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How do suburban residents organize their daily lives? A behavioural time–space analysis in Beijing, China

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ABSTRACT

Rapid suburbanization in China is dramatically reshaping the daily life of urban residents. In China, long-distance commuting, traffic congestion, spatial mismatch and the low quality of life resulting from residential suburbanization are causing widespread concern. This paper compares the changes in time allocation from a time-use perspective, based on two activity-travel survey datasets collected in suburban Beijing in respectively 2007 and 2017. Travelling time to work has increased substantially between 2007 and 2017 and particularly impacted non-working activities. Working and commuting showed to have the greatest impact on time allocated to non-work activities, both in home and out of home, both maintenance and discretionary activities. Furthermore, residents' allocation of time to non-work activities shows to be influenced too by their socioeconomic attributes, such as gender, marital status and household configuration (e.g. extended family). We found that the space–time constraints imposed by household responsibilities leads to greater gender differences in time allocation. This paper provides insight into how urban residents reallocate their time as a result of increasing suburbanization.

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Activity patterns; space–time constraints; gender differences; Chinese cities

1 Introduction

Time is a finite resource, strictly limited to 24 hours a day. How people spend this resource is in many ways determined by their personal necessities and by external constraints. Time geography strongly advocates that time and space are limited resources, and that the distribution of time reflects the resources that individuals can control. In the study of time–space behaviour, Hägerstrand (1970) first proposed a time geography framework, emphasizing the daily behaviour exhibited by individuals under the constraints of time and space. Since then, the theoretical basis and understanding of activity-travel duration has broadened and is also influenced by time-use theories found in sociology, economics and geography. However, the core of these theoretical approaches is still the time budget, which means that residents are allocating time to different types of activities in their daily lives, and the budget time for travelling is

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basically fixed and affected by individual factors such as lifecycle and behavioural preferences (Bhat & Misra, 1999; Ettema & van der Lippe, 2009; Timmermans et al., 2002; Yamamoto & Kitamura, 1999).

The study of behavioural time-space analysis is particularly relevant in the context of rapid urbanization processes like the one occurring in Chinese cities. China has transitioned from a planned economy with strong governmental intervention to a more open market economy. Within the traditional planned economy, all organizations in which people were employed – including enterprises, public institutions, government agencies and military units – were referred to as *danwei*, which provided employees not only with jobs but also with a comprehensive package of welfare and services, including housing, medical care, education and pensions (Chai et al., 2015; Xiao et al., 2020). In fact, *danwei* is a generic term denoting a work unit of any kind, including public institutions (e.g. schools, universities, hospitals, research institutes), government departments, military units, and state- or collectively-owned enterprises (Wang & Chai, 2009). Before the 1980s, the *danwei* system was the backbone institutional arrangement of the planned economy in socialist China and it provided employees with not only their salaries but also housing and other benefits (Bray, 2005). But the functions of *danwei* and its dominance in employment have changed since the introduction of the market-oriented economic reforms of the 1980s. Many social functions of *danwei*, including housing provision, have been gradually removed (Wang & Chai, 2009). Since then, citizens are able to freely choose places of residence, that is, according to their affordability of housing (Wang & Chai, 2009). A large amount of commercial housing has been built in the suburbs, since relocation to the suburbs for better housing has been the main driving force behind population suburbanization (Feng et al., 2008). At the same time, because of the influence of market forces leading to increasing land values and due to city planning, new public housing for low- and middle-income residents has been continuously pushed towards the borders of the inner suburbs and even into the outer suburbs, which resulted in low accessibility to job opportunities and urban facilities (Huang, 2004; Li & Wu, 2008). Given the rapid expansion of urban space in China, the problem of unbalanced transport supply and demand has become increasingly prominent.

The spatial development from urbanization to suburbanization has changed the daily lives of many residents in Chinese cities. Residents' lifestyles have undergone fundamental changes, becoming more diversified and personalized. As the freedom of residential choice is increasing, individuals' mobility and travel demands are increasing and constantly changing as well. The role of personal preferences and subjective initiatives in residents' activities is becoming increasingly important. Resulting from all of this, the original *danwei*-centred lifestyle has evolved into an urbanized lifestyle, and residents' daily activities – such as shopping activities, discretionary activities, social interactions and housing choices – rely more on municipal urban facilities outside the original scope of the *danwei* communities (Ta & Chai, 2019; Ta et al., 2016). In this process, the boundaries of the community are becoming increasingly blurred, and the loss of the original *danwei*-centred lifestyle is accompanied by a number of socio-economic problems, like long-distance commuting, a reduction in the number of non-work trips, reduced overall accessibility (which mostly leads to a decline in non-work activities), the fragmentation of traditional family life activities and intensified inequality based on social indicators (such as gender, age and income Hu et al., 2018; Zhao et al., 2020).

Taking these developments together, an in-depth study and analysis of residents' allocation of time to daily activities can help to understand the urban–social diversification that is brought by the overall suburbanization in the Chinese urban context. Especially in the first decades of this century the process of suburbanization in Chinese cities has increased substantially which makes it extremely interesting and relevant to investigate the changes in residents' time allocation. Time allocation structure is one of the most basic and important characteristics of daily behaviour patterns and can be used as a relevant perspective to interpret the change in lifestyle of suburban residents in China.

