Chapter 2

The Relationship between Land Use and Travel Patterns: Variations by Household Type

Tim Schwanen, Martin Dijst and Frans M. Dieleman

Introduction

Transport researchers have traditionally considered the relationships between urban structure and travel patterns at the aggregate level. During the 1960s, they recognised, however, that for a better understanding of such relationships it is necessary to consider the travel behaviour of individuals (Chapin and Hightower, 1965). Since then numerous studies employing disaggregated data at the individual or household level have been undertaken in which the influence on travel behaviour of characteristics of the built environment is modelled alongside a range of other determinants, mostly socio-demographic variables, such as gender, employment status and income.

While most studies in this field have suggested that urban form affects individual travel patterns, a consensus seems to have developed that socio-demographics are more important for the explanation of travel behaviour (Stead, 2001). Because of this, and the fact that households with a given socio-demographic profile are not distributed uniformly across urban space, it has become standard practice to include socio-demographics as control variables in studies investigating the impact of urban form on travel behaviour. Although this approach is superior to not considering socio-demographic variables at all, we believe that the empirical analysis of the impact of urban form on travel patterns can be taken one step further by taking account of the interactions of urban form and socio-demographic characteristics. This is partly because constraints imposed by the physical environment can be compensated for, or reinforced by, personal conditions. For instance, individuals with limited time budgets who lack access to a car are at least in theory more dependent on their direct residential environment than those with more time or access to a car.

Few empirical studies have investigated the extent to which the impact of urban form on individual travel patterns varies across household types. Exceptions include the work of Herz (1982) and Snellen (2001), who have shown that built environment characteristics are not equally important for different population sectors. The same conclusion can be drawn from studies in the domains of gender, racial and

ethnic differences in commuting patterns (McLafferty and Preston, 1997; Wyly, 1998) and space-time accessibility modelling (Dijst *et al.*, 2002; Kwan, 2000). While providing valuable insights, the empirical evidence in these studies is either restricted to specific dimensions of travel behaviour (McLafferty and Preston, 1997; Wyly, 1998), is based on empirical data from only one or a limited number of urban areas (Dijst *et al.*, 2002; Kwan, 2000; Snellen, 2001), or is rather dated (Herz, 1982).

In this chapter we therefore address the following question: Does the direction and/or magnitude of the influence of urban form on travel vary across *different* household types? If the answer is 'yes', we can suggest the existence of interaction effects in the impact of urban form. If, on the other hand, the analysis shows no differences in the impact of urban form, this suggests that household types display similar responses to urban form, irrespective of their personal situation. In particular, we investigate differences in the effect of urban form, or residential context, on trip frequency and travel time across six household types: single workers, two- and one-worker couples, two- and one-worker families and senior households. The analysis of travel time is segmented by trip purpose: we differentiate between commuting times, 'maintenance' times (e.g. trips running household errands, moving goods, shopping, giving lifts to people etc.) and leisure travel times, for several reasons. First, this broader perspective permits us to obtain better insights into the impact of urban form on travel patterns than a focus on commuting alone. Second, the number of both maintenance and leisure trips is larger than that of commuting trips in the Netherlands (Schwanen *et al.*, 2001a). The data used for this analysis is derived from a nationally representative sample of the Dutch population, and stems from the 2001 Netherlands National Travel Survey.

The remainder of this chapter starts with the hypotheses underlying the empirical analysis. This is followed by two sections presenting the operationalisation of concepts and the data respectively. We then turn to a description of the distribution of household types and residential contexts, followed by the results for trip frequency and travel time. The chapter ends with a summary and discussion of the results.

Study Background and Hypotheses

The starting point for this study is that a household's longer-term residential location choice is not only related to considerations about the quality of the neighbourhood and social status of the community, but also about activities outside the home and travel. This idea has long been articulated in urban geography and urban economics literature. For instance, the household trade-off between dwelling space and commuting costs lies at the very heart of the monocentric model (Alonso, 1964), and remains important in its contemporary modifications (Clark, 2000). In addition, empirical research about residential location decision making commonly conceptualises residential location choice as a trade-off of housing characteristics, neighbourhood characteristics and accessibility considerations (Van de Vijvere *et al.*, 1998; Weisbrod *et al.*, 1980). This implies that households, *ceteris paribus*, choose a location that maximises access to relevant spatial opportunities. Various studies have produced evidence of such access maximising behaviour, see for example Bhat and

Guo (2004) for the case of shopping opportunities. Because residential preferences vary across household types (Clark and Dieleman 1996; Champion, 2001), we may expect the relative importance of specific accessibility considerations to differ by households type. Access to high-quality primary schools will be most relevant to households with young children. In contrast, small households, and especially one-person households, are attracted to city neighbourhoods, because these are close to urban leisure facilities such as cinemas and restaurants, where they can meet and interact with friends and other people (Brun and Fagnani, 1994).

Such differences in accessibility considerations may not only result in an uneven distribution of household types within urban areas, they may also affect the travel patterns of individuals belonging to the same household type, but residing in different parts of those areas, and hence to differences in the impact of urban form across household types. For example, a worker without a partner living in a suburban, lower-density environment may visit urban facilities, such as cinemas or theatres and restaurants, less frequently than a counterpart living in an urban neighbourhood. This expectation is based on prior empirical studies, which have shown accessibility to a given set of opportunities to be positively correlated with trip frequency (see Handy, 1996 and Meurs and Haaijer, 2001 for shopping travel and Schwanen and Mokhtarian, 2003 for trips for dining and other leisure purposes). Empirical evidence is equivocal, however, because various authors have found (virtually) no effects of built environment characteristics on trip frequency (Hanson and Schwab, 1987; Sun *et al.*, 1998). None of these studies has, however, considered differences in the impact of built environment factors on trip frequency *across* households types.

