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Short-term Dynamics in the Use of Places: A Space–Time Typology of Visitor Populations in the Netherlands

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Summary. In a network society, spurred on by technological, social and economic factors, the process of land use deconcentration has resulted in various new urban forms such as edge cities and edgeless cities. While the consequences of this process for the distribution of the residential population and travel patterns have been extensively described and analysed, there has as yet been little investigation of the effect on visitors' use of places. Using the 1998 Netherlands National Travel Survey, the paper develops a typology of urban, suburban and rural municipalities located in monocentric and polycentric urban systems on the basis of dimensions of diurnal weekday variations in visitor populations. A two-step cluster analysis results in five types of municipality: 'central place', 'contemporary node', 'self-contained', 'mobile children' and 'local children'.

1. Introduction

Changing infrastructure networks dramatically, but highly unevenly, 'warp' and refashion the spaces and times of all aspects of interaction (Graham and Marvin, 2001). As a result, the opportunities for participation in activities and travel in a network society have become highly fragmented in space and time. Parallelled by an increase in the heterogeneity of social networks as many new groups and lifestyles have sprung up within society in the past few decades (Musterd and van Zelm, 2001; Giuliano and Gillespie, 2002; Wachs, 2002), these developments have led places in contemporary society to be increasingly structured around and by highly diverse (rhythms of) flows of people, goods and information (Castells, 1996).

Many studies have discussed the impact of these processes on the distribution of the residential population (Dieleman *et al.*, 1999; Bontje, 2001; Champion, 2001; Batty *et al.*, 2002; Camagni *et al.*, 2002) as well as on the travel patterns of the residents of urban, suburban, and rural communities (Badoe and Miller, 2000; Crane, 2000; Ewing and Cervero, 2001; Schwanen *et al.*, 2004). There is, however, another dimension of the use of places that has hitherto remained largely unexplored: namely, the function of places for visitors. In the web of individual movements through time–space, intersections of individual paths lead to the *becoming of places* (Pred, 1984): as Massey (1993, p. 66)

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states, places are increasingly becoming "articulated moments in networks of social relations and understandings". Places can be interpreted as clusters of spatial events that take place in time and space, and "where the event is characterized by its duration, intensity, volatility, and location" (Batty, 2002, p. 1). This interpretation implies that, in a network society, large differences develop in the ways in which nighttime or residential populations and temporary or visitor populations use places. As van der Knaap (2002) states, places may increasingly show an uncoupling of economic threshold, the supply of goods and services and residential population size. At the same time, new opportunities arise for developing small and medium-sized cities that lack a strong local basis. Increasingly, visitor populations now determine the social, economic and environmental performance of places.

By looking at the characteristics of visitor populations, the aim of this study is to provide an alternative way of understanding the performance of places in a network society. In this paper, we report our development of a typology of urban, suburban and rural municipalities located in monocentric and polycentric urban systems based on diurnal weekday variations in visitor populations and examine the extent to which the process of land use deconcentration (that is, the shift from monocentric into polycentric urban structures) has affected the characteristics of visitor populations. For this analysis, we have used the 1998 Netherlands National Travel Survey (NTS) from which we derived dimensions of diurnal weekday variations in visitor populations.

In the next section, we briefly discuss the main factors that have contributed to the process of land use deconcentration that has resulted in the development of various new urban forms. The implications for the distribution of visitor populations are also discussed. Section 3 consists of a description of the research design. The constructed typology of municipalities of visitor populations is discussed in sections 4 and 5. Our conclusions are given in the final section.

2. Land Use Deconcentration and Temporary Populations

In the second half of the 20th century, the spatial structure of urban systems was dramatically modified as the result of technological innovations, rising levels of affluence and changing lifestyles and household structures. In the first place, mass transit and the private automobile increasingly enabled people and economic activities to move out of town, creating huge suburbs and out-of-town locations for all kinds of business activity (Kloosterman and Musterd, 2001). In the past two decades, these tendencies were spurred on even further by the adoption of innovations in information and communication technologies (Wheeler *et al.*, 2000). Secondly, prosperity and car ownership offered people the opportunity to suburbanise:

> The bargaining power and spatial mobility (on a daily basis) of almost all households expanded more and more (Musterd and van Zelm, 2001, p. 690).

Thirdly, new household structures have also diminished the notion of monocentricity since members of two-earner households have to find a residential compromise between two different job locations (Gordon *et al.*, 1998; Champion, 2001; Kloosterman and Musterd, 2001). Finally, as the consumptive order replaced the productive order (see for example Glennie, 1998), mobility patterns became increasingly affected by the locations of leisure facilities, some of which specialise and concentrate in space relatively independent of their local demand.

These developments in society have led to land use deconcentration in various forms. Land use patterns are seen primarily as the outcome of accessibility and locational trade-offs (Clark, 2000). Initially, this mechanism led to concentric circles of land use around one dominant centre (see for example Alonso, 1964). However, as cities expanded and new nodes of accessibility developed, the applicability of this monocentric model was increasingly questioned (Davoudi, 2003). According to Clark (2000),

the traditional mechanism still applied, but the model itself needed modification in order to capture the clustering of activities in subcentres. The 'edge city' is one of the paradigms facilitated by the suggested polycentric model. Garreau (1991) characterises an edge city as a large sub-centre at the edge of the built-up area of a metropolitan region; it is a single destination for jobs, shopping and entertainment. Others (Gordon and Richardson, 1996; Lang and LeFurgy, 2003) take a decentrist view, stating that households are the centres in a post-polycentric urban landscape, with urban sprawl or 'edgeless cities' as the dominant settlement structure. In the decentrist view, the dominant structuring mechanism is personal mobility. Since these two mechanisms—centralising and decentralising—co-exist, the contemporary landscape is characterised by a large variety of urban forms, ranging from historical urban centres to Lang and LeFurgy's (2003) edgeless cities.

This wide variety of urban forms and structures has had a marked influence on mobility patterns and interactions between locations. Studies analysing changes in mobility patterns as a consequence of the emergence of polycentric structures or sprawl (see, for example, Levinson and Kumar, 1994, and Gordon and Richardson, 1996, for the US; Cortie *et al.*, 1992, for The Netherlands; and Clark and Kuijpers-Linde, 1994, for the US and the Netherlands) concentrate on travel direction, travel time and travel mode. With respect to travel direction, Cortie and colleagues (1992), drawing on the 1985–88 NTS, found that three-quarters of all trips in the Randstad had their origin and destination within the residential municipality. They also found that some 40 per cent of the intermunicipal trips in the Randstad took place between central city and suburban locations, while some 60 per cent took place between suburban locations. Thus, while many interactions (such as shopping and leisure) still take place within the residential municipality, the importance of tangential movements relative to radial movements has also increased, especially with regard to commuting (Harms, 2000). In the US the increase in both suburb-to-suburb commuting and reverse commuting has been emphasised by, for example, Pisarski (1996), Guiliano (1999) and Cervero and colleagues (2002).

