Promoting Active Transport in Students' Travel Behavior: A Case from Yogyakarta (Indonesia)

Muhammad Zudhy Irawan (Corresponding author)

Graduate School of Engineering, Kyushu University

744, Motooka, Nishi-ku, Fukuoka, Japan, 819-0395

Tel: 81-92-802-3403   E-mail: irawan@civil.doc.kyushu-u.ac.jp

Tomonori Sumi

Graduate School of Engineering, Kyushu University

744, Motooka, Nishi-ku, Fukuoka, Japan, 819-0395

Tel: 81-92-802-3403   E-mail: sumi@doc.kyushu-u.ac.jp

Abstract

School active commute has decreased in the last few decades. This occurrence resulted not only in increasing congestion and pollution, but also in decreasing children's physical health. This study aims to understand students' travel behavior on school commute by finding the factors influencing travel mode choice. A multinomial logit model was used to explain the students' travel behavior in Yogyakarta, a city which is dominated by motorcyclists.   A number of 878 students were selected classifying into children (6-12 years old) and adolescents (13-18 years old). Empirical results showed that distance from home to school is the critical factor in determining active commute. However, factors of age, gender, and characteristics of students' household also play an important role in shaping students' travel behavior. Finally, to revive active commute, several appropriate policies such as bike to school program or synchronization of work and school start/end time were proposed in this study.

Keywords: Travel behavior, Active commute, Mode choice, Students

1. Introduction

The development of sustainable transportation is always associated with transport policy and technology, where it aims to minimize environment impact caused by motor vehicles such as congestion, air pollution, and noise. The design of vehicle free city planning and making environmentally-friendly vehicles are some actions taken toward a sustainable transport in the future.

However, by the low impact on the environment produced, promoting an active transport is an easy way to pursue that goal for the present. According to Litman (2003), walking, cycling, skating, and manual wheelchairs were classified into definitions of active transport in regards to means of transportation moved by human power. Further, trips using public transport were also considered within active transport due to walking on access or egress roads (National Public Health Partnerships, 2001).

Unfortunately, several countries have suffered significant decline of active transport in the last few decades. For instance, in the United Stated, walking has decreased from 9.35% of all trips in 1969 to 8.6% of all trips in 2001 (Florida Department of Transportation and Center for Urban Transportation Research, 2006). A decrease in active transport is also indicated by a sharp increase of motor vehicles ownership. According to the Federal Highway Administration, the number of motor vehicles in United Stated steadily increases in each year since 1960 except in 1991 and 1998 (Federal Highway Administration, 2003).

The dependency of private vehicle use has spread out to the children's travel behavior. McDonald (2007) found that a significant increase of students using automobiles either escorted or self driven has occurred from 17% in 1969 to 55% in 2003. In fact, the population of children has been increasing since the last few decades (Ewing et al., 2004; United States Census Bureau, 2005). These occasions give a tendency to private motor vehicle use in the future, and therefore it is contrary to the principle of development of sustainable transportation which is expected for people to take public transports, walk, or cycle in their daily travels.

In Indonesia, the similar condition has been occurring. Motor vehicles especially motorcycles sharply increase in every year. Indonesia Ministry of Transportation recorded that private vehicles have risen 74.95 percent in just four years. This situation directly impacts on high number of traffic accidents. In 2008, there were 91,598 traffic

accident casualties or increase 429 percent from the previous five years. People aged 15-25 years old have the highest percentage due to accident casualties on the road (Indonesia Ministry of Transportation, 2008).

This study aims to understand the children's travel behavior regarding to school commute in Yogyakarta, Indonesia. Specifically, we examine the relationship between travel mode and the factors that might influence mode choice. By understanding their behaviors, we thus can find various rigorous policies to promote school active commute based on the empirical results. Obviously, since the groups of population aged 5-9, 10-14, and 15-19 years old are three largest respectively based on five year groupings (Indonesia Central Bureau of Statistics, 2005), children's trips are predicted have a significant contribution on traffic congestion. By promoting active transport on children's travel behavior, we not only reduce traffic congestion and pollution, but also increase the physical fitness (Oja et al., 1998) and prevent children obesity (Fox, 2004).