The amount of effort required to access destinations (travel distance or time) may also vary across households of the same type in different residential settings. Given that the suburban one-person households in the previous example have chosen to visit urban leisure facilities, they have to travel longer and may select a different transport mode than urban residents. Numerous studies have shown that travel distance tends to be higher among suburban residents (see Dieleman *et al.* 2002 for a review). For travel time, this relationship is less clear-cut because lower travel speeds, which are a result of the wider use of public transport, and more walking and cycling, combined with congestion and parking problems, may offset the impact of shorter distances in cities (Levinson and Kumar, 1997). Nevertheless, we *a priori* expect one-person households living in the suburbs to spend more time on travelling to leisure facilities than their urban counterparts.

Although we have so far concentrated the discussion on one-person households, we can formulate hypotheses for several household types. For two-worker couples we expect largely similar results as for one-person households, because these are also known for their above-average preference for urban living (Brun and Fagnani, 1994). Travel times are thus hypothesised to be lower, and trip frequency higher, in large cities than in suburban or low-density areas. At the other end of the continuum we find household types with a strong preference for suburban or low-density living; these are households with young children. For them, we expect inverse relationships: travel times will be shorter, and trip frequencies higher in low-density or suburban settings.

Research Design

Household Types

To classify households we have chosen a series of criteria associated with households' time budgets: the number of adults in the households; the number of employed adults; and the presence of children younger than twelve. The following household types have been defined:

- Single worker: an adult aged 30 or over living without a partner who is formally employed; he/she does not live with any children.
- Two-worker couple: a household consisting of two partners without any children or other dependants living with them; both partners are aged 30 or over and are formally employed.
- One-worker couple: a household consisting of two partners without any children or other dependants living with them; both partners are aged 30 or over but only one is formally employed.
- Two-worker family: a household consisting of two partners with at least one child younger than twelve living with them; both partners are aged 30 or over and are formally employed.
- One-worker family: a household consisting of two partners with at least one child younger than twelve living with them; both partners are aged 30 or over but only one is formally employed.
- Retired household: a single adult aged 55 or over and retired from the labour force, or two adults each aged 55 or over and no longer formally employed.

While time availability is the overriding motivation behind the classification, we also concentrate on these groups because they will remain or become important in the future. At least in the Netherlands, the trends of the ageing of the population, the decrease of the average household size, and the rise in the number of people who combine paid employment with household maintenance will continue during the coming decades. The minimum age of 30 years is used because younger individuals and households are often still 'settling down': they frequently hold temporary jobs and/or have not yet made stable commitments regarding co-habitation or marriage. This is exemplified, for instance, by the fact that starters in the housing market are responsible for a large share of all residential moves; the propensity to relocate declines rapidly after the age of 35 (Clark and Dieleman, 1996).

Residential Setting

Urban form or residential context is operationalised in this study through a categorisation of municipalities in the Netherlands. It combines several interdependent dimensions related to the spatial configuration of land uses and infrastructure, thus capturing possible synergies among the following factors: density; land-use mix; distance to the urban centre; the mono/polycentric

orientation of an urban area; and city size. The classification is based on two criteria: the location of a municipality within or outside the Randstad (the economic and cultural heartland of the Netherlands located in the western, heavily urbanised part of the Netherlands); and its level of urbanisation. Within the Randstad we distinguish the *three major cities* (Amsterdam, Rotterdam, The Hague), the *medium-sized cities*, and *suburbs*. A fourth category is the *growth centres*. These are the Dutch equivalent of the English New Towns. These new communities were expressly designed in the 1970s and 1980s to attract suburbanising households and firms. Outside the Randstad, municipalities are split into *more urbanised* and *less urbanised.*

Data

The data employed for this study stems from the 2001 Netherlands National Travel Study (NTS). Implemented in 1978, this is a continuous survey into the travel behaviour of Dutch households. Since 1995, data has been available for 70,000 households, or 130,000 persons, annually. Every month a random sample of households living independently (that is, excluding nursing homes, children's homes, etc.) is drawn from the Municipal Basic Administration (GBA in Dutch). All members of a selected household over the age of six are requested to complete a travel diary for a single day, in which they have to report the purpose, transport mode, distance, starting and ending time, and origin and destination location of all their trips. Households are allocated a specific day to ensure that all days of the week and months of the year are represented in the final data set. In addition to the travel diary, respondents are asked to fill out several surveys, including one on socio-demographic variables, one on trips undertaken by public transport and one on trips undertaken by children below the age of six (Statistics Netherlands, 2002).

From the 2001 data we have only selected individuals who belong to one of the six household types introduced previously and whose daily travel and activity pattern starts and ends at their home location. Further, only data of male and female heads of households are used; grown-up children are excluded from the analysis to enable sound comparisons between households in different residential settings. Moreover, for each of the dependent variables, travellers with the 0.5 per cent highest values were excluded from the empirical analysis to reduce the influence of out-liers on the final results. The value of 0.5 per cent was arbitrarily chosen. It can be considered a compromise of minimising the impact of extreme values and including as many individual cases as possible in the analysis (to prevent any selectivity bias in the outcomes).

The data collected from the travel diaries has been used to construct the following dependent variables for each individual:

- Total daily number of trips;
- Daily number of non-work trips, excluding the mandatory trip purposes of commuting, work-related and education;
- Daily travel time for commuting trips;

- Daily travel time for maintenance trips, i.e. trips for shopping, giving lifts to passengers, moving goods and doing personal business; and
- Daily travel time for leisure trips, i.e. trips for social visits, sports or hobbies, entertainment or recreation.

