De autoliefhebber die in de compacte stad plots een fanatiek fietser werd …

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Samenvatting

De autoliefhebber die in de compacte stad plots een fanatiek fietser werd

Ken je dat sprookje over de autoliefhebber die plots een fanatiek fietser werd. Inderdaad…die bestaat niet. Desondanks komt dit wensdenken in ons ruimtelijk mobiliteitsbeleid veel voor. Er gaat in Nederland veel aandacht uit naar de afstemming tussen mobiliteit en ruimte. Met concepten als de compacte stad en knooppuntontwikkeling wordt al decennialang gestuurd de ruimtelijke structuur van steden. Over de mate waarin en de wijze waarop de ruimtelijke context daadwerkelijk mobiliteitskeuzes beïnvloedt is nog veel discussie. Tot nu toe is veel bewijs op dit gebied gebaseerd op cross-sectie onderzoeken. Deze onderzoeken hebben veel inzicht opgeleverd over de rol van de ruimte maar vormen nog geen bewijs voor een oorzaak-gevolg relatie: leidt compacter bouwen nu daadwerkelijk tot duurzamer mobiliteitsgedrag?

Attitudes spelen hierbij een belangrijke rol. We mogen aannemen dat een autoliefhebber anders zal reageren dan een fietsliefhebber op een compactere stedelijke omgeving. Belangrijke vraag is hoe attitudes, de gebouwde omgeving en verplaatsingsgedrag na verloop van tijd op elkaar inwerken. Zal een autoliefhebber vaker gaan fietsen of blijft het een autoliefhebber met dito verplaatsingsgedag? En beïnvloedt de ruimtelijke context alleen het verplaatsingsgedrag of zal de omgeving na verloop van tijd ook de attitudes beïnvloeden? In dit paper worden deze relaties geanalyseerd door middel van een longitudinaal latente-klassemodel. Hierbij worden respondenten geclusterd op basis van hun attitudes en de afstand tot treinstations. Hierbij ontstaan subgroepen met een zekere (mis)match tussen hun attitudes en de afstand tot het treinstation. Vervolgens wordt gekeken in welke mate respondenten tussen 2005 en 2012 van klasse veranderen.

Resultaten wijzen erop dat mensen met positieve attitudes ten aanzien van fiets en openbaar vervoer verspreid zijn over verschillende afstanden tot het meest nabije treinstation. Opvallend hierbij is dat er geen clusters van mensen met positievere attitudes zijn in de directe nabijheid van treinstations. Subgroepen met positieve attitudes ten aanzien van openbaar vervoer en fiets wonen tot drie kilometer van de treinstations. Deze patronen blijven relatief stabiel in de tijd en respondenten in clusters met een grotere mismatch veranderen hun attitudes of hun omgeving niet vaker dan respondenten in andere clusters. Dit heeft belangrijke implicaties voor het huidige knooppuntenbeleid in Nederland. De te enge focus op knooppuntontwikkeling in de directe nabijheid van knooppunten lijkt niet nodig om duurzaam verplaatsingsgedrag te stimuleren. Het ontwikkelen van fietsvriendelijke omgevingen in een range van drie kilometers rondom het treinstation met goede connecties met de fiets en het openbaar vervoer kan net zo effectief zijn.

1. Introduction

Governments aim for more sustainable travel behaviour. One approach to this is to develop built environments that are conducive to the use of alternatives to the car (walking, cycling and public transport). In recent decades, policy measures such as densification and transit-oriented development have been applied for this purpose. While integrated spatial and transport planning is receiving increasing attention in policymaking, the causality and strength of the relationship between the built environment and travel behaviour remains subject to academic debate (see: Ewing and Cervero, 2010; Cao et al., 2009; Bohte et al., 2009).

To date, research on the nature and directions of causality has been hindered by the lack of longitudinal approaches and attitudinal data (Van de Coevering et al., 2016). Travel-related attitudes may affect travel behavior directly; a car lover drives a car more often, or indirectly, via residential choice. The later, the residential self-selection hypothesis, has become one of the prime topics in the discussion of causality. It assumes that people self-select in neighbourhoods that are conducive to the use of their preferred travel modes (Handy et al., 2005; Bohte et al., 2009). Due to the lack of longitudinal approaches, it remains unclear how travel-related attitudes, the built environment and travel behavior influence each other over time. Car lovers that move to a highly urbanized area may experience residential dissonance because their behavior is not aligned with the characteristics of their new environment. Will they keep driving as often, as before? Or will they adapt their attitudes and their behavior to align them to their new environment?