While the studies mentioned in this literature review have paid considerable attention to land uses and interactions in polycentric systems, there has been little investigation of the consequences for people's daily use of places. Although people change their daily paths through time and across space, current studies analysing the daily use of places generally focus on just one settlement or metropolitan area. Goodchild and colleagues (Goodchild and Janelle, 1984; Goodchild *et al.*, 1993; and Janelle *et al.*, 1998), for example, have analysed the temporal specialisation of the Dartmouth–Halifax metropolitan area in Canada. They identified certain factors that influence the temporal and spatial distribution of people. The main factors can be categorised along activity and socio-demographic dimensions. Home and work-related activities seem to provide the strongest dimensions of diurnal patterns of social group distributions, followed by leisure, shopping and education. The relevant socio-demographic dimensions of visitor populations are related primarily to income, educational/occupational status and age. Other studies include those of Chapin and Stewart (1959) and Mille (2000), who examined diurnal changes in population densities for Flint, Michigan, and Lille, France, respectively; Buliung (2001), who studied the spatial-temporal patterns of work and non-work out-of-home activities within the Portland region; Boffi and Nuvolati (2002), who investigated the relationship between time use and urban governance in the metropolitan area of Milan; and Bromley and colleagues (2003), who analysed the space–time layers of uses and users in the Swansea, UK, city centre.

However, a full understanding of the performance of places in a network society requires the investigation of a larger variety of spatial contexts, including central cities and suburban communities in both polycentric and monocentric systems as well as communities outside these daily urban systems. For

example, economic land use deconcentration may have led to the emergence of new types of spatial environment in which city residents co-determine visitor population characteristics in the surrounding suburbs. At the same time, we expected the orientation of suburbanites towards central places to be lower in polycentric systems than in monocentric systems. Furthermore, in rural municipalities outside daily urban systems, we expected a relatively large share of municipalities to be self-contained.

3. Research Design

In this study, we have constructed a typology of urban, suburban and rural municipalities based on diurnal weekday variations in visitor populations in the Netherlands and we have related this typology to different types of urban system and types of settlement within them. In this way, we have sought to obtain a better understanding of how land use deconcentration has affected the use of places by visitor populations. In this study, a visitor population is defined as the aggregate of all persons, including persons active within their residential municipality, performing out-of-home activities in a particular municipality during a particular time-period. To obtain a typology of municipalities, a two-step cluster procedure was adopted.

In the first step, using agglomerative hierarchical cluster analysis, we combined dimensions underlying diurnal variations in the presence of visitor populations in the Netherlands into a typology of space–time units. These dimensions, which account for most of the variance in the diurnal variation of visitor population presence occurring within different Dutch municipalities on an average weekday in 1998, were identified using a principal factor analysis. Therefore, drawing on the 1998 Netherlands National Travel Survey (NTS), which yields data on the travel behaviour of some 130 000 individuals in a single-day diary format (Statistics Netherlands, 1999), we first calculated the total visitor population and sub-populations within it present in each municipality during each one-hour time-period of an average weekday. The sub-populations were defined by a selection of categories of individual and household characteristics, activity characteristics and trip characteristics, and were expressed as a proportion of the total visitor population. We weighted by activity duration to reflect the 'presence' of each individual within each municipality during each of the one-hour time-periods. To aggregate to the total Dutch population, we multiplied the weighted presence of a person by weight factors from the NTS. Subsequently, the factor analysis was performed using the six one-hour time-periods in which overall participation in various classes of out-of-home activity was empirically found to be highest: 8am–9am (morning traffic), 10am–11am (work and education), 12am–1pm (lunchtime), 2pm–3pm (shopping), 5pm–6pm (evening traffic) and 8pm–9pm (leisure—sports, recreation and entertainment—and social activities). The spatial-temporal units (that is, combinations of a municipality and a time-period) were grouped on the basis of their (standardised) scores on the dimensions identified with the factor analysis. The Netherlands comprised 548 municipalities in 1998 and we used six one-hour time-periods, so we needed to cluster 3288 space–time units in the first step.

The criterion of a meaningful interpretation and graphical plots of four validity indices (see Halkidi *et a.l*, 2001) that need to be applied to each stage of the hierarchical clustering algorithm were both used to determine the most suitable number of clusters. To improve cluster fit (Punj and Stewart, 1983; Aldenderfer and Blashfield, 1984; Milligan, 1996), cluster means found with the agglomerative algorithm were used as initial cluster centres ('seeds') in a *k*-means cluster analysis. As a result, after the first clustering step, we could indicate for each individual municipality the type of space–time unit to which the municipality belonged to during each of the six one-hour time-periods used in the analysis.

The second clustering step consisted of binary hierarchical cluster analysis to identify the main patterns between the various diurnal

structures of types of space–time unit (that is, each municipality can belong to more than one type of space–time unit in the course of one day and thus has its own unique diurnal structure). Therefore, binary variables were created to indicate the presence or absence of each type of space–time unit during each one-hour time-period for each municipality. These binary variables were entered into the second clustering step to retrieve types of municipality with similar diurnal structures of visitor presence.

We formulated a large set of spatial variables (Table 1) in order to examine the relationship between spatial context at both the local and regional levels and the type of municipality based on visitor population characteristics. After removing the multicollinear variables (in order to gain a sharper spatial profile), those remaining were used as independent variables in a discriminant analysis procedure with our typology of municipalities as the grouping variable. In Table 1, *address density of the surrounding area* indicates the degree of concentration of human activities (Den Dulk *et al.*, 1992). *Residential population characteristics* refer to the residential population of the destination municipality. *Local* and *national specialisation indices* relate a particular land use in a municipality to other land uses within the same municipality and the same land use in other municipalities respectively (for a description of the 15 land use types used, see Harts *et al.*, 1999).