Spatial Distribution of Household Types

As an introduction to the analysis of travel behaviour, we start with a brief overview of the distribution of the household types over the six types of municipalities (Table 2.1). In line with our expectations, single workers exhibit the strongest orientation towards city living. Comparing across household types, we find that they form the highest shares in the large and medium-sized cities within the Randstad and the more urbanised municipalities outside the Randstad. At the other end of the spectrum, the family households are the most suburban and rural oriented. This is even more so for one-worker than two-worker families. These results are also consistent with the existing literature on residential location choice (Brun and Fagnani, 1994; Champion, 2001). The two- and one-worker couples and retired households occupy the middle ground between these extremes. Two-worker couples are more concentrated in the Randstad than one-worker couples and households consisting of seniors.

Table 2.1 Distribution of household types across residential settings (per cent)

	Single worker	Two-worker couple	One-worker couple	Two-worker family	One-worker family	Retired household
R[a] 3 big cities	22.2	10.7	9.6	8.5	5.6	11.3
R medium-sized cities	11.3	8.1	7.0	8.4	5.9	7.8
R suburbs	14.7	20.2	19.6	20.0	22.0	18.6
R growth centers	5.4	7.1	5.6	7.8	6.5	4.9
Rest NL more urbanised	31.4	28.9	30.7	27.5	28.2	31.1
Rest NL less urbanised	14.9	25.0	27.5	27.8	31.7	26.4

[a] Randstad
NL = Netherlands

Trip Frequency

Having established that differences exist in the distribution of household types across residential settings, we now proceed with analysing the extent to which the relationship between trip frequency and residential setting varies among household types. Table 2.2 summarises the results for the daily number of trips per person. For the two family groups and the retired, the average daily trip frequency varies

Table 2.2 Daily number of trips per person, by household type and residential context

	Single worker		Two-worker couple		One-worker couple		Two-worker family		One-worker family		Retired household	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R three big cities	3.42	2.05	3.13	2.04	3.02	2.26	3.68	2.28	3.55	2.61	2.15	2.10
R medium cities	3.45	2.04	3.17	2.10	3.01	2.29	3.89	2.47	3.32	2.48	2.29	2.19
R suburbs	3.49	2.31	3.09	2.06	3.10	2.39	3.80	2.47	3.86	2.66	2.39	2.24
R growth centres	3.27	1.96	3.04	2.09	2.86	1.99	3.79	2.52	3.82	2.77	2.18	2.06
Rest NL more urbanised	3.56	2.20	3.29	2.24	2.87	2.22	3.92	2.50	3.77	2.67	2.24	2.18
Rest NL less urbanised	3.36	2.31	3.17	2.17	2.90	2.23	3.71	2.51	3.67	2.63	2.18	2.15
ANOVA (*F*-ratio)	1.4		2.1		2.1		2.3[a]		3.5[b]		5.4[b]	

[a] Statistically significant at $\alpha = 0.05$
[b] Statistically significant at $\alpha = 0.01$

statistically significantly among residential settings, although these variations do not show a particular character (Table 2.2). While this might suggest that built-environment characteristics are not true determinants of trip frequency, it may also imply that the relationships between urban form and trip frequency are not as straightforward as hypothesised. Ranking residential settings from high to low in terms of the total number of trips per person, per day, for the one- and two-worker families and elderly, we notice considerable differences across household types. A common finding is that the three big cities have low scores for these household types. This does not mean that living in a city is always associated with a lower trip frequency for these households; the mean is high for the medium-sized cities in the western part of the country and the more urbanised municipalities outside the Randstad (with the exception of one-worker families in the medium-sized cities).

For three of the population sectors (the single workers and the one- and two-worker couples) ANOVAs (Analysis of Variance between groups) indicate that the differences between residential settings in the daily trip frequency are not statistically significant (at the 5 per cent level). Post-hoc Bonferroni tests indicate that none of the pair-wise differences between residential settings are statistically significant for these households.

To gain further insights into the relationship between trip-making propensity and residential setting, we have also analysed the number of non-work trips (that is, excluding the mandatory trip purposes of commuting, work-related and education) per residential setting for each of the six population sectors (Table 2.3). By leaving out the activity types which are least flexible in space and time, we may be better able to capture any influence of urban form on trip frequency. Only for the one-worker couples and retired households do we find statistically significant variations across residential contexts. Because these household types appear to be least affected by time pressure, the number of trips by individuals in these groups may be more sensitive to differences in urban context. In particular, a suburban environment in the Randstad appears to stimulate the trip-making propensity for non-work purposes for these groups. On the other hand, the average frequency is rather low in the growth centres and the more and least urbanised municipalities outside the Randstad. The number of non-work trips is also low among elderly households in the three big cities. An explanation for this last result might be that car availability and ownership tend to be lower in urban areas. Elsewhere, we have argued that car ownership is an important condition for remaining mobile among older seniors (Schwanen *et al.*, 2001b). Perhaps the lower car ownership rate among elderly people in the large cities means they make few non-work trips. In short, while we do find statistically significant differences in the number of non-work trips by residential context for some household types, the results do not support our hypotheses that trip frequency varies statistically significantly between urban and suburban environments, and that the direction of this difference depends on household type.