This article aims to enhance the understanding of the interaction between the built environment, travel-related attitudes and travel behaviour. We explore how the adjustment process differs across population groups, depending on people's residential dissonance and socio-demographic characteristics. We specify the following research question:

What consonant and dissonant subgroups can be identified based on travel-related attitudes and residential environment characteristics and how and to what extent do people in these subgroups adjust their travel-related attitudes and residential environments over time?

We answer this question by applying latent class transition modelling (LCTM) on a longitudinal dataset. Travel-mode attitudes (related to the use of cars, public transport and bicycles), the distance to the nearest railway station and travel behaviour indicators are included in the analysis. LCTM is a segmentation technique – related to cluster analysis – that inductively reveals patterns of residential dissonance between travel-related attitudes and the built environment. It may reveal, for example, classes of people with favourable and non-favourable attitudes towards public transport within transit-oriented developments.

The remainder of this article is organised as follows. The following section describes the theoretical background and current knowledge on the relationship between travel-related attitudes, the built environment and travel behaviour. The method section describes the data collection and model specification. The results section describes the findings of the analyses, and the final section presents the conclusions and a discussion, including policy recommendations.

2. Overview of current literature

At the start of the causality debate on the built environment and travel behaviour (BE-TB) link, most studies hypothesised a direct relationship between the two, more recently followed by studies that controlled for socio-demographics and attitudes. The direction of causality between attitudes the built environment and travel behaviour is subject to debate. In line with common theories about attitudes, such as the theory of planned behaviour (Ajzen, 1991), the residential self-selection hypothesis assumes that influences run from attitudes to behaviour, that is, attitudes causally precede and determine behaviour. This article focuses on attitude based residential self-selection; for example, someone who has a positive attitude towards car driving settles in a neighbourhood that is conducive to car use and consequently uses the car often. The other direction of causality represents the 'reverse causality' hypothesis and has received less attention. According to the theory of cognitive dissonance (Festinger, 1957) people may change their behaviour or their attitudes when they are dissonant. In case of residential dissonance, people may become more familiar with sustainable transportation modes over time and start to see them as good alternative travel options and consequently adjust their attitudes and travel behaviour to their environment (Chatman, 2009; Bohte et al., 2009).

The first studies incorporating travel-related attitudes appeared in the late 1990s. Since then, more studies assessing the residential self-selection hypothesis have appeared. The reverse causality hypothesis has received considerably less attention in studies on the BE-TB link. Overall, the literature supports the residential self-selection hypothesis, but the outcomes are mixed (Ewing and Cervero, 2010).
Many approaches have been applied to control for residential self-selection. Most evidence to date is based on cross-sectional research designs and most studies apply variable-centred models such as regression analyses and structural equations modelling (SEM) (see: Mokhtarian and Cao, 2008 for a review). Schwanen and Mokhtarian (2005) took another approach and introduced the concept of residential neighbourhood dissonance. They distinguished consonant and dissonant groups of urban/suburban residents and residents with a high/low preference for high-density living and compared their travel behaviour. They also incorporated measures of dissonance in their models. Similar approaches were adopted by Frank et al. (2007), De Vos et al. (2012) and Kamruzzaman et al. (2013).
A couple of studies have used longitudinal or quasi-longitudinal designs (Krizek 2003; Handy, Cao, and Mokhtarian, 2005; Cao, Mokhtarian, and Handy, 2007; Van de Coevering et al., 2016). To the best of our knowledge, only the study by Van de Coevering et al. (2016) incorporated attitudes at two separate moments in time. The other studies did not incorporate attitudes, or included attitudes at only one moment in time due to their retrospective design.

Another less popular approach is based on person-centred analyses, which identify key patterns of values across variables, where the person is the unit of analysis. These analyses – with cluster analysis as a typical example – result in the identification of a small set of segments from a sample by maximising homogeneity within these segments and heterogeneity between segments (Kroesen, 2014). In transportation studies, to the best of our knowledge, Anable (2005) was the first to use cluster analysis to define clusters based on attitudinal variables. The applications in studies on the interaction between land use and transportation are few (see Manaugh and El-Geneidy, 2015; Liao et al., 2015). This article contributes to the current knowledge by applying LCTM to a longitudinal dataset from the Netherlands.