From this perspective, the present research starts from an analysis of individuals' daily time use to examine the changes in residents' activity behaviour and their external contextual factors (i.e. effects of suburbanization). The main question of this paper is: 'How do residents of diverse Chinese neighbourhoods reconstruct their daily time-use patterns following the rapid suburban transformation of Beijing between 2007 to 2017?'. We used individuals' activity diary data from suburban residents of Beijing in 2007 and 2017. Accordingly, the paper is structured as follows. The next section starts with a review of the literature on built environment research based on housing developments in China and confronts this with individual daily time-use research. Section 3 presents an overview of the data and a description of the changes in time allocation. This is followed by the results in Section 4 that present a description of their impacts. The conclusions are put forward in Section 5, as are some ideas for future research.

2 Literature review: suburbanization and daily time-use in China

2.1 The importance of housing developments in characterizing the residential built environment

In the Chinese context, researchers typically classify neighbourhoods into different types (e.g. Z Liu et al., 2017; Shen et al., 2015; Yao & Wang, 2018; M Zhang et al., 2018; X Zhang et al., 2019; Zhou et al., 2013). These neighbourhood types are often differentiated by distinct types of housing development. In general, four major sources of housing in Chinese cities are identified: (1) housing bought from/provided by work units (i.e. *danwei* housing); (2) housing bought or rented from the private market (i.e. commodity housing); (3) housing bought or rented from the government with a subsidy (i.e. affordable housing); and (4) self-built housing (i.e. Urban Villages Wang & Zhou, 2017). These distinct types of housing development have led to various types of neighbourhoods that are differentiated not only by their built environment, but also by the location within the wider urban fabric and by the social environment (Wang et al., 2011).

Looking at these different neighborhoods, studies have focused on comparisons of the commuting behaviour of different groups of inhabitants in terms of time, distance, transport mode, etc. Most of these studies have reported that residents living in *danwei* housing have shorter commuting trips and a higher probability of using non-motorized transport than residents in other housing sources (Jiangping et al., 2014; Wang & Chai, 2009; Yao & Wang, 2018; M Zhang et al., 2018). People living in these more self-contained (*danwei*) communities as provided by their work units were more constrained in their residential choice, and their need for outward travel was largely reduced because

the residential compounds were usually within or next to the job location (Yao & Wang, 2018). Some researchers found that *danwei* housing has promoted a better job–housing balance in Chinese cities. For example, a study of Xi’An by Zhou et al. (2014) found that jobs and housing were rather balanced in these development zones of the city and that this had been achieved through a combination of land-use planning and market forces. Similarly, another study in Beijing found that local families would choose to move back to a house in Danwei to cope with the growing burden of commuting and the quest for quality of life (M Zhang et al., 2018).

Compared to *danwei* community residents, people living in commodity housing (formal housing that can be purchased from the private housing market) have been reported to travel for longer periods and distances (M Zhang et al., 2018) and to be more likely to rely on cars for commuting and other travel purposes (Chai et al., 2010). As the new commodity housing is often located in suburban areas, some findings show that residents have longer commuting distances and times associated with its poor transport infrastructure in terms of metro accessibility (Wong et al., 2020). It has also been posited that residents of commodity housing are more likely to own a car than others, even with the same household characteristics (C Liu et al., 2018).

Social welfare (or affordable) housing communities have been found to travel longer distances, especially for commuting purposes. For example, X Zhang et al. (2019) reported that among the different types of housing in Beijing, affordable housing residents have the longest commuting distances and are highly dependent on public transport. Besides, a study in Nanjing found that residents living in affordable housing had poorer access to services than other housing type groups because of lower capacity of the communities to provide various services (M Zhang et al., 2018).

Several studies show that residents of traditional residential neighbourhoods (such as *hutongs* in Beijing, which were built around 700 years ago and were usually located in the city centre) have lower rates of car ownership. It may be due to the fact that traditional communities are mostly located in urban centres, which have locational advantages and less demand for private car ownership (Yao & Wang, 2018).

A few studies have investigated differences in activity behaviour rather than travel behaviour between neighbourhood types. Wang et al. (2011) found that residents of commodity housing and social welfare housing neighbourhoods both spend more time on out-of-home activities than do residents of *danwei* communities. Feng et al. (2014) reported that housing type has a significant impact on the mode choice of shopping and leisure travel. Thus, more research is needed on the activity behaviour impacts of neighbourhood types.

Furthermore, from our literature review it shows that a few studies have focused on changes in activity behavior in time by making use of longitudinal data or panel data. One research compared the travel behavior of households of different incomes in Chengdu in 2005 and 2016 and found that the average travel time for non-work activities increased in 2016 for all households in the metropolitan area, with the smallest increase for higher-income households, who now appear to be better off in terms of local and regional transport compared to lower- and middle-income households. (Srinivasan et al., 2020). Some scholars have also discussed the variation in home-work distance across years. A Swedish study shows that there has been increasing variation in the home working distance of workers living in the same neighbourhood and that the importance

of place of residence for home working distance has decreased from 1990 to 2010 (Elder, 2014). Another comparative study based in Beijing finds that built environment and socioeconomic attributes that respond to market forces have a stronger impact on home-work separation. They suggest that by comparing 2007 and 2017, the influence of the built environment factors became stronger and the influence of institutional factors represented by *hukou* and *danwei* became weaker (Li et al., 2021). This all suggests that Chinese cities have undergone a dramatic transformation in the context of rapid urbanization and suburbanization, in particular in the last decades.

The aforementioned comparative studies look more at the overall level of travel behavior and less at the daily activities of residents. In contrast, in our comparative research we make use of the before mentioned housing types to categorize neighbourhood types to be able to discuss the impact of the built environment on daily activities of their residents and changes therein in time, between the years 2007 and 2017.