Table 2.3 Daily number of non-work trips[a] per person, by household type and residential context

	Single worker		Two-worker couple		One-worker couple		Two-worker family		One-worker family		Retired household	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R three big cities	2.12	2.08	1.76	2.05	2.29	2.32	2.64	2.43	2.63	2.72	2.11	2.08
R medium cities	2.05	2.04	1.83	2.03	2.30	2.31	2.78	2.51	2.60	2.55	2.24	2.16
R suburbs	2.06	2.34	1.81	2.09	2.36	2.40	2.64	2.55	2.95	2.84	2.30	2.20
R growth centres	1.83	2.04	1.80	2.04	2.18	2.04	2.69	2.61	2.95	2.95	2.12	2.04
Rest NL more urbanised	2.15	2.20	1.93	2.15	2.10	2.16	2.76	2.58	2.92	2.79	2.17	2.15
Rest NL less urbanised	1.89	2.15	1.86	2.12	2.08	2.19	2.62	2.56	2.81	2.74	2.12	2.12
ANOVA (*F*-ratio)	2.0		1.1		3.5[b]		1.0		2.0		5.0[b]	

[a] Non-work trips include all trip purposes except commuting, work-related and education
[b] Statistically significant at $\alpha = 0.01$

Travel Time

For each of the trip purposes considered (commuting, maintenance and leisure), we start by comparing mean travel times and testing whether observed differences are statistically significant. Because variations around the average values are generally large, we also pay detailed attention to the travel time distributions through the estimation of 'survival' functions: a technique specifically developed for the exploratory analysis of duration processes and adopted quite frequently in travel demand analysis (Bhat, 2000).

A survival function gives the proportion of individuals spending an equal amount (or more) time on travelling, than a specified time (t). It can be used to calculate the cumulative probability of surviving beyond the j^{th} time, t: where n_j is the number of individuals still travelling at time t_j, and q_j is the total number of travellers who end travelling at t_j.

$$\hat{S}(t_k) = \prod_{j=1}^{k} \frac{n_j - q_j}{n_j}$$

Graphically, a survival curve appears as a step with a drop at each discrete time (t_j) a person stops travelling. Because individuals filling out a travel diary tend to round off travel times to five- or even ten-minute intervals, we have grouped travel times in five-minute intervals: $t_1 = 2.5$, $t_2 = 7.5$, $t_3 = 12.5$ and so on. Beyond a certain t_j, observations are grouped together in a single class, because otherwise their number becomes too low for reliable analysis. These cut-off points have been set arbitrarily at 147.5 minutes for commuting; 117.5 for maintenance; and 197.5 for leisure. For each of the three trip purposes, and all household types, we have calculated cumulative survival probabilities for travellers in all residential settings, and tested whether the pair-wise differences between each combination of two residential settings are statistically significant (using Wilcoxon tests).

Commuting

Comparing average commuting times per residential setting, we find statistically significant differences *within* all five population sectors examined (Table 2.4). (retired households are left out of this analysis). Differences *across* the five sectors seem to be minor. However, the lowest average travel times can consistently be found in the more and less urbanised municipalities outside the Randstad, whereas the highest value is always associated with the growth centres in the Randstad. Moreover, for all household types, the differences between the residential settings with the highest and lowest mean are large. Dividing the highest by the lowest average, for each household category, yields ratios in the range 1.27-1.37, which indicates that the maximum difference in average commuting times between residential sectors within a household type is between 27 and 37 per cent. When we repeat this calculation, but compare household types within a single residential

Table 2.4 Daily commuting time per person, by household type and residential context[a]

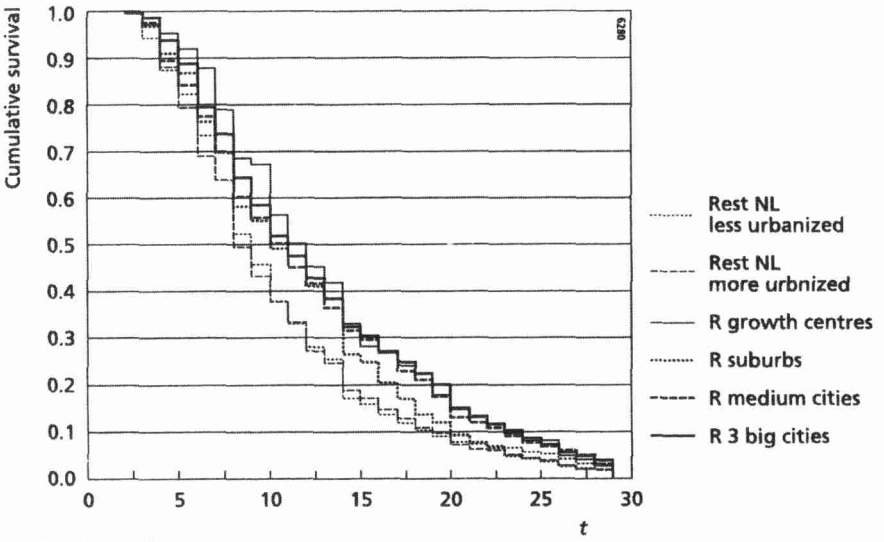
	Single worker		Two-worker couple		One-worker couple		Two-worker family		One-worker family	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R three big cities	54.1	35.7	50.6	32.0	52.0	32.9	50.6	32.4	53.5	32.7
R medium cities	52.0	36.4	57.1	37.3	55.2	37.5	49.6	37.1	52.2	36.3
R suburbs	48.3	31.0	53.7	36.3	50.4	33.2	45.3	32.8	50.1	34.4
R growth centres	55.5	33.8	59.1	36.4	59.6	40.6	53.5	37.0	58.9	35.9
Rest NL more urbanised	42.0	30.8	44.2	31.5	43.7	29.1	39.5	29.0	46.2	31.3
Rest NL less urbanised	43.0	31.8	44.2	30.3	46.2	31.7	42.0	30.9	43.3	30.0
ANOVA (*F*-ratio)	13.1[b]		21.8[b]		6.8[b]		15.3[b]		8.2[b]	