Table 1. Explanatory variables

Size—Surface area in square kilometres
Size—Number of residents
Size—Number of jobs
Size—Number of student places
Density—Job density
Density—Address density of the surrounding area
Ratio—Number of jobs per resident
Ratio—Number of student places per resident
Residential population characteristics—Percentage of residents aged 0–14 years
Residential population characteristics—Percentage of residents aged 65 years or more
Residential population characteristics—Percentage of families with children
Residential population characteristics—Mean available income per income receiver in euros
Land use (30 variables)—Local and national specialisation indices for highly, moderately and less urbanised centre respectively; concentration of services; highly, moderately and lesser urbanised residential area and residential district; industry and business area; green and sports area; combinations of respectively residential and green/sports area, industry/business and residential area, and industry/business and green/sports area; infrastructure; services in the countryside
Land use—Land use balance index based upon 15 different land uses
Land use (3)—Percentage of companies in respectively the industrial sector, the commercial service sector and the non-commercial service sector
Accessibility (2)—Car accessibility; number of people that can reach the centre four-digit postal code area within respectively 15 and 30 minutes of car travel
Accessibility (10)—Car accessibility; number of 250*250-metre cells accessible within respectively 15 and 30 minutes of car travel from the centre four-digit postal code area of the municipality. Cells are defined by the following five land use types: highly urbanised centre, moderately urbanised centre, less urbanised centre, concentration of services, and industry and business area
Accessibility (4)—Distance in kilometres of the centre four-digit postal code area to respectively the nearest train station, intercity station, interchange station and highway exit
Typology of destination environments (6)—Inside the Randstad, three largest cities, medium-sized cities, growth centres, and suburbs; outside the Randstad, more and less urbanised municipalities
Typology of daily urban systems (5)—Monocentric systems (core city/suburb), polycentric systems (core city/suburb) and outside daily urban systems

The *land use balance index* measures the extent to which land use types are equally strongly represented within a municipality (with 1.0 expressing a perfect balance). We also incorporated various measures of accessibility by car and train.

On the basis of whether a municipality is located within or outside the Randstad—the large and heavily urbanised polycentric region in the western part of the Netherlands—and on its level of urbanisation, we distinguished six types of destination environment (Table 1). Following Van der Laan (1996, 1998), we distinguished two types of daily urban system: monocentric and polycentric. Both are dichotomised into core cities and surrounding suburbs. We also distinguished municipalities that do not belong to a daily urban system. Figure 1 shows the different types of daily urban system in the Netherlands, including their core cities. It should be stressed that this typology of daily urban systems is based only on commuter flows, whereas the typology that we developed in this study reflects not only interactions, but also people's actual use of places while participating in all kinds of out-of-home activity.

4. Typology of Space–Time Units

In this section, we describe our typology of space–time units; the result of the first clustering step. Each type of space–time unit describes the activity, trip and socio-demographic characteristics of the visitor population present within a certain municipality during a particular time-period.

Our typology of space–time units was based on seven dimensions underlying diurnal variations in the presence of visitor populations in the Netherlands. The seven dimensions were the result of a principal factor analysis of which the results are provided in Table 2. For example, it can be seen from Table 2 that the variable *work* loads −0.965 on the first dimension. This first and most important dimension was labelled the leisure dimension: it is oriented towards different degrees of participation in leisure activities. Accordingly, we found two dimensions related to the size of the territory on which visitor populations operate combined with the use of different transport modes (the interlocal and local dimension), one dimension expressing the direction in which interlocal movement occurs (the central place dimension) and three dimensions capturing different life-stages within the visitor population (children, high-income family and senior dimensions).

The combined hierarchical *k*-means cluster analysis procedure based on these dimensions resulted in 10 clusters with each one indicating a different type of space–time unit (see Table 3). These are actually *sub-clusters* since they are the input for the second clustering step. Using the mean score and one standard deviation per factor, a short description of the sub-clusters is provided in this section. Table 4 shows the distribution of the types of space–time unit across the six time-periods used in the analysis.

In general, we can distinguish between three work-oriented space–time units (cluster 1–3), two education-oriented space–time units (clusters 4 and 5) and five leisure-oriented space–time units (cluster 6–10). Among the work-oriented space–time units, the 'central interlocal' type comprises visitors residing in municipalities at lower spatial scales participating in work activities. In contrast, the 'decentral interlocal' type captures visitors whose residence is in a municipality at a higher spatial scale. Visitors from high-income families participating in non-leisure activities characterise the 'high-income family' type. From Table 4, it can be seen that during the day about 20 per cent of the municipalities belong to the 'central interlocal' type. At noon, nearly 50 per cent of the municipalities belong to either the 'central interlocal' or 'decentral interlocal' type, which is mainly the result of children's lunch break. Between 8am and 9am, about one-third of the municipalities belong to the 'high-income family' type; apparently high-income workers dominate visitor populations early in the morning.

Among the education-oriented space–time units, the 'children' type is typified by an overrepresentation of children within the