The city of Yogyakarta was selected as a study area regarding the centre of education in Indonesia. As shown in Figure 1, there are 349 schools within Yogyakarta, which consists of 184 elementary schools, 64 junior high schools, and 61 senior high schools (Yogyakarta Statistical Agency, 2007). Students in those levels of school were chosen as respondents. However, considering the different travel behaviors between children and adolescents, particularly relating to parental intervention in determining travel mode to/from school, we thus classified the respondents into two different groups: students aged 6-12 years old were categorized as children and students aged 13-18 years old were categorized as adolescents.

2. Literature Review

Even though the studies on children's travel behavior are intensively researched lately, most of these studies focused travel mode choice on whether using bicycle or walk (Everson et al., 2003; Hume et al., 2009). Also, policies proposed to promote active transport to school still remain on walking and biking transport modes (Staunton et al., 2003).

In its development, several studies have considered alternative transport modes (e.g. private vehicles, school buses, public transports) and the effect of household characteristics such as factors of income and number of private motor vehicles ownership into children's travel mode (DiGuiseppi et al., 1998; Vovsha and Petersen, 2005). However, only a few studies that examine more deeply about the characteristics of each household member. For instance, whether or not there is an influence of the number of employees with designated start time at workplace or the number of school going children in a household on children's travel mode choice to school.

More importantly, in regards to private motor vehicle as an alternative mode to/from school, several previous studies examined that identified private motor vehicles are car (Muller et al., 2008; Fyhri and Hjorthol, 2009; Zwerts et al., 2009).Therefore, children from low income household tend to do active transport due to private car unavailability (McMillan, 2006; McDonald, 2008). Meanwhile in eastern Asian countries, it is clear that motorcycle plays an important role in daily life even though it is not popular in western countries (Hsu et al., 2003; Chang and Wu, 2008). By the motorcycle's affordable price, it will be easier for children from low income household to use this transport means as an alternative mode to school.

Therefore, considering the above mentioned, we also attempt to solve the major gaps from previous researches in achieving the objective of this study.

3. Methodology

3.1 Questionnaire Survey

A questionnaire survey was carried out from March to May 2009 in several schools in Yogyakarta. Out of 1,362 randomly distributed forms, 878 forms (64.46%) were recollected effectively.   The surveying items consist of two main parts, those are: 1) individual information, such as age, gender, home address, driving license ownership, and transport means to and from school, 2) characteristics of household, such as: number of private vehicles ownership, number of school going children, and characteristics of family members in a household. As a result, a basic descriptive statistic and travel mode to/from school are shown in Table 1 and Table 2 respectively.

A number of 472 children and 406 adolescents participated in this survey. There were seven alternatives on modes combination to and from school. Escorted by family members became the highest students' travel mode choice. Many students prefer to be escorted by family members particularly on travel to school. From 58.66 percent of students escorted to school and 43.85 percent of students picked up at school, there were only 3.69% and 3.38% of escorted students were chauffeured by cars on trip to and from school respectively, whereas the rest were chauffeured by motorcycles.

3.2 Proposed Model

A multinomial logit model was used to find the factors influencing students' travel modes choice. This model assumes that a person will choose a choice which has the highest utility value (McFadden, 1981). Suppose that the utility of a mode (*i*) chosen by person *n* between the other modes (*j*) is given by:

$$U_{ni} = \alpha_i + \beta X_{ni} + \varepsilon_{ni} \tag{1}$$

Where, α represents a vector of constants of mode *i*, β indicates a vector of coefficients defining the utilities of mode *i*, X_{ni} is a vector of explanatory variables on mode *i* by traveler *n*, and ε_{ni} shows an extreme-value error vector specific to mode *i* by traveler *n*.

In this study, the explanatory variables consist of characteristics of students (age, gender, and driving license ownership), characteristics of households (number of vehicles ownership, number of school-going children), characteristics of family members (number of family members with designated work start/end time), and distance from home to school.

Then, by assuming ε_{ni} is independently and identically gumbel distributed among other choice travel mode, the probability of mode *i* chosen by traveler *n* is expressed by:

$$P_{ni} = exp\,(U_{ni})/\sum_{i\epsilon j} exp\,(U_{nj}) \tag{2}$$

The coefficients can be estimated by maximizing the log likelihood function as shown below.

$$LL = \sum_{n=1}^{N} \sum_{i\epsilon j} \theta_{ni}\,ln\,(P_{ni}) \tag{3}$$

Where θ_{ni} is equal to 1 if traveler *n* chooses mode *i* and 0 if otherwise.