3. Method

Sample

An internet questionnaire was conducted in three municipalities in the Netherlands in 2005 and 2012: Amersfoort, a medium-sized city; Veenendaal, a small town with good bicycle facilities; and Zeewolde, a remote town. It included questions about demographic, socioeconomic, attitudinal and travel-related characteristics. 1,788 individuals from 1,325 different households participated in both rounds. GIS software was used to obtain detailed data on land use, infrastructure and accessibility in both research years.
To avoid any problems with dependence of observations in the analysis, we randomly selected one of the partners from the 463 households in which both partners participated. Furthermore, a couple of cases were removed because their data was incomplete on important variables. As a result, 1,322 respondents were included in analyses for this article.

Variables

Table 1 provides an overview of the key variables and their descriptive statistics in the first (2005) and second waves (2012). Socio-demographics include gender, the age of the respondents, the number of children in the household and income level. Travel-related attitudes were determined using confirmatory factor analysis. Attitudes to car use, cycling and public transport use were measured by asking respondents to rate nine statements on a 5-point Likert scale, ranging from -2 'strongly disagree' to +2 'strongly agree'. These statements included affective (e.g. 'driving a car is pleasurable') as well as cognitive (e.g. 'bicycling is environmentally friendly') aspects.
The built environment was operationalised by measures of accessibility. Shortest routes between respondents' homes and the nearest railway station were calculated based on the network (source of road network: Dutch National Roads Database, NWB, 2013).
Travel behaviour was assessed by the question: 'How often do you use the car compared to other modes such as public transport, bicycling and walking?' Responses were provided on a 7-point Likert scale ranging from 1: '(Almost) never with the car and (almost) always with alternatives' to 7 '(Almost) always with the car and (almost) never with alternatives'.

TABLE 1 Key variables in 2005 and 2012 (N = 1322)

Variables	**Description**	**2005**	**2012**
		%/Mean (st.dev)	**%/Mean (st.dev)**

Socio-demographics			
Age	Average	50.4 (10.6)	57.4 (10.6)
Gender	% Female	42.7	42.7
	% Male	57.3	57.3
Children	Number of children in household	1.18	0.98
Net personal income (monthly)	% Low (< €1000)	19.0	12.2
	% Middle (> = €1000 - < €2000)	39.4	33.1
	% High (> €2000)	42.6	54.7
Travel-mode-related attitudes			
Car attitude		0.57 (0.35)	0.54 (0.35)
- Travelling by car is comfortable (loading = 0.69)		1.30	1.31
- Travelling by car is flexible (loading = 0.90)		1.35	1.36
- Travelling by car is fun (loading = 0.73)		0.89	0.94
- Travelling by car is private (loading = 0.89)		1.16	1.13
Public transport attitude		-0.85 (0.41)	-0.81 (0.42)
- Travelling by PT is comfortable (loading = 0.69)		-0.21	-0.10
- Travelling by PT is flexible (loading = 0.90)		-1.10	-0.91
- Travelling by PT is fun (loading = 0.73)		-0.27	-0.13
- Travelling by PT is private (loading = 0.89)		-1.04	-0.98
Bicycle attitude		0.29 (0.41)	0.28 (0.40)
- Travelling by bicycle is comfortable (loading = 0.69)		0.39	0.43
- Travelling by bicycle is flexible (loading = 0.90)		1.00	1.06
- Travelling by bicycle is fun (loading = 0.73)		1.21	1.16
- Travelling by bicycle is private (loading = 0.89)		0.63	0.62
Built environment variables			
Average distances	To neighbourhood shopping centre (m)	*1123 (778)*	*1161 (819)*
	To nearest railway station (m)	*6150 (5458)*	*5627 (5721)*
Travel behaviour variables			
Modal share	Frequency of car use compared to other modes	4.8 / (1.9)	4.7 (1.9)
Car availability	% always access to a car	73	73
Car ownership	# of cars in household	1.48 (0.64)	1.47 (0.66)
Company cars	# of company cars in household	0.24 (0.44)	0.20 (0.42)
Public transport card	% of public transport card owners	23.1	32.5

Model specification

The model specification is presented in Figure 1. They show that LCTMs consist of a measurement, a structural and a longitudinal part. The model clusters travel-mode attitudes and their interaction with the distance to the nearest railway station. It is specified by four indicators: three travel-mode-related attitudes, for car, public transport and the bicycle, respectively, and one built environment characteristic, the distance to the railway station. In the measurement part, latent profiles (a set of latent classes) are assumed to explain associations between these indicators (Vermunt and Magidson, 2013). The latent classes represent different combinations of travel-related attitudes and distances to the nearest railway station. The assumption here is that, due to the processes of residential self-selection and reverse causality, the majority of people will have travel-mode attitudes which are aligned to the characteristics of their residential environment. Thus, people living in areas in closer proximity to railway stations will have more positive attitudes to alternatives to the car (public transport and cycling), while people who have positive attitudes to the car would live further away.