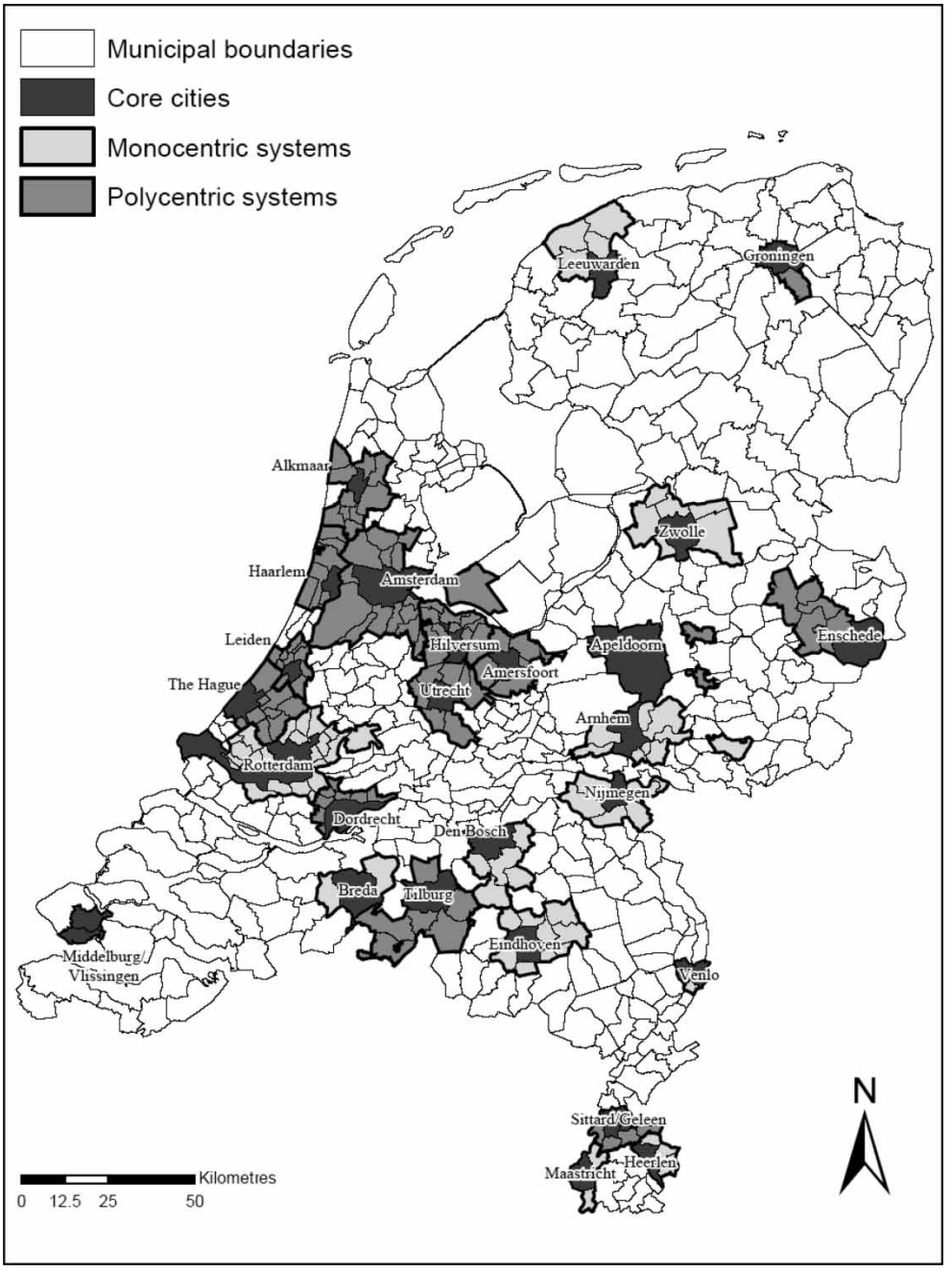

Figure 1. Types of daily urban system in The Netherlands. *Source*: based on Van der Laan, 1998.

visitor population, whereas the 'children local' type combines the presence of children with a strong local orientation and only a few visitors from other municipalities (Table 3). Compared with the 'children' type, the 'children local' type is thus much more restricted to local users. The effect of school times—including the midday lunch break—can clearly be derived from Table 4. It can also be observed that in the afternoon more municipalities belong to the 'children' type (38.0 per cent) than to the 'children local' type (13.5 per cent).

Table 2. Factor analysis pattern matrix (only loadings ≥ |0.400| displayed)

	Dimension						
	Leisure	Interlocal	Local	Central place	Children	High-income family	Senior
Working	−0.965						
Leisure	0.682						
Social activities	0.509						
Used public transport		0.653					
Travel time ≥30 minutes		0.624					
Travel time <10 minutes		−0.604					
Destination municipality is not residential municipality		0.550					
High educational level		0.426					
No cars available							
Used car			−0.933				
Used bicycle			0.689				
Residential municipality at a higher spatial scale[a]				−0.931			
Residential municipality at a lower spatial scale				0.544			
Age <12 years					0.674		
Education					0.570		
Age 18 ≤30 years					−0.505		
Couple, 2 workers, adult					−0.466		
Female, adult							
Single, worker, adult						−0.600	−0.499
Low income						−0.589	
High income						0.543	
Two or more cars available						0.400	
Non-worker, adult							0.661
Age ≥65 years							0.551

[a]We formulated four spatial scales. From the highest to the lowest, these are: the three large cities inside the Randstad (1); medium-sized cities inside the Randstad and, more urbanised municipalities outside the Randstad (2); growth centres and suburbs inside the Randstad (3); and, less urbanised municipalities outside the Randstad (4). Someone living in a medium-sized city inside the Randstad and visiting a suburb inside the Randstad has a residential municipality at a higher spatial scale than the destination municipality. The four scales thus define different levels of urbanisation with (1) being the highest and (4) being the lowest level.

In the late afternoon and evening, the share of education-oriented space–time units is practically zero.

Among the leisure-oriented space–time units, the 'adults' type represents adults participating in leisure activities. Visitors residing in municipalities at higher spatial scales combined with an underrepresentation of visitors participating in local activities can be found in the 'decentral non-local' type. The 'high-income adults' type comprises adults from high-income families participating in leisure activities. This type is also characterised by a relative lack of inflow from visitors from other municipalities. The 'local' type contains visitors participating in local leisure activities and has an underrepresentation of visitors from other municipalities. Finally, the 'senior' type captures seniors participating in leisure activities. From Table 4, it becomes clear that the leisure-oriented space–time units are concentrated in the last two time-periods, particularly in the evening. Between 8pm and 9pm, about 30 per cent of the municipalities belong to the 'adults' type and about 30 per cent belong to the 'high-income adults' type, probably indicating an urban–suburban dichotomy in evening leisure environments.

Table 3. Mean factor scores per type of space–time unit

Sub-cluster number	Type of space–time unit	*N*	Dimension						
			Leisure	Inter-local	Local	Central place	Children	High-income family	Senior
1.	Work-oriented central interlocal	478	**−0.47 (0.44)**	**1.16 (0.69)**	0.29 (0.59)	**1.20 (0.37)**	−0.14 (0.49)	−0.21 (0.53)	−0.40 (0.48)
2.	Work-oriented decentral interlocal	364	−0.52 (0.65)	**0.80 (0.76)**	−0.35 (0.80)	**−0.94 (0.72)**	−0.45 (0.63)	−0.34 (0.74)	−0.64 (0.64)
3.	Work-oriented high-income family	405	**−0.99 (0.53)**	−0.54 (0.64)	−0.19 (0.86)	−0.09 (0.69)	−0.36 (0.74)	**0.84 (0.72)**	−0.50 (0.55)
4.	Education-oriented children	620	−0.29 (0.48)	−0.22 (0.55)	0.39 (0.58)	−0.12 (0.63)	**0.56 (0.53)**	−0.29 (0.60)	0.11 (0.65)
5.	Education-oriented children local	346	−0.40 (0.58)	**−0.96 (0.64)**	0.76 (0.83)	0.06 (0.75)	**1.69 (0.88)**	0.53 (0.75)	−0.24 (0.64)
6.	Leisure-oriented adults	266	**1.26 (0.69)**	0.54 (0.81)	−0.45 (0.70)	0.67 (0.72)	**−0.67 (0.52)**	−0.48 (0.72)	0.11 (0.76)
7.	Leisure-oriented decentral non-local	225	0.61 (0.95)	0.09 (0.63)	**−1.37 (0.76)**	**−1.64 (0.90)**	−0.20 (0.87)	0.32 (0.90)	0.26 (0.87)
8.	Leisure-oriented high-income adults	224	**1.28 (0.61)**	**−0.85 (0.75)**	−0.47 (1.04)	0.24 (0.59)	**−0.88 (0.79)**	**1.31 (0.85)**	−0.01 (0.89)
9.	Leisure-oriented local	148	**1.15 (1.01)**	**−0.92 (0.86)**	**1.41 (1.02)**	0.30 (0.71)	−0.64 (1.14)	−1.10 (1.43)	0.40 (1.14)
10.	Leisure-oriented senior	212	**0.95 (0.82)**	0.02 (0.83)	−0.55 (0.99)	−0.23 (0.84)	−0.21 (0.71)	−0.93 (1.04)	**2.34 (1.11)**

Note: Values printed in bold were used for a meaningful interpretation of the sub-clusters. In these cases, the mean value plus or minus one standard deviation (between brackets) does not result in a different sign.