4. Result and Discussion

Applying the above proposed model, the estimated coefficients of explanatory variables are shown in Table 3 and Table 4. It should be noted that motorcycle mode and escorted by parents/family members were treated as reference points for adolescents' and children's trip behaviors respectively. Then, the utilities of other modes were modeled relative to the base mode.

4.1 Characteristics of Students

Looking into the factor of gender, there were no reciprocal relationships on children's and adolescents' trips to school by walk, bicycle, or take the buses. The similar result occurred on travel from school except on children walking and taking the buses. On these two modes, positive correlations were found showing boys are more likely to walk or take the buses from school than picked up at school.

Relating to the factor of age, a positive relationship occurred on children walking, biking, and taking the buses from school. Meanwhile, on travel to school, the similar result only occurred on bicycle mode choice. It shows that younger children tend to be escorted by family members than use those modes. Perhaps, parental fears in respect to the children's maturity and capability in overcoming vehicle traffic flow are one of the reasons of these circumstances. Therefore, a safe route to/from school program by providing sidewalks or special lanes for bicyclists is predicted can stimulate children in active commute.

In term of adolescents' travel behaviors, negative correlations were found both on travel to and from school in all travel modes, meaning older adolescents have a propensity to self driven. This phenomenon can be connected with driving license ownership factor, which shows a positive correlation on motorcycle use. When an adolescent is old enough to obtain driving license, he/she absolutely chooses motorcycle as his/her travel mode on school commute. However, girls have a tendency to be escorted by family members than self driven due to parental fears. As a result, an increase on minimum age to obtain the driving license can effectively shift to active transport means both on travels to and from school.

4.2 Characteristics of Households

Except on children walking and cycling to school, the presence of multiple vehicles in a household affects on private vehicle mode choice. The more vehicles owned in a household, the more possibility for students to use private vehicle either escorted or self driven. Meanwhile, in term of children walking and cycling to school, uncorrelated variables between private motor vehicle ownership and active transport to school showed that children have a dependence to be chauffeured to school by motorcycle mode. This result gives a different behaviour on children's travel mode choice compared to several previous researches, where the identified private motor vehicles are car (see: McMillan et al., 2006; Ewing et al., 2004; Braza et al., 2004).

The existence of multiple school-going children only influence on children's travel mode choice by bicycle. In this case, a negative correlation was found showing children from a household with multiple school-going children are less likely to be escorted to/ from school.

4.3 Characteristics of Family Members

Designated work end time has a positive impact to all travel modes choice by children, meaning that parents or family members are less liable to pick their children up at school due to parents' unfinished working time. Meanwhile, there was a positive relationship in adolescents' travel behavior relates to parental escort, showing that parents or family members with designated work start time incline to set out to work jointly with their children or siblings who are high school students. Probably, it reflects the convenience to synchronize students' and workers' departure time. Hence, a synchronization of work and school start/end time is predicted can reduce the possibility to self driven on adolescents' travel behavior.

4.4 Distance

As shown by negative values in active transport modes, the tendency of students in active commute will decline due to the increasing of distance from home to school. Walking has a much higher sensitivity compared to the other active transport means, mainly on travel to school. Consequently, it will be difficult to promote "walk to school" program. Other programs such as "bike to school" can be chosen as an alternative in promoting active school commute. Instead reducing air pollution level, this program also can be a barrier to motorcycle use.

5. Conclusion

This paper revealed the factors influencing students' travel behaviors in mode choice due to decreasing active commute in the last few decades in Yogyakarta, Indonesia. Several appropriate policies are then proposed in this study to promote active transport and reduce the motorcycle use.

Empirical results showed that students' travel mode to/from school is highly influenced by students' inherent characteristics. For instance, older students tend to walk, bike, or take the buses on school commute. Meanwhile, boys are less likely to be escorted in case of travel from school. However, driving license ownership and distance are the most influence factors in shaping students' travel behavior whether or not students do active commute. On the other hand, characteristics of students' household, such as the number of vehicles ownership and the number of school-going children in a household also contributed in determining students' travel behavior. The more private vehicles are owned in a household, the less possibility for students to walk, cycle, or use the buses to/from school. Meanwhile, in term of family members' characteristics, designated start/end time at workplace also impacted on students' travel mode choice. Many adolescents are escorted to school by family members on the way to office.

Finally, several proposed policies such as providing sidewalks and bicycle special lanes, increasing the minimum age in obtaining a driving license, synchronizing work start/end time and adolescent's school start/end time, and bike to school program are useful programs to promote school active commute and pursue a sustainable transport in Yogyakarta, Indonesia.

