourhood$_a$	5.5	1.4	
Satisfaction number of parking places	*There are enough parking places in the neighbourhood$_a$	5.4	1.7	
Satisfaction with social contacts	*We get along well with each other in this neighbourhood$_a$	5.4	1.2	
2.5 Socioeconomics				
Age$_c$	*Age of respondent	51.0	15.1	
Age-squared$_c$	*The age of respondent squared	2,813.9	1,607.6	
Gender: Female	*Respondent=woman	48.3%		
Children	*Household has children	36.3%		
High Education level	*Respondent has high education level	60.8%		
Income above EUR 2,000 (net)	*Respondent had income above EUR 2,000 per month	75.1%		
Owned house	*Homeowner	75.3%		
Duration of residence (years)	*Number of years of living in the house	12.7	10.6	
Total number of respondents (N=1,220)				

$_a$ 1 = totally disagree; 7 = totally agree.
$_b$ Only available for working respondents (n = 759).
$_c$ Mean centering was performed in the model estimation.
$_d$ pct = percent.
$_e$ St.dev. = Standard Deviation.

4.3.4 Descriptive statistics

Table 4.1 shows that moving intentions are in general moderate. On a Likert scale of 1 'totally do not want to move' to 7 'would like to move within 2 years', the average intention to move within two years is 2.6 (Table 4.1; 1.1). This means that approximately 20% of respondents intend to move within 2 years, which corresponds with the average Dutch household (e.g., Blijie et al., 2012). People

appear quite satisfied with living in the areas studied (an average of 5.9 and 5.7, respectively for house and neighbourhood on a scale of 1–7) (Table 4.1; 1.2). Annoyance regarding negative highway externalities is modest. Residents seem to be comparably annoyed by nuisance from noise and air pollution when inside their home (both scoring a mean of 2.1 on a Likert scale of 1 'I perceive no nuisance' to 7 'I perceive a lot of nuisance') (Table 4.1; 1.4 and 1.3). The number of reported health problems also appears low (on a scale of 1 'no health problems' to 7 'many health problems' 1.7 for noise and 2.1 for air pollution). In general, residents do not appear to perceive the highway as a barrier in the landscape (1.9 on average on a scale of 1 'no barrier' to 7 'barrier') and are indifferent about the integration of the highway into the landscape (an average of 4.3 on a scale of 1 'good integration' to 7 'bad integration') as well as its physical appearance (an average of 4.2 on a scale of 1 'highway is beautiful' to 7 'highway is ugly') (Table 4.1; 1.5).



aIn parenthesis we indicated the number of indicators used to measure the construct. The indicators can be found in Table 4.1.

Figure 4.2 Endogenous and exogenous variables in the model.

4.4 Results

4.4.1 Model fit

The estimated model shows a reasonable fit (Table 4.2). The Root Mean Squared Error of Approximation (RMSEA) has a value of 0.084. Values below 0.06 indicate

good fit, values over 0.10 are indicative of poor-fitting models (Browne & Cudeck, 1993). The Comparative Fit Index is 0.925, which is above 0.90, indicating a good fit (Hair et al., 2006). When excluding all insignificant variables and including some additional paths as were suggested by LISREL, the model's RMSEA improves to 0.07. The directions and significance of relationships are hardly affected by these actions and we therefore present the results of our full conceptual model. Below we describe significant effects with a confidence alpha-level of at least 0.05 ($p < 0.05$) and present standardized effects in Table 4.2.

4.4.2 Estimation results

Figure 4.3 visualises our main findings. Within the Figure the arrows represent significant direct relationships complemented with the direction of the relationship i.e. positive (light grey, +) or negative (dark grey,-). Furthermore, there is a distinction between thick and thin lines, the latter representing direct effects which are overruled by stronger indirect effects. The relationships are presented in an aggregated form given the large number of tested relationships. Relationships with perceived nuisance are not further specified into type of nuisance. Furthermore, socioeconomic controls are not visualised in the Figure to avoid complexity. Specific estimation results can be found in Table 4.2.

Highway locations and moving intentions

Our first aim was to study the impact on residential moving intentions of highway nuisances against accessibility gains alongside other residential variables, accounting for a potential mediating role for residential satisfaction. In line with other studies (e.g., Rossi, 1955; Speare, 1974; Wong, 2002), our results largely confirmed that residential satisfaction plays an important role in explaining moving intentions (Table 4.2; C.1.2). Most variables mainly influenced the intention to move indirectly through an effect on residential satisfaction. Nevertheless, some of the factors showed direct relationships with residential moving intentions.