[a] Only travellers making at least one commuting trip are considered
[b] Statistically significant at $\alpha = 0.01$

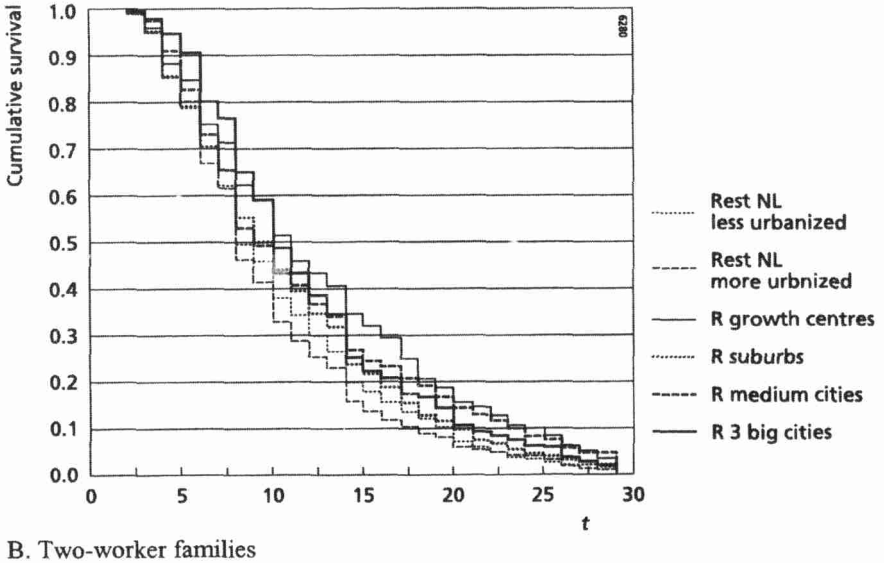
setting, we find ratios in the range of 1.07-1.18. This suggests that differences in average commuting time between residential settings are larger than those between population sectors.

To gain further insights in the differences between and within household types we have estimated cumulative survival functions. Figure 2.1 depicts survival curves for single workers (A) and two-worker families (B). Regarding the former category, Figure 2.1 shows that until t_{13} (62.5 minutes) the curves of the growth centres, and to a lesser degree the three big cities in the Randstad, clearly lie above the other lines. This means that single workers commuting up to 62.5 minutes per day are under-represented in these residential settings. Further, we notice that between t_7 and t_{20} (or 32.5 and 97.5 minutes) the curves for the more and less urbanised municipalities outside the Randstad clearly lie below those for the Randstad areas. These results suggest that single workers outside the Randstad tend to commute less than their counterparts in the Western Netherlands. The fact that the curve for the Randstad suburbs drops below those for the growth centres and big and medium-sized cities in the Randstad in Figure 2.1 (A) indicates that differences exist between residential settings within this part of the Netherlands. Reasons for the relative absence of long commutes in the suburbs appear to be the lower inclination to travel by public transport in general, and by train in particular, as well as the less severe parking problems and congestion on the local road network (Dieleman *et al.*, 2002; Schwanen *et al.*, 2002).

The graph for the two-worker families, Figure 2.1 (B) differs in various respects from that for the single workers. First of all, the lines tend to decline more steeply in the range between t_{10} and t_{20}, indicating that fewer members of two-worker families commute between 47.5 and 97.5 minutes per day (the averages in Table 2.4 are also consistent with this conclusion). This finding should not be surprising given that women in two-worker families tend to have shorter commutes than single females, because the former often have to combine commuting, frequently to a part-time job, with household and childcare duties (Turner and Niemeier, 1997). Second, the variation between residential settings is larger for two-worker families than for single workers. Third, patterns of over- and under-representation of commuting durations per residential setting differ markedly between the two population sectors. From t_6 (22.5 minutes) onwards the curve for the Randstad suburbs lies below the others; the same is true for the line for the less urbanised municipalities outside the Randstad beyond t_8 (32.5 minutes). Because these two area types are characterised by the lowest residential densities, we may conclude that the inverse relationship between density and car commuting time found to be valid for the general population of commuters (Schwanen *et al.*, 2003) seems transferable to the commuting times of the subgroup of two-worker households. In contrast, cumulative survival probabilities are high until t_{10} for the three big cities, which means that individuals from two-worker families residing there tend to have longer commutes. The cumulative survival plots further reveal that the conditional probability of staying in the commuter group is rather high for workers from the growth centres and medium-sized cities in the Randstad beyond t_{10} and t_{14}, respectively. In other words, there is an over-representation of persons from two-worker families commuting extensively in these two municipalities (see also Table 2.4).