2.2 Daily time-use research

Time use studies focus on the time different groups of people allocate on their activities which can be used to improve public policies, such as encouraging outdoor sports or promoting a better balance between work and leisure (S Jara-Díaz & Rosales-Salas, 2017). Before, studies have been conducted on various aspects of leisure, transport, and household production (e.g. K C et al., 2011; Clarke et al., 1981; S R Jara-Díaz & Astroza, 2013; Yamamoto & Kitamura, 1999).

Scholars have focused on the distribution of time spent by residents on indoor and outdoor activities. In that, individual needs are understood by analysing the patterns of occurrence and influencing mechanisms of activities that take place indoors and outdoors to understand the decision-making mechanisms behind individual activity time allocation (Bhat & Misra, 1999; Meloni et al., 2004). For example, a study based on the Multiple Discrete-Continuous Extreme Value (MDCEV) model found that commuting time and commuting travel patterns had a significant effect on workers' daily time allocation for other non-mandatory activities, and that extending (or reducing) the working day by one hour would reduce (or increase) the amount of time spent on household activities by approximately 45 minutes and approximately 15 minutes of time spent on out-of-home activities (Shi et al., 2018). Other scholars have analysed the household as a unit, where individuals in the household are considered to be autonomous decision-making units, and time allocation and resource use are discussed and decided among family members (Beblo, 2001). Cao and Chai (2007) used structural equation modelling to analyse gender differences in the allocation of time between male and female spouses in urban dual-earner households in China, and found that female spouses still bear the primary responsibility for family care. Similar findings were found in Fan's (2017) study, where differences in travel time and distance to work between men and women increased if there were children in the household. A study by Goulias (2002) using multilevel analysis showed the complex interdependence of individuals in their families, within their own time frame and between their own different behavioural indicators, with non-linear dynamic behaviour in time allocation.

In the above-mentioned studies, activities are generally classified into three categories of activities (work, maintenance, leisure/recreational activities) or also into two categories (compulsory activities, e.g. sleeping; and discretionary activities, e.g. leisure, socializing). Of these, non-work activities can be divided into two categories, maintenance activities and discretionary activities. Maintenance activities generally include the most basic and necessary human activities such as eating, sleeping and personal care, because they are the basis of survival, and we cannot pay someone else to do them for us. Discretionary activities refer to leisure activities and socializing. Especially leisure activities have received significant attention (e.g. Fezzi et al., 2014; Mullahy & Robert, 2010). However, there is a lack of research on residential maintenance activities, and with the spread and development of the information communication technologies (ICTs), the travel needs of individual maintenance activities are more complex, more vulnerable to changes in the travel environment, and may affect the travel needs of free activities. Therefore, on the basis of existing research, it is necessary to further study the changes and influencing factors of residents' time allocation for maintenance activities, as well as the possible impact on time allocation for other activities, in order to better understand the formation mechanisms behind residents' daily travel demand. In this study, we therefore focus on all non-work activities, including maintenance activities and free time discretionary activities.

3 Data and methodology

3.1 Research area and data

The city of Beijing is chosen as the contextual study area for our research. As the capital of China, Beijing's urban space covers traditional industrial areas, new industrial development zones, and residential areas of various construction eras and development patterns, such as hutongs, *danwei* communities, policy housing communities, commercial housing communities, and urban villages, and has good typicality and research value. The built-up area of Beijing had expanded from 1289 km² in 2007 to 1446 km² in 2017,¹ while the municipal population has increased from 16.760 million in 2007 to 21.707 million in 2017 (Beijing Municipal Bureau of Statistics, 2018). Since the market-situated change in the mid 1980s, Beijing has been going through fast urbanization and metropolitan extension. In 2007, the per capita disposable income of urban residents in Beijing was RMB 21,989 (\$3,347.24),² while in 2017, this figure increased to RMB 62,406 (\$ 9,499.64).³ A survey of 3,000 Beijing urban residents in 2007 showed that the proportion of residents living in purchased commercial housing was 17.4%, while in 2017, this proportion rose to 27.0%. At the same time, the proportion of residents living in *danwei* housing has fallen from 63.2% to 18.9%(Beijing Municipal Bureau of Statistics, 2018).

This study used data from two activity diary surveys conducted in Beijing in October–November 2007 (n = 1119) and April–June 2017 (n = 1280), which included both activity-travel diaries and the socioeconomic characteristics of individuals. In the 2007 survey, 10 neighborhoods were chosen dependent on their areas, local area type, and year of development. Notwithstanding subtleties on sociodemographic qualities, respondents were approached to participate in a two-day activity diary (for one work day and one end of the week day). The 2017 survey likewise followed a comparative survey method. To

Table 1. Characteristics of respondents.

Frequency (%)			Frequency (%)			
Gender	Male	47.1	Car ownership	No car	54.9	
	Female	52.9		1 car	44.3	
Marital status	Married	88.6		more than 1 car	0.8	
	Not married	12.4	Education	Middle school or lower	6.2	
Age	<18	0.7			High school	22.0
	19–29	15.9		Undergraduate	57.7	
	30–39	39.4		Master's or above	14.1	
	40–49	26.9	Child	<6 years of age	16.6	
	50–59	15.0			6–12 years of age	9.6
	>60	2.0			13–18 years of age	8.8
Hukou	Local	79.0				
	Not local	20.6				

start with, 26 neighbourhoods were chosen dependent on spatial area, local area type, and lodging condition, identical to the 2007 survey. The substance of the questionnaire was identical to the 2007 questionnaire and contained individual and family sociodemographic data, a work day activity diary and their home and work environment areas. In accordance with our purpose, we selected only the samples with work activities during the survey days. Finally, data analysis was conducted on 1254 valid observations (712 in 2007 and 542 in 2017). The socioeconomic attributes of the sample are shown in Table 1. As can be seen, the sample contains a high proportion of married people, with nearly eighty percent having a local household. There is a high level of education and nearly half of those own a car. About one third of the sample had children under the age of 18. It should be noted that, limited by the lack of information in the process of data collection, the effective sample rate of *age* and *hukou* is less than 100%.