With respect to highway nuisances, perceived noise, barrier-effect and air pollution nuisances were all associated negatively to residential satisfaction and as such indirectly increased the intention to move(Table 4.2; C.1.3-5). For people perceiving high air pollution nuisance, the indirect effect via residential satisfaction overruled a weaker direct negative effect on moving intentions, the latter indicating that the impact on moving intentions is somewhat lower as might be expected based on the impact on residential satisfaction. The influence of perceived noise and barrier-effect nuisance on residential moving intentions was entirely mediated

by residential satisfaction. Surprisingly people in high exposure areas do not intend to move more based on total moving intentions, despite a higher nuisance perception (Table 4.2; C.2.1). In other words, irrespective of nuisance perception people in higher exposure areas seem to move less, which 'neutralizes' the indirect effect via nuisance perception. Other reasons such as lower house prices may prevent people from moving elsewhere (e.g., Nijland et al., 2007).

The perceived accessibility of the residential location, of the car commute and the actual distance from the access lane show no direct or indirect association with the intention to move (Table 4.2; C.2.2). Also having a preference to live near a highway is not reflected in a lower intention to move, despite higher residential satisfaction. People less often stuck in traffic jams had higher satisfaction and lower moving intentions. A positive attitude towards car driving was however not found to be associated with moving intentions. Our finding that accessibility gains affected residential moving intentions only to a limited extent is in line with studies arguing that the impact of accessibility in location and relocation decisions decreased (e.g., Giuliano, 1989; Molin & Timmermans, 2002). Nevertheless, accessibility could still be important in the choice of a residential location (e.g., Tillema et al., 2012).

Additionally included residential characteristics showed strong relationships with residential satisfaction and indirectly influence moving intentions (Table 4.2; C.2.4). People who were satisfied with the attractiveness of buildings, with the level of social contacts and traffic safety had a higher residential satisfaction and indirectly lower moving intentions. As such these residential characteristics could (partly) balance the stress of highway annoyance. The indirect effects of building attractiveness and traffic safety are somewhat corrected in strength by a direct effect on moving intentions in the opposite direction. With respect to neighbourhood house prices, direct and indirect effects neutralized each other, leading to an insignificant overall effect. On the one hand, people in areas with higher house prices were less satisfied when living close to highways, causing an indirect positive effect on moving intentions. On the other hand, people in higher house price areas were generally less inclined to move despite lower satisfaction. Furthermore, satisfaction with greenery, facilities and the amount of parking space did not explain either residential satisfaction or moving intentions.

Finally, with respect to socioeconomic variables results indicated that older people were more satisfied with their residential area and less inclined to move. Moreover home owners were less inclined to move (direct effect), independently of their residential satisfaction (Table 4.2; C.2.5). These findings are in line with other studies (e.g., Lu, 1998; Speare, 1974) and could relate to higher perceived costs of

moving (e.g., Coulombel, 2010). Rather surprisingly, and in contrast to other studies (e.g., Lee et al., 1994; Lu, 1998), we found that people with longer duration of residence were less satisfied with their residential area and had higher moving intentions. Although this group may be highly willing to move or be highly skeptical about a highway, perceived moving costs could prevent this group from leaving (e.g., Coulombel, 2010). In addition, cognitive dissonance may play a role for those with short duration of residence. Residents with higher levels of education, lower incomes or with children were found to be less satisfied and consequently more likely to move. Finally women showed slightly lower satisfaction, but also lower moving intentions.