Table 4. Distribution of types of space–time unit across time-periods

Time-period	Work-oriented			Education-oriented		Leisure-oriented					
	Central inter-local	Decentral inter-local	High-income family	Children	Children local	Adults	Decentral non-local	High-income adults	Local	Senior	Total
8am–9am	18.4	11.7	31.0	15.9	20.3	0	1.1	0	1.1	0.5	100
10am–11am	18.2	6.6	9.7	35.4	24.8	0.2	1.6	0	1.6	1.8	100
12am–1pm	23.5	24.6	14.2	18.2	3.1	2.4	7.8	0.9	1.6	3.5	100
2pm–3pm	19.2	10.0	7.1	38.0	13.5	1.1	5.7	0.7	1.1	3.6	100
5pm–6pm	7.8	12.4	11.1	5.7	1.1	16.8	11.5	10.0	9.5	14.1	100
8pm–9pm	0	1.1	0.7	0	0.4	28.1	13.3	29.2	12.0	15.1	100
Total	14.5	11.1	12.3	18.9	10.5	8.1	6.8	6.8	4.5	6.4	100

5. Typology of Municipalities by Visitor Population Characteristics

In this section, we describe how the typology of space–time units featured in section 4 was transformed into a typology of spatial units (municipalities). Binary hierarchical cluster analysis resulted in five clusters, with each cluster indicating a different municipality type: central place; contemporary node; self-contained; mobile children; local children. The interpretation of these types is partly dependent on the spatial characteristics of the municipalities visited. For that reason, we applied a discriminant analysis to a set of spatial variables (Table 1). This analysis resulted in four discriminant functions; of these, a non-significant function was omitted from further discussion. The remaining three functions were assigned meaningful labels by investigating the structure coefficients. The largest coefficients are shown in Table 5. Average discriminant scores per type of municipality per discriminant function are presented in Table 6. Finally, the classification results are displayed in Table 7; they have been used for assessing how well the discriminant functions work.

At 82.5 per cent, the first discriminant function explains by far the most variance. Inspecting the structure coefficients (Table 5) led us to label this function the 'supply of opportunities'. Considering the large coefficient for the more urbanised municipalities outside the Randstad (0.525) and the lack of such large coefficients for medium-sized and large cities inside the Randstad, an urban–rural dichotomy can be considered important for this function. Such a dichotomy—and its apparent effect on the supply of opportunities—is much stronger outside the Randstad. The core cities in the monocentric regions outside the Randstad offer a more complete package of urban functions and thus have a higher correlation with function 1. The medium-sized and large cities in the polycentric Randstad do not correlate so highly with function 1 because the different functions are much more evenly distributed across space in the Randstad. The second function explains 9.3 per cent of the variance and is labelled the 'car accessible jobs' function, since it combines a large job-to-resident ratio with high car accessibility (Table 5). The third function accounts for a mere 5.4 per cent of the variance but,

Table 6. Discriminant analysis output: mean discriminant scores per type of municipality

	Function		
Type of municipality	1	2	3
Central place	3.955	−0.022	−0.060
Contemporary node	−0.807	1.660	−0.110
Self-contained	−1.037	−0.173	−0.638
Mobile children	−0.725	−0.004	0.699
Local children	−0.875	−0.668	0.067

Table 5. Discriminant analysis output: structure matrix (only variables with coefficients ≥ |0.300| displayed)

	Function		
Variable	1	2	3
Outside the Randstad, more urbanised municipalities	0.525		
Number of residents	0.371		0.573
Number of jobs per resident	0.371	0.556	
Job density	0.310		
National specialisation index for concentration of services		0.341	
National specialisation index for infrastructure		0.320	
Car accessibility 15-minute contour measure		0.309	
Car accessibility 30-minute contour measure		0.305	
National specialisation index for residential district		0.303	
Surface area in square kilometres			0.349

Table 7. Discriminant analysis output: classification results

Type of municipality	Predicted cluster membership					
	1	2	3	4	5	Total
Original count						
Central place	92	2	2	3	0	99
Contemporary node	0	37	10	6	6	59
Self-contained	5	16	80	17	31	149
Mobile children	9	17	16	71	24	137
Local children	7	5	23	19	50	104
Percentage						
Central place	92.9	2.0	2.0	3.0	0.0	100.0
Contemporary node	0.0	62.7	16.9	10.2	10.2	100.0
Self-contained	3.4	10.7	53.7	11.4	20.8	100.0
Mobile children	6.6	12.4	11.7	51.8	17.5	100.0
Local children	6.7	4.8	22.1	18.3	48.1	100.0

Note: 60.2 per cent of original grouped cases correctly classified.

according to Wilks' lambda, it is still significant. It has been labelled a 'size' function, reflecting not only the number of residents, but also the surface area (Table 5). From Table 7, it can be seen that the discriminant functions can correctly classify some 60 per cent of all municipalities grouped by their diurnal structure of visitor population presence. However, the classification is skewed; whereas almost all municipalities belonging to the 'central place' type (93 per cent) are correctly classified by the discriminant analysis, it misclassifies a considerable share (some 50 per cent) of the municipalities belonging to the 'self-contained' type, the 'mobile children' type and the 'local children' type.

In the remainder of this section, we discuss the five types of municipality of visitor populations bearing in mind both the spatial characteristics of the municipalities and the characteristics of their visitors. Figure 2 indicates which sub-clusters (types of space–time unit discussed in section 4) belong to each of the five types of municipality at different times of the day. Figure 3 indicates the spatial distribution of the five types of municipality.