3.2 Statistical analyses

The test results were analysed using a multiple regression model, in which the duration (in minutes) of residents' various activities were taken as the dependent variable. Here, we divided the original activity types into four categories: work-related activities, non-working activities within the home, non-working activities outside the home, and travelling. In-home non-working activities were subdivided into sleeping, in-home maintenance activities and in-home discretionary activities; out-of-home non-working activities were divided into out-of-home maintenance activities and out-of-home discretionary activities. Maintenance activities included cooking, housework, having a meal and taking care of family members and others. Discretionary activities included social, recreational and leisure activities.

Personal attributes (e.g. gender, age, income, level of education), family characteristics (e.g. family structure, household responsibilities), individual and family mobility options (family car ownership) were included in the model as independent variables (Table 1).

Table 2. Definition and description of independent variables.

Indicator		Description
Year	Year	2017 = 1; 2007 = 0
Neighbourhood types	Self-built	<i>danwei</i> housing as the base 1 for self-built housing residents, otherwise 0
	Commodity	1 for commodity housing residents, otherwise 0
	Affordable	1 for affordable housing residents, otherwise 0
Travel behaviour Interactions	Commuting time	Daily commuting time (mins)
	Year*SB	Interactions between self-built housing and year
	Year*CO	Interactions between commodity housing and year
	Year*AF	Interactions between affordable housing and year
	Year*CM	Interactions between commuting time and year
	Year*female	Interactions between gender and year

We used the age of children (but not the number of children) as an indicator of the amount of household responsibilities. As the phenomenon of parents living with their married children is still very common in China, we divided family structure into three types: family without child, nuclear family and extended family (including the father's and mother's parents or parents-in-law).

Considering that the commuting time determines the time budget of non-working activities in a day, the commuting time was also used as an explanatory variable to analyse individuals' allocation of activity time. In this study, we used neighbourhood types to characterize the built environment.

An explicit aim of this study is to establish the effect of time (2017 vs. 2007) controlled for socio-economic and spatial variables. To that end, a dummy variable representing the effect of 2017 was added as an explanatory variable. Further, since it was hypothesized that the time effect might differ between neighbourhood type and gender, interactions of the time variable with neighbourhood type and gender were used as explanatory variables. (Table 2).

The mean substitution method was used to estimate the missing values in social and economic attributes in SPSS software, after which the data was used as input into the model for parameter estimation.

4 Results

4.1 Descriptive analysis: time allocation and its changes in Beijing

Table 3 describes the average time spent on various activities per day (in minutes) for 2007 and 2017, with a t-test of the significance of the difference.

Between 2007 and 2017, the time spent on travel increased significantly by more than 60 minutes per day, while the time spent on work and discretionary activities decreased. This is likely caused by the suburbanization in Beijing, which has increased residents' home-work separation and their long-distance commuting. As maintenance activities are difficult to change, and show limited changes over the years, residents have to make trade-offs with time spent on other activities. Especially, less time is allocated to out-of-home discretionary activities in 2017 compared to 2007. Trade-off mechanisms are not the same for the residents of different communities. Residents of affordable housing communities are more inclined to reduce their working hours, possibly because they are

Table 3. Mean value of activity duration (mins) for the various activities analysed in this study in the years 2007 and 2017.

		Affordable		Commodity		<i>danwei</i>		Self-built		Totals	
		2007	2017	2007	2017	2007	2017	2007	2017	2007	2017
Working	Working	470.28	421.51	461.36	456.91	485.86	466.83	471.42	460.50	475.01	452.30
In-home non-working activity	Sleeping	498.36	508.19	518.00	512.54	499.82	502.56	501.98	501.07	503.12	514.17
	Maintenance	147.85	151.53	159.93	152.39	175.34	143.15	187.73	176.00	168.42	151.44
	Discretionary	121.82	111.93	120.44	80.18	121.52	89.32	122.09	90.52	121.51	85.45
Out-of-home non-working activity	Maintenance	47.25	48.49	44.44	52.14	35.54	55.95	21.62	26.80	38.20	52.51
	Discretionary	26.32	22.99	14.50	20.96	33.50	20.95	27.91	23.71	27.33	20.73
Travelling		105.95	159.82	98.04	156.77	78.62	125.20	95.37	155.70	91.81	155.59
Others		6.62	5.54	16.41	3.06	2.51	9.38	5.92	5.49	6.62	4.17

low-income groups who do not have full-time jobs and the increased travelling times limit their ability to find jobs (Allen & Farber, 2019). Residents of other communities are more inclined to reduce the time spent on in-home discretionary activities.