A. Single workers



B. Two-worker families

Figure 2.1 Survival curves for daily commute time per person, by residential context

Table 2.5 Results of Wilcoxon tests on pair-wise differences in the distribution of daily commuting time per person between residential contexts, by household type[a]

		Single worker					Two-worker couple					One-worker couple					Two-worker family					One-worker family				
		2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
1	R three big cities				••	••			••	••	••				••	••		••		••	••				••	••
2	R medium cities	--			••	••	--			••	••	--			••	••	--			••	••	--				••
3	R suburbs	--	--	•	••	••	--	--	••	••	••	--	--		••		--	--	••	••	••	--	--	••		••
4	R growth centres	--	--	--	••	••	--	--	--	••	••	--	--	--	••	••	--	--	--	••	••	--	--	--	••	••
5	Rest NL more urbanised	--	--	--	--		--	--	--	--		--	--	--	--		--	--	--	--		--	--	--	--	
6	Rest NL less urbanised	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[a] Only travellers making at least one commuting trip are considered

• Statistically significant at $\alpha = 0.05$

•• Statistically significant at $\alpha = 0.01$

Table 2.6 Daily travel time for maintenance trips per person, by household type and residential context[a]

	Single worker		Two-worker couple		One-worker couple		Two-worker family		One-worker family		Retired household	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R three big cities	32.2	27.8	35.6	27.9	38.6	29.5	36.4	26.4	38.5	26.8	37.8	27.7
R medium cities	31.4	26.0	31.0	25.4	31.0	25.1	34.8	26.8	35.0	28.2	35.3	25.2
R suburbs	29.7	25.0	32.4	27.3	33.4	26.7	33.6	26.0	35.2	26.4	32.7	26.0
R growth centres	33.4	30.8	35.6	29.0	40.5	30.4	34.4	26.7	36.5	23.8	34.1	25.8
Rest NL more urbanised	27.8	23.6	30.2	23.5	31.2	24.5	33.5	25.5	35.1	26.0	33.4	25.3
Rest NL less urbanised	26.2	22.5	32.9	27.3	32.2	26.3	29.7	24.2	32.8	25.5	31.5	25.1
ANOVA (*F*-ratio)	3.0[b]		2.6[b]		5.9[c]		5.9[c]		2.3[b]		10.7[c]	

[a] Only travellers making at least one maintenance trip are considered
[b] statistically significant at $\alpha = 0.05$
[c] statistically significant at $\alpha = 0.01$

With Wilcoxon tests we have tested whether the pair-wise differences in the distributions of daily commuting times are statistically significant (Table 2.5). The results clearly illustrate that the distinction between the Randstad and the rest of the Netherlands prevails: for the single workers and those from two-worker couples and families all pair-wise differences concerned are statistically significantly different at the 1 per cent level. Differences between the more and less urbanised municipalities outside the Randstad are not statistically significant at the 5 per cent level for any of the population sectors considered. In addition, only 6 out of 30 of the pair-wise differences *within* the Randstad are statistically significant. These patterns hold more or less for all five household types.

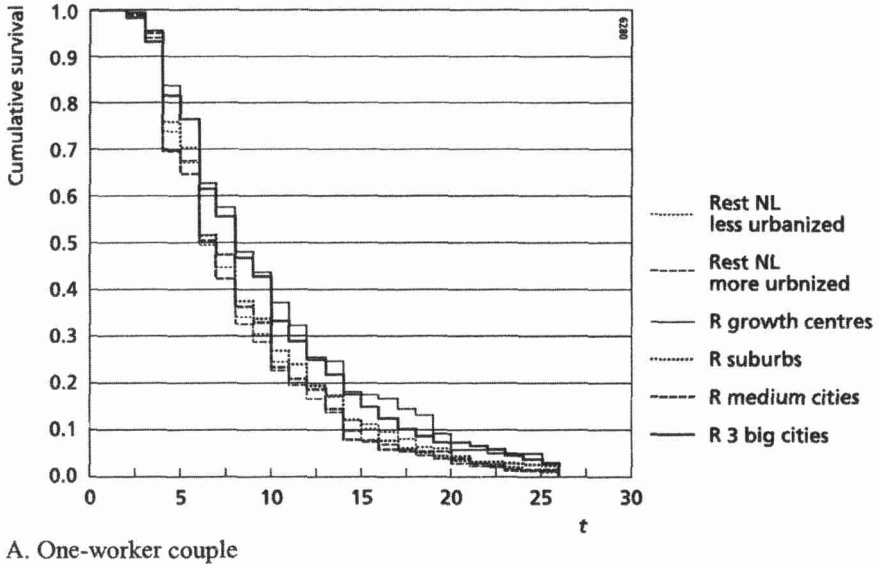
With respect to our hypotheses, the analysis suggests that the role of the residential context in determining commuting times does not differ much across household types. For all groups, commuting times tend to be highest in the growth centres, followed by the cities in the Randstad. Yet, commuting trips comprise a mere one-fifth of all trips in the Netherlands and are outnumbered by the number of shopping and leisure trips (Schwanen *et al.*, 2001a). We will therefore also consider travel times for maintenance and leisure activities.

Maintenance Travel

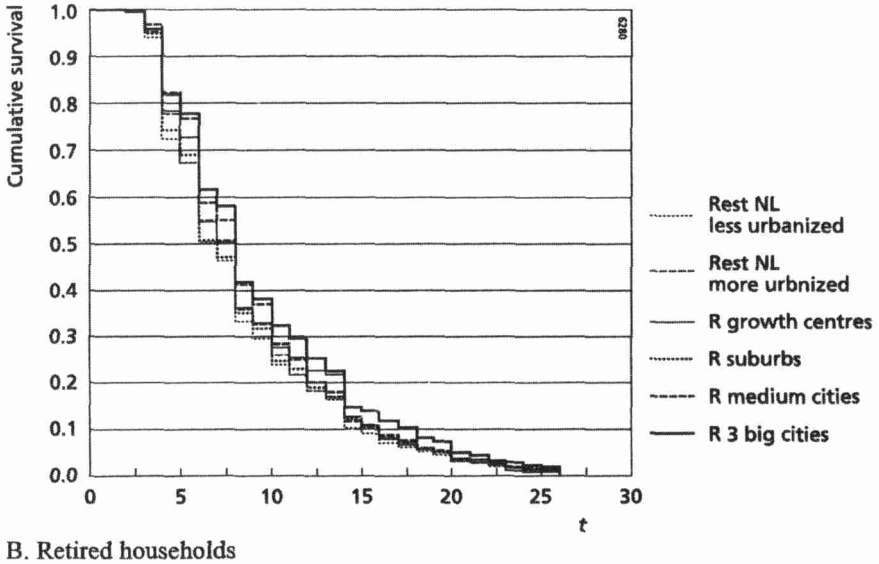
As for commuting, all of the ANOVAs for the average travel time for 'maintenance' yield statistically significant results (Table 2.6). Yet, the differences between the Randstad and the rest of the Netherlands are less pervasive than in the case of commuting. The maximum variation between residential settings is also smaller. Ratios of the highest and lowest average per household type fall between 1.18 for the one-worker families and 1.28 for the single workers, suggesting that the spatial variation in mean maintenance travel times varies between 18 per cent and 28 per cent. The maximum variation between household types in a single residential context falls in a comparable range (14-27 per cent). Thus, the variation between residential settings in average travel time for maintenance activities is no larger than that between household types.