The first type of municipality is defined as the 'central place' type. During the day, this type of municipality is mainly occupied by visitors originating from municipalities at lower spatial scales carrying out work activities. In the evening, adults participating in leisure activities are particularly apparent (Figure 2a). This type of municipality encompasses Amsterdam, Rotterdam, The Hague and all medium-sized cities inside the Randstad (including Utrecht), as well as almost all the more urbanised municipalities outside the Randstad (Figure 3). The large supply and variety of opportunities (jobs, shops, restaurants, bars and so forth) generally found within this type (Table 6: consider the high positive score of 3.955 on function 1) translates into an almost consistent presence of visitors originating from municipalities at lower spatial scales and thus into a central position within the urban network. Apparently, a simple central-place—non-central-place dichotomy is still capable of explaining visitor populations in the Netherlands to a large extent.

The increasing importance of accessibility in the supply of opportunities in a network society, and its influence on visitor population distribution, is revealed in the second type of municipality. As a result of functional deconcentration processes, the 'contemporary node' type of municipality captures the nodes or centres of (working) activity developed comparatively recently (during the past two or three decades). These municipalities are mainly concentrated around the highway exits at the fringes of the larger 'established' cities, but are also prevalent in more peripheral regions. Figure 3 indicates that many municipalities of this type are concentrated in the Amsterdam and Utrecht regions (Randstad North Wing). Although municipalities of the 'contemporary node' type are very similar during the day (Figure 2b: sub-cluster 2: presence of working visitors originating from municipalities at higher spatial scales), they appear to be considerably more diverse in the evening as some transform into more urban-like leisure environments (sub-cluster 6), some retain their decentral position (as a recreational outlet for city residents) (sub-cluster 7) and some become leisure

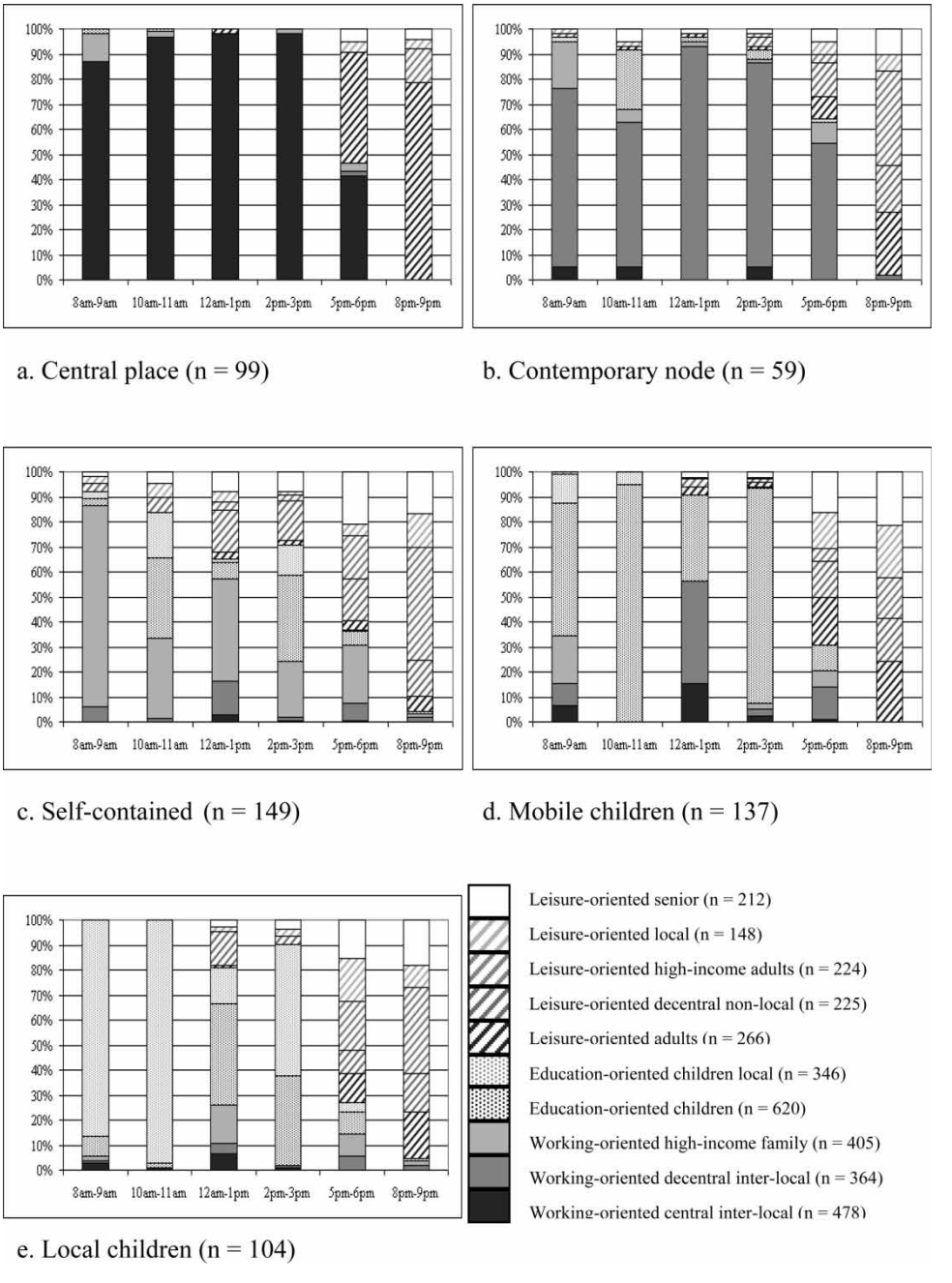

Figure 2. Distribution of types of space–time unit across types of municipality of visitor population.

environments for high-income adults (sub-cluster 8). The average discriminant scores indicate that, in contrast with the 'central place' type, municipalities of this type do not offer a wide variety of opportunities (Table 6: score of −0.807 on function 1). They mainly offer jobs that are readily accessible by car (Table 6: score of 1.660 on function 2). This high job accessibility by car enables municipalities of this type to attract visitors with a place of residence at higher spatial scales, undermining the traditional hierarchical