The total time spent on maintenance activities did not change between 2007 and 2017. However, the time spent on in-home maintenance activities decreased while that on out-of-home maintenance activities increased. A possible reason for this is that, restricted by travelling time, individuals tend to make some non-work stops during their commute to do some maintenance activities, such as having a meal or picking up children. This change is most evident for the residents of *danwei* housing. Due to the increase in travel time, they replace in home for out-of-home maintenance activities. An examination of the Danwei residents' activity diary reveals that in 2007, residents mostly ate their meals at home, while in 2017 the majority had their meals outside their homes. Another possible explanation is the increasing diversity of attributes of the inhabitants living in the *danwei* housing. Because some residents have purchased these housing from their *danwei* after the housing policy reform, they are able to sell or rent them to others, and the residents in them are no longer strictly controlled.

In both 2007 and 2017, the duration of in-home maintenance activities was significantly longer than the duration of such activities outside of home, and the duration of discretionary activities inside of home is also significantly longer than outside of home, which reflects that the home is still an important place for non-work activities.

4.2 Regression model results

The results in Table 4 show that personal attributes have an impact on the time allocated to activities. Women spend less time on work and discretionary activities and more time on maintenance activities at home compared to men. To some extent, this reflects the gender difference in the distribution of family responsibilities: women are more likely to perform such household activities as taking care of children and the elderly. The variable 'gender' has no significant correlation with out-of-home maintenance and discretionary activities. In other words, there is no significant gender difference in the time allocated to out-of-home non-work activities.

Table 4. Summary of the regression model results.

	Working	Maintenance		Discretionary	
		At home	Out of home	At home	Out of home
Gender					
Hukou	-35.936***	54.880***	-2.707	-19.826***	3.611
Marital status	-21.794**	19.166**	-8.240**	5.789	7.102*
Age	-3.926	15.183*	3.002	-24.565***	-7.488*
	111.689***	-39.869	-8.489	-2.422	25.280
	96.952***	-5.961	-11.251	-9.730	21.687
	87.009**	-9.883	-9.661	-6.469	22.168
	62.402*	-3.581	-13.028	0.748	25.408
Education	14.184	15.265	2.949	-16.084	1.333
	7.952	3.846	14.480**	-7.871	0.803
	16.619	-0.269	16.914**	-21.589*	-7.004
	10.729***	-3.157	-2.924*	2.240	-0.481
	-1.507*	-0.199	1.254***	0.136	0.015
Extended family	-3.544	33.677***	4.503	-32.248***	-8.073
Car ownership	-3.913	22.551**	11.362**	-25.499***	-3.204
Child	-0.233	16.767*	-2.568	-9.149	5.190
Neighbourhood type	1.728	10.933	-5.041	-3.969	-8.887
	-26.585**	3.937	-0.001	3.635	-9.567
	-10.414	-10.427	8.806*	10.364	-1.709
	14.221	-19.626	25.603***	-38.130**	-24.253***
Year	-0.117	-0.577***	0.090***	-0.185***	-0.091**
Commuting time	35.247***	-32.902***	1.587	5.307	-5.547
Year*female	-69.307	23.785	19.883	21.685	-15.838
Year*SB	-35.545	7.817	-13.175	12.599	-1.314
Year*AF	16.125	13.301	-8.881	-7.207	10.698
Year*CO	-0.371***	0.340***	-0.079*	0.050	0.159***

*significant at 0.10 level, **significant at 0.05 level, ***significant at 0.01 level.

The influence of family attributes on time allocation reflects the division of family responsibility and resource allocation characteristics. Married couples spend more time on in-home maintenance activities and less time on discretionary activities. With respect to age, it is found that with increasing age, people spend less time on working. Higher educated people are found to spend more time on out-of-home maintenance, and less time on in-home discretionary activities. The presence of a child has a significant positive correlation with maintenance activities and a negative correlation with discretionary activities. Residents are more likely to take part in maintenance activities at home under the constraint of family responsibilities of taking care of children, especially if they have young children. This also limits their ability to participate in discretionary activities. As the child grows, the correlations between child age and both maintenance and discretionary activity decrease. It was also found that 6- to 12-year-old children have a positive correlation with out-of-home maintenance activities, possibly because children of this age are mostly at elementary school and need their parents to pick them up from and drop them off at school.

The 'extended family' variable has a significant positive correlation with work activities, so more time is spent on working, and a negative correlation with out-of-home maintenance activities, so less time is spent thereupon. One possible explanation for this is that under the influence of China's one-child policy, the increase in family size is usually brought about by living with grandparents. Elderly people have more free time and are often willing to help their working children with housework, child-care and other activities, which allows their children to allocate more time to work activities.

Furthermore, the results show that in general, the housing type attribute doesn't have a significant correlation with the time allocated to activities. In contrast, residents living in affordable housing spent less time on working and those who live in commodity housing spent more time on out of home maintenance activities than *danwei* housing residents.

In addition, there were some significant changes in the lifestyles of urban residents during the 10-year period. Between 2007 and 2017, the time residents spent on out-of-home maintenance activities increased significantly while the time spent on discretionary activities decreased. The longer travel time apparently invites residents to combine their travel with out-of-home maintenance activities. For example, the detailed activity diaries show that in 2017, most of the residents ate lunch (some even ate dinner) at the workplace or on the way to commute.

In order to analyse this change more specifically, we used five interaction variables to analyse the changes over the decade. For the interaction of 'year' and 'female', we found that women spent more time working and less time on maintenance activities in 2017 than in 2007. The possible explanation is that along with the increase in commuting distance, the division of household responsibilities tends to become more equal and women spend more time at work.