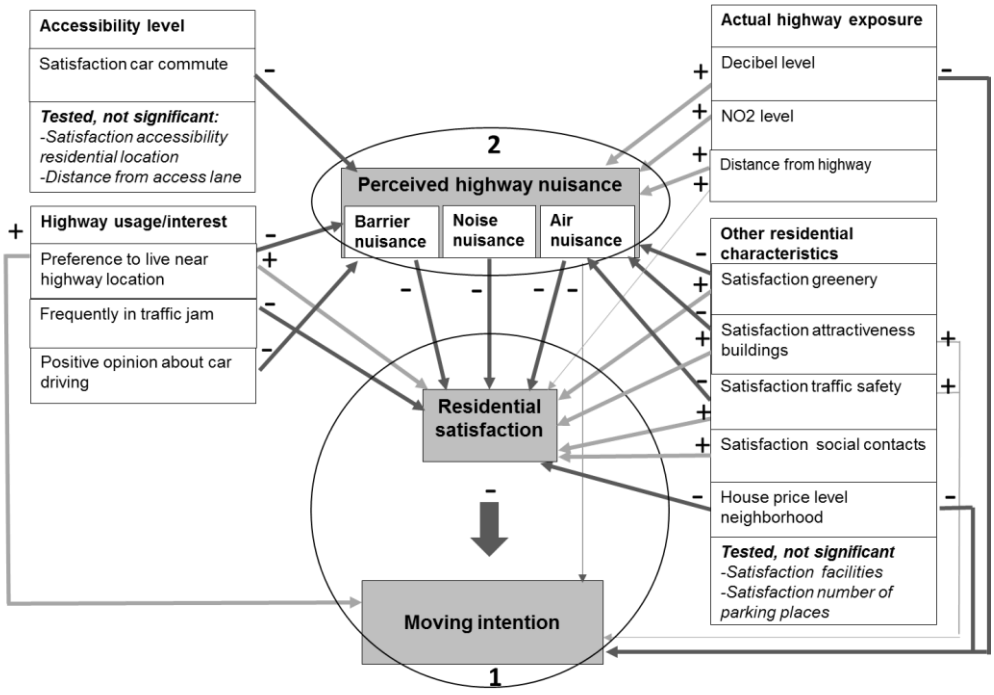


Figure 4.3 Final results model.

Table 4.2 Results Structural Equation Model.

	Endogenous variables								
	A			B			C		
	Perceived air nuisance	**Perceived noise nuisance**	**Perceived barrier nuisance**	**Residential Satisfaction**			**Moving intention**		
	Direct (St.B)$_a$	Direct (St.B)$_a$	Direct (St.B)$_a$	Direct (St.B)$_a$	Indirect (St.B)$_a$	Total (St.B)$_a$	Direct (St.B)$_a$	Indirect (St.B)$_a$	Total (St.B)$_a$
1 Endogenous variables									
1.1 Moving intention									
1.2 Residential Satisfaction	na	na	na	na	na		-1.192***$_c$		-1.192***
1.3 Perception Air nuisance	na	na	na	-0.151***	na	-0.151***	-0.103***	0.179***	0.076***
1.4 Perception Noise nuisance	na	na	na	-0.183***	na	-0.183***	-0.018	0.218***	0.200***
1.5 Perception Barrier effect nuisance	na	na	na	-0.099***	na	-0.099***	0.058	0.118***	0.176***
2 Exogenous variables									
2.1 Actual highway exposure									
Decibel level (DB)	0.260***	0.248***	0.249***	-0.016	-0.109***	-0.125***	-0.156***	0.132***	-0.024
NO2 level (ug-m^3)	0.194***	0.149***	0.088*	0.070**	-0.065***	0.005	0.025	-0.024	0.001
Distance from highway (metres)	0.076**	0.04	0.096**	0.004	-0.028**	-0.024	-0.080*	0.026	-0.054
2.2 Accessibility level									
Distance from access lane (metres)	0.01	-0.036	0.003	-0.002	0.005	0.003	-0.043	-0.003	-0.046
Satisfaction accessibility residential location	0.044	-0.02	0.013	0.033	-0.004	0.029	0.049	-0.038	0.011
Satisfaction car commute$_b$	-0.088**	-0.03	-0.059	-0.038	0.021*	-0.017	0.056	0.02	0.076*
2.3 Highway usage/interest									
Preference to live near highway	-0.045	-0.082**	-0.233***	0.085***	0.045***	0.130***	0.120***	-0.162***	-0.042
Frequently in traffic jam	0.045	0.052	-0.010***	-0.120***	-0.015	-0.135***	0.068	0.154***	0.222***
Attitude car driving	-0.172***	-0.107***	-0.230***	-0.025	0.068***	0.043*	0.019	-0.045	-0.026
2.4 Other residential characteristics									
Average house price neighbourhood (euro's x1,000)	0.102**	0.013	-0.037	-0.132***	-0.014	-0.146***	-0.100**	0.161***	0.061
Satisfaction attractiveness buildings	-0.162***	-0.210***	-0.199***	0.502***	0.082***	0.584***	0.427***	-0.687***	-0.260***
Satisfaction traffic safety	-0.078**	-0.062*	-0.045	0.128***	0.027***	0.155***	0.101***	-0.178***	-0.077**
Satisfaction greenery	-0.056*	0.035	-0.084**	-0.026	0.01	-0.016	-0.01	0.019	0.009
Satisfaction facilities	-0.040*	-0.057*	0.006	-0.001	0.016*	0.015	0.076**	-0.013	0.063*
Satisfaction number of parking places	0.038	0.033	-0.006	0.001	-0.011	-0.01	0.012	0.008	0.02
Satisfaction social contacts	0.024	0.047	0.095**	0.251***	-0.022**	0.229***	0.068	-0.271***	-0.203***