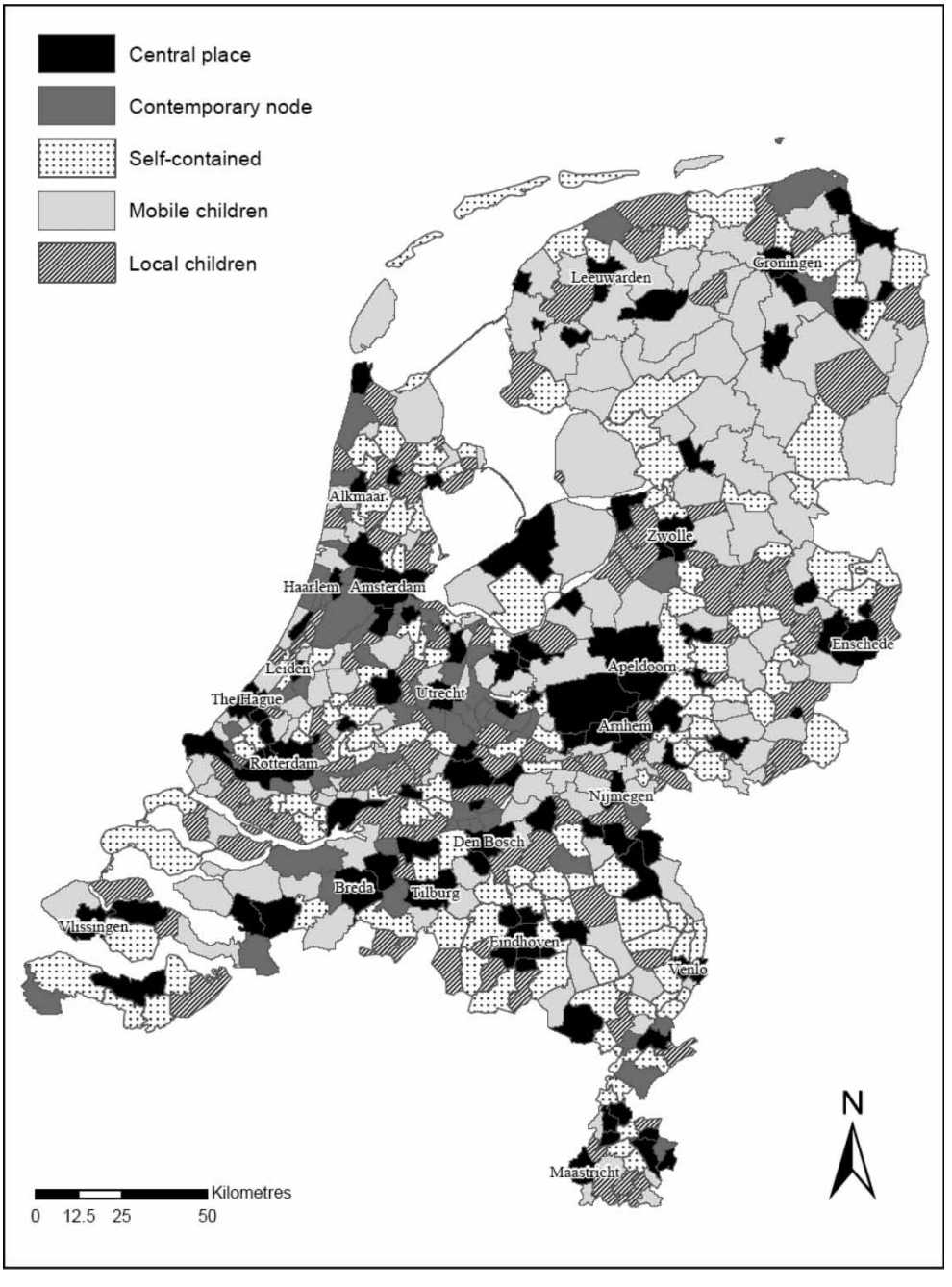

Figure 3. Types of municipality by diurnal structure in visitor population presence.

system of central places and claiming a position in the emerging network society.

The third type of municipality generally contains visitors from high-income families participating in non-leisure activities (work) during the day (sub-cluster 3) and in leisure activities in the evening (Figure 2c). Also, during school hours (10am–11am, 2pm–3pm), children make up a considerable part of the visitor population in this type of municipality. Since this municipality type generally lacks an inflow of visitors from other

municipalities, but does contain people at work, learning and in recreation locally, we have labelled this type 'self-contained'. Large concentrations of this municipality type can be found in the suburban regions around Eindhoven, Venlo and Arnhem (Figure 3). Apparently, some municipalities belonging to the 'self-contained' type are capable of profiting from their proximity to larger cities and their industries and have developed a local job market. Possibly, companies within these municipalities take up a position within the regional business networks of larger companies residing in, for example, Eindhoven (Philips). Other municipalities may be self-contained in that they are farming communities or municipalities with small local businesses or industries served by their own residential population. Municipalities belonging to the 'self-contained' type can be seen from Table 6 (score of -0.638 on function 3) to be small, either by number of residents or surface area. Possibly, smaller municipalities offer better (socio-spatial) conditions for establishing self-containment.

The fourth type of municipality is the first of two children-led types; it is labelled the 'mobile children' type, indicating that the diurnal rhythm within this type is mainly determined by the supply and timing of primary and secondary schools that attract children from other municipalities. Sub-cluster 4 plays an important part within this type during the day; however, in the evening a great diversity of sub-clusters emerges (Figure 2d). Some of the larger municipalities in the northern (and rural) part of the Netherlands belong to this type of municipality (Figure 3), as do some municipalities around large cities such as The Hague, Rotterdam and Dordrecht. Apparently, visitor population characteristics are quite similar in rural municipalities and a selection of municipalities around large cities inside the Randstad, in particular during school hours; outside these hours, these municipalities might actually differ markedly from each other (Figure 2d: compare 10am–11am and 2pm–3pm with the other time-periods). A reason for their similarity might be that within this municipality type children are relatively mobile. On the one hand, the sparse distribution of schools in rural municipalities might contribute to such mobility among children. On the other hand, secondary schools in municipalities around large cities in the Randstad may receive children living in those large municipalities but going to school elsewhere, leading to a similar kind of child mobility. Apparently, a large size—either in number of residents or surface area—plays an important part in accounting for such mobility among children (Table 6: score of 0.699 on function 3).

The fifth and final type of municipality has been labelled the 'local children' type. During the day—particularly in the morning time-periods—sub-cluster 5 plays an important part (Figure 2e). This sub-cluster describes a type of space–time unit in which children active within their local environment are over-represented. The 'local children' type of municipality is thus much more exclusive to local residents than the 'mobile children' type. Very young children usually go to a primary school within their own residential municipality, providing an explanation for this confined character and the label used. We can find further evidence of the confined character of this type of municipality in its spatial characteristics. The average score on function 2 is negative and large (Table 6: score of -0.668 on function 2), indicating relatively poor accessibility features and a low job-to-resident ratio. Together with a negative score on function 1 (-0.875), these figures might suggest that adults living in this type of municipality often need to visit other municipalities for work, shopping or recreational activities and that only a few people from outside are spurred on to visit this type of municipality.