It is worth noting that commuting time has a significant correlation with the time allocated to non-work activities. In addition, car ownership has a significant positive correlation with maintenance activities outside the home, indicating that private cars increase the flexibility of the residents' activity space. For the interaction of 'year' and 'commuting time', the results show that in 2017, commuting time has

a significant negative correlation with the time allocated to working and positive correlation with the time spent on in-home maintenance activities and out-of-home discretionary activities. Nevertheless, these modifications on the general trend are small.

5 Conclusion and discussion

Rapid suburbanization in China is dramatically reshaping the daily life of urban residents. In China, long-distance commuting, traffic congestion, spatial mismatch and the low quality of life resulting from residential suburbanization are causing widespread concern. This paper compares the differences in time allocation of diverse categories of residents, based on activity-travel survey datasets collected in Beijing in 2007 and 2017.

Western research has used activity analysis as an important perspective for travel demand research and posits that participation in maintenance and discretionary activities is closely related to the residents' travel behaviour. In the present research, we took Beijing as an example to analyse the time allocation to in- and out-of-home activities and to identify the factors that influence that allocation. This led to the following main conclusions.

(1) Working and commuting have the greatest impact on time allocated to non-work activities, both in home and out of home. Thereof, the overall increase in commuting time due to suburbanization has a substantial negative correlation with (less time spent) discretionary activities within the home, while it has a positive correlation with (more time spent) maintenance activities out of home. Translated to concrete activities one has less time for leisure activities within the home and does spend more time on tasks like family- or childcare out of home.

(2) Residents' allocation of time to non-work activities is influenced too by the socioeconomic attributes of individuals and families, such as gender and marital status. Gender differences still are clearly evident while this constraint has weakened in 2017 in comparison to 2007. In addition, married couples show to spend more time on maintenance activities at home, i.e. like taking care of family members, and less time over there on discretionary activities, i.e. like leisure activities.

(3) Family lifecycle plays an important role in individuals' time allocation, wherein having a child, the age of the child and the participation of parents or parents-in-law all influence daily time use. Increasingly, Chinese households get help from members of the extended family, such as retired live-in parents of the heads of household, which reduces the time they have to spend on housework.

The rapid (sub-)urbanization in China has resulted in notable changes in residents' daily activities. In this paper, we discussed the time allocated to non-working activities in Beijing and the factors that influence that allocation of time. We found that in contemporary Chinese cities the gender differences in lifestyles are emerging and expanding. When family responsibilities and work responsibilities conflict, women tend to turn to their families and choose jobs closer to home and engage more in family-related activities. In this change, professional women are increasingly subject to the dual pressure of work and family, gender inequality, and time and budget constraints; consequently, for them a declining quality of life is emerging. At the same time, as a coordination mechanism, the

(extended) family influences and limits individuals' time allocation by different family strategy choices, helping individuals to better cope with the pressures in their own lives. These family's impact mechanisms need to be better analysed in the future.

We also found that with the intensification of urban living differences, lifestyle and living conditions have also undergone fundamental changes. As the geographical background to residents' daily lives, urban space not only provides the necessary facilities for residents' living, but also brings the available resources and space-time constraints to the daily behaviour of residents through the urban structure, road network conditions and facility configuration. Especially in the process of suburbanization, the separation of work from living space is recognized as the urban spatial change that has the greatest impact on residents' daily lives. The spatial separation between the place of residence and the place of employment directly affects the most important daily travel of the residents – namely commuting behaviour – and indirectly affects the relevant schedule and space selections of the residents. In the present research, we simply divided the residents' residence by neighbourhood type and thereby identified that the influence of these distinctive types is not as significant as we expected on forehand. The reciprocal impacts of built environment characteristics and travel behaviour have been widely explored in Western countries, but more detailed research into these impacts is still needed in the Chinese context.

Notes

1. Data source:<https://data.stats.gov.cn/easyquery.htm?cn=E0103>.
2. Data source:http://tjj.beijing.gov.cn/tjsj_31433/yjdsj_31440/jmsz_32036/2007/202002/t20200217_1647428.html.
3. Data source:http://tjj.beijing.gov.cn/zxfbu/202002/t20200216_1633949.html.

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References

- Allen, J., & Farber, S. (2019). Sizing up transport poverty: A national scale accounting of low-income households suffering from inaccessibility in Canada, and what to do about it[J]. *Transport Policy*, 74, 214–223. <https://doi.org/10.1016/j.tranpol.2018.11.018>
- Beblo, M. (2001). *Bargaining over time allocation: Economic modeling and econometric investigation of time use within families[M]*. Springer Science & Business Media.

