



School travel mode choice in Beijing, China

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ABSTRACT

This study explores school travel mode choice behavior of 7–18 year-old students in Beijing, China, based on the data collected in Fifth Travel Survey of Beijing Inhabitants. The integration of tree-based and logit-based models is employed to examine the influence of key variables on school travel mode choice. In particular, the tree-based model is used to preliminarily select the traits which have a statistical effect on mode choice, and the logit-based model is used to provide deeper understanding of the underlying decision processes and the correlation effects of the variables. Results show that car ownership, poor walking/cycling environment, and adults' convenience for escorting students significantly stimulate the use of cars in school commuting. Students are more inclined to choose cars when their departure time is at rush hour compared to the other time. Moreover, the longer distance encourages the use of motorized transport, where the households with local *hukou* (usually related to the car ownership and other welfares) are more willing to drive their children to school. A number of recommendations on car restraint, sustainable travel environment improvement, different working hour implementing, and educational resources layout for the encouragement and promotion of sustainable travel practices are lastly proposed.

1. Introduction

Active modes of travel and independent mobility among children have attracted attention for their benefits to personal growth, communal harmony, and sustainable development of the society (Mitra and Buliung, 2015; Marique et al., 2013). From the personal perspective, the behavior of children now will build their future behavior (Carlos, 2003). The phase in school is the most important period in students' growth, during which the world outlook, philosophy and value view begin to form in their mind. Understanding students' school travel mode choice behavior is significant to reinforce or reshape their travel pattern and awareness of active and independent mobility, and further promote their physical and mental health. For the families, scheduling a child escort becomes increasingly widespread for many parents around the world due to the travel safety concerns and the poor walking/cycling environment. Understanding students' school travel mode choice behavior can help government create a better travel environment for school commuting, and decrease the share of household escort. At the household level, the associated travel demand can be reduced and the travel cost can be saved. From the social perspective, the household escort, especially the auto-based household escort, results in traffic congestion and environment pollution near school. Not only has the road capacity been degraded, but also the access environment of school gate is affected negatively. Thus, it is necessary to analyze students'

school travel mode choice behavior to encourage an active and independent lifestyle, and eventually support the sustainable development of the society.

The existing research on students' school travel behavior analysis has paid disproportional attention to Western countries. In view of the situation in China, there are several special aspects need to be mentioned given the different economic and social settings. 1) *Household structure*: Because of the population control effort (i.e., one-child policy) between 1978 and 2015, most Chinese families have no more than one child in recent years. According to the data from United Nations Population Division Department of Economic and Social Affairs, the total fertility rate in China has fallen to nearly 1.5 by the late 1990s from 5.9 births per woman in 1970 and remained at this level since (Zeng and Hesketh, 2016). Specifically, the one-child policy was strictly enforced for urban residents, who accounted for about 20% of the population in 1980, and almost half by 2010. The Beijing Statistical Yearbook (2015) also shows that there are 81.7% of households having three or less people in Beijing. As the result, the only-child is the greatest hope of the whole family and is provided with all the available resources from the emotional aspect to the economical aspect. He/she may be loved and taken good care of, and get the best possible education within the household financial ability. 2) *Public school construction mechanism*: In China, there are more than 95% of students attending the public school constructed and maintained by the local

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government (Lu et al., 2017). In contrast to Western countries, Chinese people have no obligation to pay the property tax and thus have no right to influence the public budgeting of local government. During the rapid spatial expansion of monocentric Beijing city, many citizens move to suburb due to the expensive house price and limited land supply in downtown. However, the government funding cannot afford to build more public schools, especially good-quality public schools in the new neighborhoods. There is a serious spatial separation between public schools of high quality and suburbanites. And many students will face to the longer school travel distance between home and school. 3) *Admissions policy*: In China, especially in a large city like Beijing, *hukou* and house property are the two indispensable requirements for a child to get the access to public school. It should be noted that *hukou* institution is a special population policy used to control the movement of the rural population into the city (Li and Zhao, 2015). Moreover, it directly influences the distribution of the state's welfare, such as education as well as the purchase qualifications of house and vehicle. In this situation, a child without local urban *hukou* can be refused to attend the near public school, while a child with local urban *hukou* can go to a good school although he/she does not actually live in the specified school district. For the later one, his/her parents can buy an old or small house in good school district and live in other place with better living conditions. *Hukou* can provide a child better education, better living conditions, and more travel mode choices, etc. In this context, it is questionable whether the same results concluded in western world can be also found in China.