In the structural part of the model, the transition probabilities are conditional on exogenous covariates to control for differences in socio-demographic characteristics. Socio-demographic characteristics in 2005 (t = 0) are assumed to influence membership of the profiles in 2005. For example, males may have a higher probability of being assigned to classes with stronger car attitudes. The following covariates are considered: gender, age, the number of children in the household and personal income. Travel behaviour variables are included as inactive covariates. This means that they do not actively contribute to the model, but their average values are included for the respective classes. This enables us to describe the travel behaviour of the different classes and to also profile them.

In the longitudinal part of the model, the same latent profiles are estimated for two separate moments in time (2005 and 2012), which results in an LCTM. Change is represented by transitions between latent classes over time. These transitions are based on a model that estimates the probability of class membership in 2012 (t = 1), conditional on class membership in 2005. They can be translated into a matrix of transition probabilities. In accordance with the theory of cognitive dissonance (Festinger, 1957), we expect that the influence of residential self-selection and reverse causality will depend on the level of initial dissonance in 2005. For example, it is expected that car lovers living in close proximity to the railway station have a higher probability of moving house and self-select to a more conducive neighbourhood than their counterparts who already live in a suburban area. The above-mentioned covariates (socio-demographics) are assumed to influence class membership in 2012. For example, older people may have a higher probability of transitioning to classes with more positive attitudes to public transport. In addition, changes in socio-demographics and two dummy variables indicating whether a person moved house or changed jobs, respectively, in between the two waves, are assumed to influence class membership in 2012.