- Beijing Municipal Bureau of Statistics. (2018). *NBS Survey office in Beijing. Beijing Statistical Yearbook[R]*. China Statistics Press. <http://nj.tjj.beijing.gov.cn/nj/main/2018-tjn/zk/indexch.htm>
- Bhat, C. R., & Misra, R. (1999). Discretionary activity time allocation of individuals between in-home and out-of-home and between weekdays and weekends[J]. *Transportation*, 26(2), 193–229. <https://doi.org/10.1023/A:1005192230485>
- Bray, D. (2005). *Social space and governance in urban China: The danwei system from origins to reform[M]*. Stanford University Press.
- Cao, X., & Chai, Y. (2007). Gender role-based differences in time allocation: Case study of Shenzhen, China[J]. *Transportation Research Record*, 2014(1), 58–66. <https://doi.org/10.3141/2014-08>
- Chai, Y., Ma, J., & Zhang, W. (2010). The residential differentiation of tour-based spatio-temporal decision-making of travel behavior in Beijing City[J]. *Geographical Research*, 29(10), 1725–1734. <https://doi.org/10.11821/yj2010100001>
- Chai, Y., Liu, Z., & Zhang, Y. (2015). *Space-time behavior research and application in China[M]//space-time integration in geography and GIScience*. Springer.
- ChengShi,HaixiaoPan,YingHui,Xin Ye, et al. (2018). *Daily time allocation Behavior Analysis in Xiaoshan District of Hangzhou, China[M]//CICTP 2017: transportation reform and change—equity, inclusiveness, sharing, and innovation*. American Society of Civil Engineers.
- Clarke, M. I., Dix, M. C., and Jones, P. M., et al. (1981). Some recent developments in activity-travel analysis and modeling[J]. *Transportation Research Record*, 794, 1–8. <http://onlinepubs.trb.org/Onlinepubs/trr/1981/794/794-001.pdf>
- Ellder, E. (2014). Commuting choices and residential built environments in Sweden, 1990–2010: A multilevel analysis[J]. *Urban Geography*, 35(5), 715–734. <https://doi.org/10.1080/02723638.2014.916906>
- Ettema, D., & van der Lippe, T. (2009). Weekly rhythms in task and time allocation of households[J]. *Transportation*, 36(2), 113–129. <https://doi.org/10.1007/s11116-009-9190-3>
- Fan, Y. (2017). Household structure and gender differences in travel time: Spouse/partner presence, parenthood, and breadwinner status[J]. *Transportation*, 44(2), 271–291. <https://doi.org/10.1007/s11116-015-9637-7>
- Feng, J., Zhou, Y., & Wu, F. (2008). New trends of suburbanization in Beijing since 1990: From government-led to market-oriented. *Regional Studies*, 42(1), 83–99. <https://doi.org/10.1080/00343400701654160>
- Feng, J., Dijst, M., Wissink, B., & Prillwitz, J. (2014). Understanding mode choice in the Chinese context: The case of Nanjing metropolitan area[J]. *Tijdschrift voor Economische En Sociale Geografie*, 105(3), 315–330. <https://doi.org/10.1111/tesg.12068>
- Fezzi, C., Bateman, I. J., & Ferrini, S. (2014). Using revealed preferences to estimate the value of travel time to recreation sites[J]. *Journal of Environmental Economics and Management*, 67(1), 58–70. <https://doi.org/10.1016/j.jeem.2013.10.003>
- Goulias, K. G. (2002). Multilevel analysis of daily time use and time allocation to activity types accounting for complex covariance structures using correlated random effects[J]. *Transportation*, 29(1), 31–48. <https://doi.org/10.1023/A:1012973004152>
- Hägerstrand, T. (1970). What about people in regional science? *Papers in Regional Science*, 24(1), 7–24. <https://doi.org/10.1111/j.1435-5597.1970.tb01464.x>
- Hu, L., Sun, T., & Wang, L. (2018). Evolving urban spatial structure and commuting patterns: A case study of Beijing, China[J]. *Transportation Research Part D: Transport and Environment*, 59, 11–22. <https://doi.org/10.1016/j.trd.2017.12.007>
- Huang, Y. (2004). The road to homeownership: A longitudinal analysis of tenure transition in urban China (1949–94)[J]. *International Journal of Urban and Regional Research*, 28(4), 774–795. <https://doi.org/10.1111/j.0309-1317.2004.00551.x>
- Jara-Díaz, S. R., & Astroza, S. (2013). Revealed willingness to pay for leisure: Link between structural and microeconomic models of time use[J]. *Transportation Research Record*, 2382(1), 75–82. <https://doi.org/10.3141/2382-09>