Ranking residential settings from the highest to the lowest average travel time yields considerable differences between household types. For the one- and two-worker families and retired households the average travel time tends to increase with the level of urbanisation. The growth centres and the big cities in the Randstad are associated with the highest mean values for the one- and two-person households.

Given the large variation around the mean values, we have again considered travel time distributions. Those for one-worker couples and retired households are depicted in Figure 2.2. Consistent with Table 2.6, the cumulative survival curves for the three big cities and the growth centres lie above those for the other residential settings, indicating that travel times tend to be longer for residents of these two municipality types. Differences between the other four residential settings are limited.



A. One-worker couple



B. Retired households

Figure 2.2 Survival curves for daily travel time for maintenance trips per person, by residential context

If the retired households are considered, several differences between them and the one-worker couples stand out. First, the curves for the former tend to lie below those for the one-worker couples, revealing that individuals from retired households tend to spend slightly less time on maintenance travel. Second, only the curve for the three big cities lies clearly above the others; it is the retired inhabitants of those cities who spend most time on travelling for maintenance activities (a finding corroborated by Table 2.6). Third, whereas Figure 2.2 may suggest that the variation across residential settings is smaller for the retired households than for the one-worker couples, the statistical tests in Table 2.7 show the opposite: the retired households are the sector with the most statistically significant pair-wise differences. When the full distribution of travel times is taken into account, this is the population sector with the largest differences between the less urbanised areas outside the Randstad, and the big, and to a lesser degree, the medium-sized cities in the Randstad.

The retired households differ markedly from the single workers and the two-worker couples in that for those household types the residential context is less relevant in explaining the pair-wise differences in maintenance travel time (Table 2.7). Because these are households in which working full-time is most common, they tend to have limited time available for conducting maintenance activities. Individuals in these households may therefore try to increase the efficiency of their travel through 'trip chaining', using a private car more frequently, and choosing the nearest available destination. Whilst the exact behavioural strategy may depend on the configuration of land use, the outcome in terms of travel time seems to be more or less the same in all residential settings.

One may wonder why, according to Table 2.7, the above reasoning appears not to apply to two-worker families, which could be regarded as the most time-pressured household type. Perhaps this is because adults in such households have to perform many chauffeuring trips to bring young children to school, sports clubs, friends, etc. These trips tend to be fixed in space and time, thereby curtailing the opportunities for parents to achieve more efficient travel patterns (Kitamura, 1983; Misra and Bhat, 2000). Consequently, the spatial distribution of potential destinations may have a larger impact on travel times than in situations where few chauffeuring trips need to be undertaken (as in households without young children).

In short, the analysis for maintenance travel times has indicated that the *direction* of differences between residential settings is largely the same across households types. Travel times tend to be higher in the big cities and the growth centres and lower in the less urbanised areas outside the Randstad. The *magnitude* of these differences seems to vary, however, by household type. The size of the differences appears to depend on the level of time pressure as reflected in the number of hours worked per week, combined with the types of maintenance activity conducted.

Table 2.7 Results of Wilcoxon tests on pair-wise differences in the distribution of daily travel time for maintenance trips per person between residential contexts, by household type[a]

		Single worker					Two-worker couple					One-worker couple					Two-worker family					One-worker family					Retired household				
		2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6	2	3	4	5	6
1	R three big cities				•	•				•		••	•		••	••						••		•		•	••		••	••	••	••
2	R medium cities	--				•	--					--		••			--				••	--						--	••		••	••
3	R suburbs	--	--				--	--				--	--	••			--	--			••	--	--			•	--	--			•	
4	R growth centres	--	--	--			--	--	--			--	--	--	••	••	--	--	--		••	--	--	--		•	--	--	--			•
5	Rest NL more urbanised	--	--	--	--		--	--	--	--		--	--	--	--		--	--	--	--	••	--	--	--	--	•	--	--	--	--	--	••
6	Rest NL less urbanised	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

[a] Only travellers making at least one commute trip are considered

• Statistically significant at $\alpha = 0.05$

•• Statistically significant at $\alpha = 0.01$

-- redundant comparison

Leisure Travel

The discussion for leisure (social visits, sports and hobbies, entertainment and recreation) is restricted to some key findings, because many results reinforce the conclusions for commuting and maintenance travel. As Table 2.8 indicates, the variation across residential settings is statistically significant for all population sectors with the exception of two-worker couples. Note, however, that the ANOVA *F*-ratio is also low for the single-worker group, suggesting that differences are small for these households. Contrary to expectations, the 'means' for singles in the big and medium-sized cities of the Randstad are higher than elsewhere. For the one- and two-worker families, the average travel time for leisure activities is highest in the growth centres. Again this is not as expected, given that the percentage of families residing there is higher than for other household types (Table 2.8).