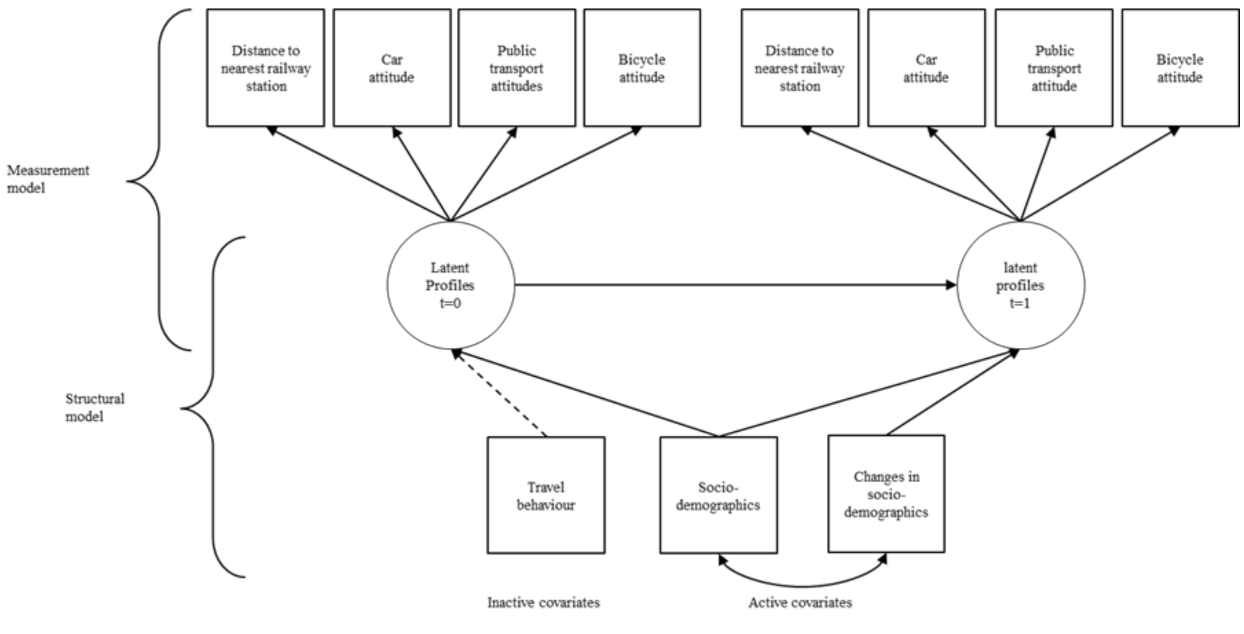

FIGURE 1 LCTM for travel-mode attitudes and distance to the railway station

Multiple measurement models with one to seven classes that only included the indicators were estimated and compared to determine the optimal number of latent classes. Their ability to account for the associations between the indicators and their BIC values were compared to determine the best model. The six class solutions showed the lowest BIC values and the chi-square of all bivariate residuals was below 3.84 for both models, indicating that there was no significant covariation between the indicators. These were selected and are described in the following section. The models in this study were estimated with Latent Gold 5.0 (Vermunt and Magidson, 2013), a dedicated software package for LCTMs.

4. Results

Table 2 presents the results of the measurement and structural part of the model. This includes the unconditional probability of belonging to a certain class and the conditional probability of having a certain response pattern dependent on class membership. In addition, it describes the influence of the covariates on these latent classes. For ease of interpretation, we translated these probabilities into the profile of class membership in 2005. Table 2 includes: (1) the class sizes based on unconditional class membership probabilities, (2) the Wald statistics and average values of the indicators and covariates conditional on class membership and (3) the inactive covariates and their average values.

Class size shows that people have a relatively high probability of being in the first class, while the remainder are distributed quite evenly over the other classes. The Wald indices reveal that all indicators have a significant influence on the latent class variable. Thus, the indicators significantly discriminate between the clusters. With regard to the active covariates, age, the presence children in the household and income have a significant influence on class membership in 2005. Gender is significant at the 10% level. Note that no coefficients were calculated for the inactive covariates since they are not part of the model. However, below they are used to characterise the classes.

TABLE 2 Profile of class membership in 2005: mode attitude and distance to railway station N = 1322

Indicators	**Class**	**1**	**2**	**3**	**4**	**5**	**6**	**Overall**
	Class size (%)	26	18	16	16	12	12	100
Distance to nearest train station ((Wald = 95, p < 0.01)	Avg. [meters]	2282	2253	13918	14045	3248	2629	6150
Car attitude (Wald = 188, p < 0.01)	Factor score	.40	.34	.43	.82	.87	.79	.57
Public transport attitude (Wald = 307, p < 0.01)	Factor score	-.87	-.34	-.70	-1.21	-1.22	-.92	-.85
Bicycle attitude (Wald=223, p < 0.01)	Factor score	.17	.44	.30	.24	-.01	.69	.29
Active covariates								
Age (Wald = 52, p < 0.01)	Avg. [years]	49	50	45	44	46	48	47
Children in household (Wald = 15, p < 0.01)	% hh with children	53	49	62	70	49	66	58
Gender (Wald = 10, p < 0.1)	% males	48	58	47	63	82	58	57

Income (Wald = 12, p < 0.05)								
% < avg. income (< €20,000 net personal income)		43	34	48	30	12	37	36
% avg. income -2x average income (€20,000-30,000)		37	42	34	44	53	3	41
% > 2 x avg. income (> 30,000)		20	24	18	26	36	23	24
Inactive covariates								
Car availability	% car always access to car	69	54	80	83	88	72	73
Car share	1 = never car, always alternatives, 7 = always car never alternatives	4.48	3.56	5.30	5.83	5.83	4.23	4.79
Public transport card	% of PT card owners	23	53	12	10	14	21	23
# cars per household	% 0 cars	2	9	0	0	0	1	2
	% 1 car	57	72	38	37	47	54	52
	% 2 cars	38	18	57	56	44	42	42
	% 3 + cars	4	1	4	6	10	3	4
Company cars	% hh with company car	23	11	25	31	31	23	23

The latent profiles uncover six classes at, on average, 2, 3 and 14 kilometres from the railway station. Differences in attitude profiles vary strongly between – and interestingly also within – these distance categories. Overall, the patterns of attitudes and distance to the railway station do not completely support our assumption that people living in closer proximity to the railway station have more favourable attitudes towards public transport and the bicycle. Two classes are aligned with this expectation and show consonant profiles:

- Class 2 (18%): people who live, on average, closest to the railway station and have favourable attitudes towards public transport and the bicycle and the least favourable attitude towards car use.
- Class 4 (16%): people who live furthest from the railway station and have more favourable car use attitudes and less favourable attitudes towards the bicycle and, in particular, public transport.