- Jara-Díaz, S., & Rosales-Salas, J. (2017). Beyond transport time: A review of time use modeling[J]. *Transportation Research Part A: Policy and Practice*, 97, 209–230. <http://dx.doi.org/10.1016/j.tra.2017.01.022>
- Jiangping, Z., Chun, Z., Xiaojian, C., Wei, H., & Peng, Y. (2014). Has the legacy of Danwei persisted in transformations? The jobs-housing balance and commuting efficiency in Xi'an[J]. *Journal of Transport Geography*, 40, 64–76. <https://doi.org/10.1016/j.jtrangeo.2014.04.008>
- Jiangping, Z., Chun, Z., & Xiaojian, C., et al (2014). Has the legacy of Danwei persisted in transformations? the jobs-housing balance and commuting efficiency in Xi'An[J]. *Journal of Transport Geography*, 40, 64–76.
- Karthik C, Konduri., SebastiánAstroza, BhargavaSana, Ram, M. Pendyala, and Sergio R. Jara-Díaz, et al. (2011). Joint analysis of time use and consumer expenditure data: Examination of two approaches to deriving values of time[J]. *Transportation Research Record*, 2231(1), 53–60. <https://doi.org/10.3141/2231-07>
- Li, Z., & Wu, F. (2008). Tenure-based residential segregation in post-reform Chinese cities: A case study of Shanghai[J]. *Transactions of the Institute of British Geographers*, 33(3), 404–419. <https://doi.org/10.1111/j.1475-5661.2008.00304.x>
- Li, C., Zhang, Y., & Chai, Y. (2021). Do spatial factors outweigh institutional factors? Changes in influencing factors of home-work separation from 2007 to 2017 in Beijing[J]. *Journal of Transport Geography*, 96, 103201. <https://doi.org/10.1016/j.jtrangeo.2021.103201>
- Liu, Z., Ma, J., & Chai, Y. (2017). Neighborhood-scale urban form, travel behavior, and CO2 emissions in Beijing: Implications for low-carbon urban planning[J]. *Urban Geography*, 38(3), 381–400. <https://doi.org/10.1080/02723638.2016.1191796>
- Liu, C., Sun, Y., Chen, Y., & Susilo, Y. O. (2018). The effect of residential housing policy on car ownership and trip chaining behaviour in Hangzhou, China[J]. *Transportation Research Part D: Transport and Environment*, 62, 125–138. <https://doi.org/10.1016/j.trd.2018.02.008>
- Meloni, I., Guala, L., & Loddo, A. (2004). Time allocation to discretionary in-home, out-of-home activities and to trips[J]. *Transportation*, 31(1), 69–96. <https://doi.org/10.1023/B:PORT.0000007228.44861.ae>
- Mullahy, J., & Robert, S. A. (2010). No time to lose: Time constraints and physical activity in the production of health[J]. *Review of Economics of the Household*, 8(4), 409–432. <https://doi.org/10.1007/s11150-010-9091-4>
- PengjunZhao, DiLiu, ZhaoYu, Haoyu Hu, et al. (2020). Long commutes and transport inequity in China's growing megacity: New evidence from Beijing using mobile phone data[J]. *Travel Behaviour and Society*, 20, 248–263. <https://doi.org/10.1016/j.tbs.2020.04.007>
- Shen, Y., Chai, Y., & Kwan, M. P. (2015). Space–time fixity and flexibility of daily activities and the built environment: A case study of different types of communities in Beijing suburbs[J]. *Journal of Transport Geography*, 47, 90–99. <https://doi.org/10.1016/j.jtrangeo.2015.06.014>
- Srinivasan, S., Guan, C. H., & Nielsen, C. P. (2020). Built environment, income and travel behavior: Change in the city of Chengdu, China 2005–2016[J]. *International Journal of Sustainable Transportation*, 14(10), 749–760. <https://doi.org/10.1080/15568318.2019.1625088>
- Ta, N., Shen, Y., & Chai, Y. (2016). Progress in research from a lifestyle perspective of space-time behavior[J]. *Progress In Geography*, 35(10), 1279–1287. <https://doi.org/10.18306/dlxxjz.2016.10.011>
- Ta, N., & Chai, Y. (2019). Understanding the Lifestyle in Chinese Cities: A framework based on space-time Behavior research[J]. *Human Geography*, 34(2), 17–23. doi:10.13959/j.issn.1003-2398.2019.02.003.
- Timmermans, H., Arentze, T., & Joh, C. H. (2002). Analysing space-time behaviour: New approaches to old problems[J]. *Progress in Human Geography*, 26(2), 175–190. <https://doi.org/10.1191/0309132502ph363ra>
- Wang, D., & Chai, Y. (2009). The jobs–housing relationship and commuting in Beijing, China: The legacy of Danwei[J]. *Journal of Transport Geography*, 17(1), 30–38. <https://doi.org/10.1016/j.jtrangeo.2008.04.005>

- Wang, D., Chai, Y., & Li, F. (2011). Built environment diversities and activity–travel behaviour variations in Beijing, China[J]. *Journal of Transport Geography*, 19(6), 1173–1186. <https://doi.org/10.1016/j.jtrangeo.2011.03.008>
- Wang, D., & Zhou, M. (2017). The built environment and travel behavior in urban China: A literature review[J]. *Transportation Research Part D: Transport and Environment*, 52(Part B), 574–585. <https://doi.org/10.1016/j.trd.2016.10.031>
- Wong, C., Zheng, W., & Qiao, M. (2020). Urban expansion and neighbourhood commuting patterns in the Beijing metropolitan region: A multilevel analysis[J]. *Urban Studies*, 57(13), 2773–2793. <https://doi.org/10.1177/0042098019884254>
- Yamamoto, T., & Kitamura, R. (1999). An analysis of time allocation to in-home and out-of-home discretionary activities across working days and non-working days[J]. *Transportation*, 26(2), 231–250. <https://doi.org/10.1023/A:1005167311075>
- Yao, M., & Wang, D. (2018). Mobility and travel behavior in urban China: The role of institutional factors[J]. *Transport Policy*, 69, 122–131. <https://doi.org/10.1016/j.tranpol.2018.05.012>
- Zhang, M., He, S., & Zhao, P. (2018). Revisiting inequalities in the commuting burden: Institutional constraints and job-housing relationships in Beijing[J]. *Journal of Transport Geography*, 71, 58–71. <https://doi.org/10.1016/j.jtrangeo.2018.06.024>
- Zhang, X., Wang, J., Kwan, M. P., & Chai, Y. (2019). Reside nearby, behave apart? Activity-space-based segregation among residents of various types of housing in Beijing, China[J]. *Cities*, 88, 166–180. <https://doi.org/10.1016/j.cities.2018.10.009>
- Zhou, S., Wu, Z., & Cheng, L. (2013). The impact of spatial mismatch on residents in low-income housing neighbourhoods: A study of the Guangzhou metropolis, China[J]. *Urban Studies*, 50(9), 1817–1835. <https://doi.org/10.1177/0042098012465906>
- ZuopengXiao,TianbaoLiu,YanweiChai,Mengke Zhang,et al. (2020). *Rethinking the spatial prototype and operational organization of the Chinese danwei system from a collective perspective[M]// The socio-spatial design of community and governance*. Springer.