2.5 Socioeconomics									
Age	0.153***	0.167***	0.006	0.000	-0.054***	-0.054	-0.316***	0.046	-0.270***
Age-squared	-0.071**	-0.088***	-0.125***	-0.034	0.039***	0.005	0.046	-0.005	0.041
Gender: woman	0.047	0.003	0.134***	-0.033	-0.021**	-0.054*	-0.123***	0.067**	-0.056*
Higher education level	0.017	0.048	0.107**	-0.123***	-0.022**	-0.145***	-0.075**	0.176***	0.101***
Income above 2000eu	-0.080	0.134***	0.067	0.191***	0.03**	0.221***	0.083**	-0.249***	-0.166***
Household with children	0.092**	0.013	-0.133***	-0.120***	-0.003	-0.123***	-0.037	0.129**	0.092**
Owned house	-0.012	0.147***	0.139***	0.002	-0.039***	-0.037	-0.212***	0.051	-0.161***
Duration of residence (years)	0.084**	0.100**	-0.129***	-0.073**	-0.018**	-0.091***	0.093**	0.09**	0.183***
R^2	**0.295**	**0.255**	**0.358**		**0.759**			**0.783**	
Fit indices	**Chi-square**	**3945.01**	**RMSEA**	**0.084**	**CFI**	**0.921**			

* p < 0.1, ** p < 0.05, *** p < 0.001.

[a] Standardized Beta's.

[b] Based on separate model with only working respondents.

[c] The choice to test both direct and indirect effects resulted in some high standardized beta's as a consequence of multicollinearity. Robustness checks however showed results to be stable.

Perceived highway nuisances and countervailing effects

Our second aim was to study whether accessibility gains and other residential characteristics influence nuisance perception directly. With respect to explaining nuisance perception, the role of accessibility gains was limited. Although people who are more satisfied about the car commute showed slightly lower air nuisance perception, satisfaction with residential location accessibility and the actual distance to an access lane showed no direct relationship with eitherperceived noise, air pollution or barrier-effect nuisance (Table 4.2; A.2.2). Nevertheless, in line with other studies (e.g., Kroesen et al., 2010; Miedema & Vos, 1999), we did find that people who prefer living near a highway (proxy for highway usage) perceive less noise and barrier-effect nuisance (Table 4.2; A.2.3). In addition, the model shows that having a positive attitude towards car driving appeared to palliate awareness of all (noise, air and barrier-effect) nuisances. Finally, people who frequently encounter traffic jams did not differ from the ones less often encountering traffic jams with respect to nuisance perception.

Other included residential characteristics not only had countervailing effects by their association with moving intentions, but also showed direct associations with highway nuisance perception (Table 4.2; A.2.4). People who are more satisfied with the attractiveness of buildings in a neighbourhood appear to be less annoyed by the noise, air pollution and barrier-effects of a highway. Other characteristics only showed direct relationships with one of the perceived negative highway externalities. Annoyance regarding air quality was lower when people were more satisfied about traffic safety or when house prices were lower, whereas people who reported higher levels of social contacts in the neighbourhood were found to be more annoyed by barrier-effects. People who are satisfied with the amount of greenery in their surroundings perceived less barrier-effect annoyances and were moreover slightly less annoyed by air pollution. Nevertheless, in contrast to other studies (e.g., Gidlöf-Gunnarsson & Öhrström, 2007; Li et al., 2010), we found no direct relationship between perceived greenery and noise annoyance. A possible reason for this is presented by Joing and Kang (2010), who indicate that greenery is aesthetically appreciated but perceived as being less effective as a noise barrier. Satisfaction with facilities and the number of parking places in a neighbourhood had no impact on perceived highway nuisance.