The analysis presented so far provides clues for the emergence of 'new' types of municipality as the result of an emerging network society. The 'contemporary node' type in particular, offering jobs that are readily accessible by car, seems to be the result of the deconcentration of urban functions to more accessible locations. Also, the fact that some

of the municipalities belonging to the 'mobile children' type (originally only found in low-density rural communities) can now be found in the Randstad may indicate that this type also developed as the result of deconcentration processes; in this case, the deconcentration of educational facilities leads to more child mobility. In contrast, the 'central place' type, the 'self-contained' type and the 'local children' type seem to be the more traditional municipality types.

This image is confirmed when we pay attention to the distribution of the municipality types across the different types of daily urban system and settlements within them (Figure 4). From Figure 4, it can be seen that, first of all, regardless of monocentricity or polycentricity, all core cities belong to the 'central place' municipality type. Apparently, in the Netherlands, core cities in polycentric systems still attract large numbers of people from other municipalities. Secondly, a considerable share (23.5 per cent) of suburbs in monocentric systems, belongs to the 'central place' type. Within some monocentric systems core cities and suburbs seem to have coalesced into a cluster that attracts large numbers of visitors originating from municipalities at lower spatial scales. In contrast, the share of suburbs in polycentric systems belonging to the 'central place' municipality type is relatively low: 13.0 per cent. Thirdly, a considerable share (23.0 per cent) of suburban municipalities in polycentric systems belongs to the 'contemporary node' type. These attract visitors living in municipalities at a higher spatial scale (core cities). Together with their core city, they form a network in the sense that daily visitor flows are multidirectional. In contrast, the share of suburbs in monocentric systems belonging to the 'contemporary node' municipality type is relatively low: 11.8 per cent. Fourthly, the share of suburbs in polycentric systems belonging to the 'mobile children' municipality type (28.0 per cent) is larger than the share of suburbs in monocentric systems belonging to this type (22.1 per cent); children are thus more mobile within polycentric systems. Finally, outside the daily urban systems, the share of municipalities belonging to the 'self-contained' type of municipality is relatively large (32.1 per cent).

6. Conclusions and Discussion

In this paper, we have described our typology of urban, suburban and rural municipalities based on diurnal weekday variations in visitor populations in the Netherlands. The main aim of this study was to investigate the

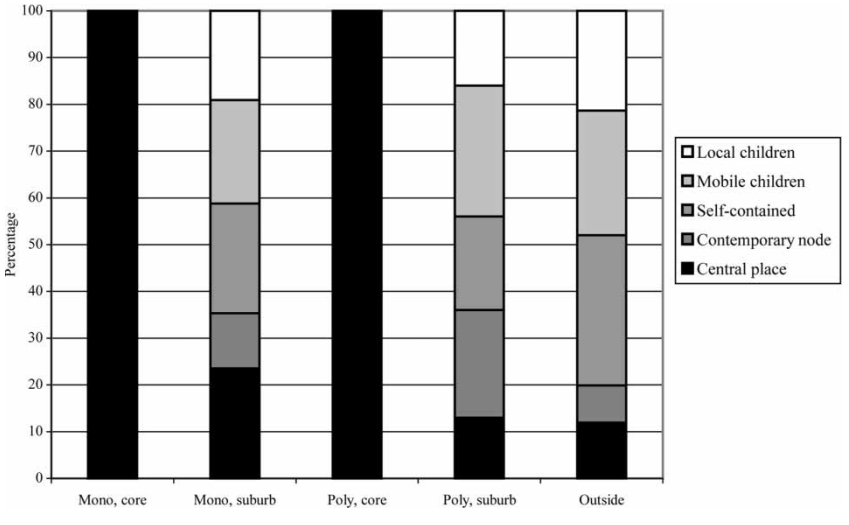

Figure 4. Distribution of types of municipality across types of daily urban system.

extent to which the process of land use deconcentration that occurred during the second half of the 20th century has affected the characteristics of visitor populations. Since this process has led to a greater variety in urban forms, it was expected that not only would visitor population characteristics of 'traditional' places have changed, but also that 'new' types of visitor population characteristics in time and space would have developed. We expected that (suburbs in) polycentric urban systems would show a greater variety in their use as the result of the deconcentration of land uses than (suburbs in) monocentric urban systems. We also expected the orientation of suburbanites towards the central city to be less in polycentric systems. Finally, in the more rural areas the degree of self-containment was expected to be relatively large.

The results reveal that, in comparison with monocentric urban systems, settlements in polycentric urban systems are more networked; suburbs in polycentric regions are capable of attracting a substantial share of working visitors that have their residence in the core city. The emergence of these 'contemporary nodes' is the result of the deconcentration of jobs to locations that are readily accessible by car, creating a new type of visitor environment in which commuters living in large and medium-sized cities visit jobs in the surrounding suburbs. It is mainly the suburbs in the Randstad North Wing that belong to this type; the 'contemporary node' type is far less apparent in the Randstad South Wing or elsewhere in the Netherlands.

The relatively large share of the 'mobile children' type, which attracts school children from other suburban and central-city communities, also illustrates the networked character of suburban settlements in polycentric systems. In this way, the trip characteristics of visitors to these suburbs resemble those of some of the rural municipalities outside the daily urban systems. But the underlying reasons differ; in polycentric systems, educational facilities have spread out from the traditional central cities; in rural areas, educational facilities are sparsely distributed across space because of low demand. In both cases, however, these spatial structures lead to more mobility among children.

In general, the types of municipality that feature the more 'traditional' visitor population characteristics, such as the 'central place' type, the 'self-contained' type and the 'local children' type, can be found to a relatively large extent in the suburbs in monocentric systems and in municipalities outside the daily urban systems. It should also be noted that, in the Netherlands, core cities in both monocentric *and* polycentric systems (still) belong to the 'traditional' 'central place' type of municipality, attracting for work and recreation large numbers of visitors who have their residential municipality at a lower spatial scale.

Future research should indicate whether, where and when network relationships develop on the basis of the temporary presence of people. In this study, we have used data from 1998; it would be interesting to see whether a longitudinal analysis would yield a different or changing picture. Such a picture could be of great importance for policy-makers since it would provide an empirical basis for applying transport measures and planning facilities at the right place and possibly at the right time.

In addition, future examinations into the space–time dynamics of visitor populations should address the sensitivity of the results to modifications in spatial scale and configuration. For example, some of the large rural municipalities in the north of the Netherlands might have been termed 'mobile children' simply because of their large surface areas, which may inherently result in more mobility. Future research should also consider the appropriateness of the temporal segmentation.

A discriminant analysis revealed that visitor population characteristics can be influenced by changing the supply and variety of land use opportunities and by influencing the job accessibility by car or locating jobs at locations accessible by car. These suggestions are, however, general policy notions; further research is needed to identify more precise measures capable of influencing visitor population characteristics.

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