Other classes show less consonant patterns.

- Class 1 (26%): people in this largest class live close to the railway station but do not show favourable attitudes towards public transport, the bicycle or, interestingly, car use.
- Class 3 (16%): people live far from the station but their car attitude is below average and their public transport attitude above average.
- Class 5 (12%): people are clearly oriented towards car use and less towards the other modes, while the average distance from the railway station is not great.
- Class 6 (12%): people with favourable bicycle attitudes close to the railway station (in line with our assumption) but also favourable car attitudes and less favourable attitudes towards public transport.

Somewhat surprisingly, it can also be observed that there are no distinct classes with more favourable attitudes towards the bicycle or public transport in closer proximity to the railway station. Instead, these more favourable attitudes appear in classes 2 and 6 at approximately 2.5 kilometres from the station, on average. This suggests that people living in areas in closer proximity to stations do not have distinct attitude profiles and, consequently, there is no gradual relationship between this distance and attitudes.

The profile of the covariates shows that people in the second class are, on average, a little older and clearly have low car availability and car use and there is a high share of public transport card holders. This suggests that public transport is used in combination with the car to cope with the single car in many households. The first class contains more females than males and income levels are lower than average. The lack of sufficient financial resources may be a cause of the less favourable attitudes towards all transport modes. The fifth class has a very large share of males, a high income level and high car availability and use. This suggests that males are more car-oriented and, in combination with sufficient financial opportunities, use the car very often, even if they live relatively close to the railway station.

Table 3 presents the results of the longitudinal part of the model. The transition probabilities reveal how and to what extent people adjusted their residential environment and attitudes between 2005 and 2012. In addition the parameter estimates for the influence of the covariates on these probabilities are included. The greatest probabilities are on the diagonal, which means that people have the highest probability of remaining in the same class over time. Contrary to our expectations, people in more dissonant classes (1, 3 and 5) generally do not have a higher probability of switching to more consonant classes (2, 4 and 6).

People in the first two classes remained almost completely inert. For people in the second consonant class, this was more or less expected. However, for people in the first class, living in relatively close proximity to the railway station for seven years apparently did not result in more positive bicycle or public transport attitudes, nor did the dissonance increase the probability of moving house. As expected, the most important transitions indicate that the built environment and mode-related attitudes mutually influence each other over time and that the direction of influence differs across the classes. People in the sixth class showed the strongest tendency to move to the second class. This indicates that people's attitudes towards public transport use shifted upwards, which may be due to their relatively close proximity to the railway station. The transition of people from the fourth to the fifth class implies a move to a residential area closer to the railway station, without adjusting their car or public transport attitudes, which indicates self-selection to a more urban area that is still conducive to car use. Interestingly, attitudes to the bicycle became less favourable after the move. A similar unexpected negative influence of proximity on attitudes appeared in the transition from the third to the first class. This involved people who move from an area far from the railway station to a residential area in closer proximity, while their attitudes towards public transport and the bicycle become less favourable.

The parameters of the covariates show that, apart from job changes, all covariates significantly influence the transition probabilities. A higher income in 2005 increases the probability of being in the second or sixth classes in 2012, with favourable attitudes towards public transport and the bicycle, respectively. It also reduces the probability of being in the first class in 2012, with less favourable attitudes towards all modes. This is also the case for an increase in income between 2005 and 2012. Households with children find themselves more often in the first and third classes in 2012, with less favourable car attitudes, and less often in the sixth class, which has a more favourable attitude towards the car and the bicycle. People who moved house had a higher probability of living in closer proximity to the railway station. In other words, there was an overall tendency to move to areas in closer proximity to railway stations.