Furthermore, direct relationships with nuisance perception were found for socioeconomic controls (Table 4.2; A.2.5) and actual highway exposure (Table 4.2; A.2.1). Older people perceived significantly more noise and air nuisance (with decreasing effect), which is in line with the study of Miedema and Vos (1999). Women, residents with higher levels of education and households without children perceived more barrier-effect nuisance. Lower incomes were more annoyed by

noise. Home owners perceived higher noise and barrier-effect annoyance, which may be due to concerns about the effect of nuisances on house prices (i.e., Miedema & Vos, 1999). Residents with longer duration of residence were more annoyed by noise and air pollution, but less annoyed by barrier-effects. Finally as could be expected, strong relationships were found between actual highway exposure (Decibel level and NO_2 level) and nuisance perception.

4.5 Conclusion

This paper investigated the moving intentions of residents living near highways from a broad perspective, accounting for both nuisances and potential accessibility gains. Structural Equation Modelling was used to test a theoretical model based on data collected by a questionnaire distributed at seven highway locations within the Netherlands. We aimed to study how highway nuisances are traded off against accessibility gains alongside other residential characteristics in residential moving intentions, in which we took account of a potential mediating role for residential satisfaction. We also tested for potential direct relationships of accessibility gains alongside other residential characteristics on perceived highway nuisance.

Our study showed that perceived highway nuisance has a strong influence on moving intentions through the mediating role of residential satisfaction. The role of accessibility gains appeared limited. Perceived accessibility did not influence moving intentions either directly or indirectly via satisfaction, nor did it directly associate with the level of perceived highway nuisance. People who specifically choose a highway location were found to be more residentially satisfied and slightly less annoyed by highway nuisance; however, this was not reflected in lower moving intentions. Other residential characteristics – satisfaction with the attractiveness of buildings, traffic safety and with social contacts – were found to reduce moving intentions (mainly via residential satisfaction) as well as to affect nuisance perception, seeming to at least partly countervail highway nuisances. Finally, although residential satisfaction plays an important mediating role, some direct relations with moving intentions were also found independently of satisfaction.

The results of our study have practical relevance. First, our results show that better (perceived) accessibility is not per definition associated with higher satisfaction levels and with lower moving intentions. Therefore, care should be taken in using accessibility-gains as an argument to highway infrastructure planning for the local community. Second, other residential characteristics, besides perceived accessibility, such as the perceived attractiveness of buildings and traffic safety in

a neighbourhood appeared important in reducing highway nuisance perception and compensating the effect of nuisance on moving intentions. While more research is needed to verify the causality of these relationships, these insights support a broader perspective on highway planning in which neighbourhood design aspects are explicitly taken in account alongside more general ways to reduce highway exposure. Third, our research revealed that specific residential groups perceive more stress from highway proximity than others and/or have lower moving intentions independent of residential satisfaction (such as differences based on highway interest, age or house type). Basing planning decisions mainly on actual highway exposure or actual moving data might be not most effective in addressing the issue of different stress perception amongst residential groups. Using also more specific information about the resident might be helpful.

Further research is needed to deepen our understanding of the residential context close to highways. Firstly, our study focused on moving intentions as an expression of emotional reactions to highway proximity. Longitudinal analysis of moving behaviour would enhance our understanding of how these emotional reactions are reflected in actual moving behaviour. Secondly, our study concluded that residential characteristics are important in explaining nuisance perception and residential moving. In contrary however, the importance of accessibility gains in reducing residential stress was found less straightforward. Additional research is necessary to verify the causality of and interrelations between these. The former by longitudinal studies and the latter by using qualitative research to better understand how these different residential preferences are (un)consciously traded off against each other. Thirdly, our results show that some residential groups, such as those living in higher noise exposure areas, have lower moving intentions despite stress (i.e., lower satisfaction or higher perceived nuisances). Greater insight into why certain groups live in an area despite residential stress would be helpful to get more insight in what consideration these groups have, to improve liveability and to know which people might need special attention. Fourthly, along with studying a ‘stable’ situation of living close to highways, additional research is needed to study residential reactions as a consequence of highway planning projects, in order to improve our understanding of how mitigation measures in plans could relieve residential reactions towards these plans and prevent protests (NIMBY-ism), undesired relocations and the time and cost overruns of projects.

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