This paper attempts to conduct an empirical study of China, in order to contribute a deeper understanding of students' school travel mode choice, and further help create a better school commuting environment for students' active and independent mobility in developing countries. To identify and quantify the key influencing factors, a tree-based regression model and a logit-based regression model are employed.

The remainder of this paper is organized as follows: Section 2 reviews recent relevant literature on students' school travel behavior. Section 3 presents an overview of the region selected. Section 4 describes the data set. The methodology is introduced in Section 5, and the modelling results are analyzed in Section 6. This is followed by a discussion of the implications for transport policy and practice in Section 7. Finally, the conclusions of the present paper are provided in Section 8.

2. Literature review

There is a growing literature examining the travel mode choice decision (McDonald, 2008a) or accompaniment decision (Ermagun and Levinson, 2016a) of children in school trips. A few studies (Yarlagadda and Srinivasan, 2008; Ermagun et al., 2015a; Ermagun et al., 2015b) have attempted to model the mode choice and accompaniment choice in a joint framework, as they believe these decisions are made simultaneously. This section discusses the previous studies on travel

mode choice of children in school trips, which are in line with the contribution of the current study. Table 1 summarizes the previous studies, which are selected to cover main characteristics of studies including location, year of study, and methodology.

From the methodology side, studies either use descriptive analysis or advanced statistical and machine learning models such as multinomial logit (McDonald, 2008a), nested logit (Ermagun and Samimi, 2015), cross-nested logit (Ermagun and Levinson, 2016b), and random forest (Ermagun et al., 2015b). Descriptive methods are usually used to identify influencing factors based on statistical descriptions only, while analytical methods not only recognize influencing factors but measure the power of these factors such that the final results can be used for forecasting (Ermagun et al., 2015b).

From the influential variable side, research has studied four main categories of variable: children's characteristics, households' characteristics, built environment, and parental concerns.

2.1. Children's characteristics

Age, gender are the most important variables that are explored among children's characteristics. As far as age is concerned, the results of studies are mixed. A few studies reported a positive correlation between age and using active modes of travel (McDonald, 2008a; Ermagun and Samimi, 2015; Li and Zhao, 2015). Some studies found a negative correlation. In a research of Australian students, it is reported that students aged 10–12 years were less likely to travel to school actively compared with their younger counterparts aged 5–6 years when their travel routes to school are well-connected (Timperio et al., 2006). Similarly, the research results of Mitra and Buliung (2015) also indicated the negative effect of age related to senior mobility in active commuting rates. In some studies, no significant correlation is reported (Kerr et al., 2006). This dissimilarity may be rooted in three aspects: 1) different sample selections, especially for the age distribution; 2) different minimum driving ages for different countries; 3) different methodologies (Samimi and Ermagun, 2012).

As far as gender is concerned, the results of studies are also mixed. Fyhri and Hjorthol's (2009) study of Norwegian children's travel modes found that boys were more often independently mobile than girls. A contrary finding was found by Leslie et al. (2010) in Australia. They showed that probability of walking is about 44% among girls and 37% among boys. Samimi and Ermagun (2012) also reported that the propensity of girls choosing to walk to and from school is more than boys in Tehran, Iran.

2.2. Households' characteristics

At a household level, it is generally acknowledged that household characteristics play an important role in students' school travel choice, the hotly debated of which are household wealth (e.g., household income, vehicle ownership etc.), household structure (number of workers,

Table 1
Summary of previous studies on mode choice decision in school trips.

Study	Location	Age	Method	Travel modes
Ermagun and Levinson (2016b)	Iran	12–17	Cross-nested Logit	Active, auto, public transit, school bus
Ermagun et al. (2015b)	Iran	12–17	Nested Logit & Random Forest	Active, auto, public transit, school bus
Deka (2013)	U.S.	5–15	Heckman Probit	Active, auto, school bus
Nevelsteen et al. (2012)	Belgium	6–12	Logistic Regression	Active, auto, public transit
Alemu and Tsutsumi (2011)	Japan	15–18	Multinomial Logit	Active, auto, public transit
Mitra et al. (2010)	Canada	11–13	Binomial Logit	Active, auto
Lin and Chang (2010)	Taiwan	3–18	Nested Logit	Active, auto, public transit, vanpooling, motorcycle
Nelson et al. (2008)	Ireland	15–17	Logistic Regression	Active, auto, public transit
McDonald (2008a)	U.S.	5–13	Multinomial Logit	Active, auto, public transit
Mota et al. (2007)	Portugal	12–16	Logistic Regression	Active, auto, public transit
Merom et al. (2006)	Australia	5–12	Logistic Regression	Active, auto, public transit
Li and Zhao (2015)	China	13–15	Logistic Regression	Active, auto, public transit

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