TABLE 3 Matrix of transition probabilities

State [t = 1](%)	**1**	**2**	**3**	**4**	**5**	**6**
State [t = 0] (%)(Wald = 43, P < 0.05)						
1	100	0	0	0	0	0
2	1	99	0	0	0	0
3	5	1	92	1	2	0
4	2	0	1	87	6	3
5	0	0	0	0	96	4
6	4	10	0	0	0	86
Age (Wald = 11, P < 0.05)	-0.07	0.09	0.08	-0.09	0.05	-0.05
Gender, ref. = female (Wald = 13, P < 0.05)	**3.74**	-1.94	-2.92	2.02	**-2.88**	1.98
Income (Wald = 12, P < 0.05)	**-1.58**	**1.23**	-0.58	-0.32	0.20	**1.04**
Children in hh, ref = no. (Wald = 16, P < 0.01)	**3.61**	-1.63	**4.66**	-2.46	0.74	**-4.91**
Arrival children (Wald = 11, P < 0.05)	**4.06**	-4.92	2.62	-2.47	0.39	0.32
Change in income (Wald = 12, P < 0.05)	**-1.72**	0.74	0.27	-0.23	0.37	0.57
House move (Wald = 15, P < 0.01)	**5.56**	0.17	**-6.77**	**-6.75**	2.62	**5.18**
Job change (Wald = 7, n.s.)	**2.03**	-0.82	1.69	-1.07	-1.97	0.13

*Estimates in bold are significant at p < 0.05.

5. Conclusions

To what extent are people's travel-related attitudes aligned with the characteristics of their residential built environment, and do people adjust one or the other over time to bring them more in line with each other? This article aimed to enhance our understanding of interactions between the characteristics of the residential built environment, travel-related attitudes and travel behaviour. We applied a LCTM on a two-wave longitudinal dataset from the Netherlands, and assessed the interaction between the distance to nearest the train station, travel-mode attitudes and travel behaviour.

Contrary to our expectations, we did not find clear-cut relationships between travel-mode attitudes and the distance to the train station. The latent profiles showed no overall tendency for people to live closer to a railway station if they liked public transport or cycling. Instead, people with supportive and non-supportive attitudes were distributed across the distance ranges, revealing consonant and dissonant population groups.

The latent class profiles remained relatively stable over time. Again, contrary to our expectations, people in more dissonant classes generally did not show a greater likelihood of switching to more consonant classes. One illustrative example, are people in a dissonant group (Class 1) who remain almost inert, despite living relatively close to the railway station and having less favourable attitudes towards all travel modes. As expected, the model reveals adjustment in people's attitudes as well as adjustments in the residential environment, which differ across population groups. This suggests that processes of residential self-selection and reverse causality both occur and depend on initial residential dissonance.

Furthermore, people's socio-demographics significantly influenced transition probabilities. One example is the role of income in the above-mentioned dissonant group (Class 1). People with lower incomes are overrepresented in this group and also had a higher probability of being in this group in 2012. This suggests that at least for a share of people in this group, their lower income reduced the opportunity to lower their dissonance by moving to a more conducive environment.

Before we turn to policy implications, some methodological remarks should be made. Despite the long time lapse of seven years, the number of changes in the dataset was limited. Although this is, in itself, an interesting research finding, it limits the data on the number of transitions over time and consequently the ability to reveal patterns of reverse causality and, especially, self-selection. Moreover, due to the long time lapse, unobserved events may have taken place that affect the 2012 values. Furthermore, more measurement points would enhance the ability to determine causal directions and the time that processes of residential self-selection and reverse causality take to fully materialise.

What do the findings of this study mean from a policy perspective? Densification of housing benefits people who have a positive public transport or bicycle attitude; however, it is not necessary to densify within close proximity to railway stations. Groups with significantly more favourable attitudes towards public transport and cycling and less towards car use are identified no closer than 2.5 kilometres, on average, from the railway station. The strong bicycle culture in the Netherlands probably allows for longer distances to the railway station. Developing bicycle-friendly neighbourhoods up to three kilometres from a railway station, and providing good connections by public transport and bicycle, is also effective and provides more opportunities for densification policies. Actively promoting such routes for cycling and/or public transport may encourage self-selection. A higher share of people with positive attitudes living within three kilometres of the station will increase the effectiveness of densification policies. However, how do we address the relatively large group of people with no positive attitudes towards travel modes within this zone? Apparently, they do not consider the use of any of these modes as comfortable, flexible or fun, which may be related to their lower income levels. This calls for the identification of the specific needs of this group and research into better ways to accommodate them in a sustainable manner, perhaps with new mobility concepts such as Mobility as a Service. However, it also makes sense to be realistic: a share of these households will not be sensitive to these policies, as they do not have positive attitudes towards sustainable travel modes. They could be encouraged to move to more remote areas, as their car use disturbs areas which have the potential to become more bicycle-friendly.

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