In comparison with commuting and maintenance travel times, the impact of residential setting on travel times, per household type, for leisure trips is larger, but difficult to interpret. Nonetheless, the conclusion that the magnitude of the differences in travel time (when taking account of the number of observations and the size of the standard deviations) is a function of time availability, and type of activities conducted, also appears to hold for leisure travel.

Conclusions and Discussion

In this chapter we have considered the question of whether the influence of built environment characteristics on trip frequency and travel time for commuting, maintenance and leisure purposes differs across household types. We hypothesised that family households, because of their over-representation in suburban and lower-density areas, would experience shorter travel times for commuting, maintenance and leisure activities and higher trip frequencies, as the level of urbanisation of their residential environment is lower. In contrast, we expected travel times for every trip purpose to be lower and the number of trips higher as the level of urbanisation increases for single workers and two-worker couples.

The descriptive analysis presented here has produced many statistically significant differences among residential contexts, stressing the general significance of urban form to the understanding of differences in travel patterns. That is not to say, however, that the impact of urban form always differs by household type. For maintenance travel, and certainly for commuting, the conclusion should be that the impact of residential setting on travel time is characterised more by similarity than by differences across household types with respect to the *direction* of the influence. Thus we find that, for most household types, travel times for these purposes are higher in the cities and growth centres and lower outside the Randstad in general and in the less urbanised municipalities in particular. Nonetheless, the *magnitude* of the differences between residential settings varies across household types for maintenance travel time. The differences

Table 2.8 Daily travel time for leisure trips per person, by population segment and residential setting[a]

	Single worker		Two-worker couple		One-worker couple		Two-worker family		One-worker family		Retired household	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
R three big cities	57.8	46.3	58.2	45.5	58.4	44.5	51.6	42.9	51.3	46.9	64.8	50.9
R medium cities	55.5	52.8	61.6	48.9	66.1	52.7	49.6	42.4	48.8	41.2	63.4	53.8
R suburbs	51.9	44.6	58.5	50.5	61.5	51.3	45.0	42.3	46.0	40.9	58.0	49.3
R growth centres	50.5	43.1	64.0	58.0	53.5	45.4	55.1	46.9	57.5	49.3	64.2	52.3
Rest NL more urbanised	50.1	45.6	56.6	53.3	53.2	45.8	43.7	38.7	42.9	39.9	58.7	49.9
Rest NL less urbanised	45.7	42.5	55.1	48.1	49.6	53.6	45.7	43.8	42.7	39.7	55.1	48.2
ANOVA (*F*-ratio)	2.7[b]		1.4		3.4[c]		3.8[c]		4.9[c]		7.7[c]	

[a] Only travellers making at least one leisure trip are considered
[b] Statistically significant at $\alpha = 0.05$
[c] Statistically significant at $\alpha = 0.01$

tend to be larger for household types with larger time budgets, such as retired households and one-worker couples. Presumably because of the adoption of various behavioural strategies to increase the efficiency of travel patterns, variations in travel time by residential setting are small for working singles and two-worker couples.

The travel time for leisure purposes and the non-work trip frequency are also statistically significantly associated with urban form in a number of instances. Nevertheless, these differences tend to be less systematic than for commuting and maintenance travel time. Perhaps some of this variation could be explained by taking account of other factors which have not been considered here, such as socio-economic condition, car availability, and lifestyle.

While we do find that single workers are concentrated in the cities of the Randstad and more urbanised municipalities in the rest of the Netherlands, and that families are gravitating towards suburban and low-density living, the analysis suggests that opportunities for efficient travel or easy access to relevant destinations seem to be of modest importance in decisions about where to live. It appears that those household types have other, non-transport and accessibility-related motivations when choosing a residential location, such as the availability of suitable housing or the prevalence of a certain lifestyle. Similar arguments have been made in other studies, although those were often limited to commuting trips, or concentrated on multiple-worker households (Giuliano and Small, 1993; Raney *et al.*, 2000; Raux and Andan, 1997; Weber, 2003). Our research contributes to this literature by showing that the modest role of transport-related factors is not limited to commuting time and multiple-worker households but also pertains to non-work travel and households with one or no workers.

The study results can also be viewed from a land use and transport policy perspective. Elsewhere we have argued that one of the dangers of reducing car travel by building compact, high-density developments is that travel times may rise (Schwanen *et al.*, 2004). This was deemed undesirable, because it may undermine the effectiveness of those policies. The results presented in this chapter suggest that single workers and two-worker couples are somewhat less sensitive to urban form than the retired and one-worker couples (at least as far as travel time is concerned). Building compact developments may therefore provide individuals in the former household types with better conditions for modifying their travel behaviour. Conversely, single workers and two-worker couples are *ceteris paribus* the most frequent users of public transport (Schwanen *et al.*, 2002), so the gains in terms of modal shift may be limited. One solution to the apparent contradiction between certain land use policies may be to develop policies targeting specific household types instead of generic national policies. Such policies could be based on the variation in both travel time and trip frequency. Regarding the latter, we assume that a higher trip frequency is indicative of a higher level of social participation and hence beneficial to the individual. On the basis of the study results, we recommend that the building of residences in high-rise buildings near public transport facilities in larger cities play a prominent role in policies for single workers and two-worker couples, whereas concentrating new developments in relatively compact suburban locations may be a better strategy for one-worker couples or retired households.

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