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Table 1. Statistic of the explanatory variables

Explanatory Variables	Description	Mean (std)	
		Children	Adolescents
Characteristics of Students			
1. Age	Student's age	9.157 (1.526)	16.397 (1.518)
2. Gender (Male)	Dummy, 1 if male	0.436 (0.496)	0.404 (0.491)
3. Driving License	Dummy, 1 if owning	-	0.401 (0.491)
Characteristics of Households			
1. Number of vehicles	Number of cars and motorcycles in a household	2.303 (1.149)	2.522 (1.362)
2. Number of school going children	Number of students in a household	2.127 (0.785)	1.52 (0.611)
Characteristics of Family Members	Number of family members with designated work start and end time	1.290 (0.802)	1.264 (0.97)
Distance	In kilometer	3.029 (2.564)	5.187 (3.434)

Table 2. Travel mode choice

		Travel Modes From School					
		Walking	Bicycle	Motorcycle	Escorted	Bus	**Total**
Travel Modes to School	Walking	7.4					**7.4**
	Bicycle		7.97				**7.97**
	Motorcycle			18.91			**18.91**
	Escorted	3.08			43.85	11.73	**58.66**
	Bus					7.06	**7.06**
	Total	**10.48**	**7.97**	**18.91**	**43.85**	**18.79**	**100**

Table 3. Coefficients of travel mode to school

	Children			Adolescents			
	Walking	Bicycle	Bus	Walk	Bicycle	Bus	Escorted
Characteristics of Students							
1. Age	-0.318 (0.258)	**0.732 (0.162)***	-	**-2.057 (0.566)***	**-1.316 (0.307)***	**-1.043 (0.276)***	**-1.083 (0.263)***
2. Gender (Male)	-0.461 (0.63)	0.073 (0.384)	-	-0.153 (1.369)	-0.548 (0.666)	0.878 (0.53)	**1.053 (0.466)**
3. Driving License	-	-	-	**-5.43 (1.919)***	**-4.177 (1.194)***	**-3.989 (0.755)***	**-2.817 (0.49)***
Characteristics of Households							
1. Number of vehicles	0.019 (0.323)	-0.139 (0.219)	-	**-4.565 (1.133)***	**-2.528 (0.414)***	**-2.370 (0.342)***	**-1.808 (0.285)***
2. Number of school-going children	0.263 (0.363)	**-0.673 (0.27)**	-	-0.743 (1.079)	-0.075 (0.548)	-0.11 (0.426)	-0.331 (0.36)
Characteristics of Family Members	-0.224 (0.393)	0.304 (0.248)	-	0.704 (1.119)	**1.318 (0.392)***	**1.114 (0.32)***	**0.804 (0.277)***
Distance	**-1.268 (0.254)***	**-0.173 (0.035)***	-	**-0.818 (0.276)***	**-0.069 (0.018)***	-0.001 (0.007)	0.007 (0.006)
Constant	**7.596 (2.835)***	**-5.571 (1.635)***	-	**54.42 (12.859)***	**28.77 (5.593)***	22.674 (5.012)	**22.92 (4.784)***
Log-likelihood	-123.844			-250.497			

Bold indicates the parameter is statistically significant at the 95% level, whereas * is statistically significant at the 99% level. Standard errors of the estimated coefficients are in parentheses.

Table 4. Coefficients of travel mode from school

	Children			Adolescents			
	Walking	Bicycle	Bus	Walk	Bicycle	Bus	Escorted
Characteristics of Students							
1. Age	**0.556 (0.195)***	**1.119 (0.196)***	**0.91 (0.165)***	**-2.014 (0.565)***	**-1.275 (0.307)***	**-0.95 (0.266)***	**-1.3 (0.277)***
2. Gender (Male)	**1.489 (0.501)***	**0.851 (0.441)**	**0.987 (0.405)***	0.15 (1.368)	-0.516 (0.667)	-0.908 (0.487)	**1.139 (0.505)**
3. Driving License	-	-	-	**-5.436 (1.914)***	**-4.274 (1.2)***	**-3.742 (0.56)***	**-2.02 (0.575)***
Characteristics of Households							
1. Number of vehicles	**-1.393 (0.352)***	**-0.61 (0.27)**	-0.384 (0.211)	**-4.564 (1.137)***	**-2.524 (0.412)**	**-2.134 (0.304)***	**-1.663 (0.31)***
2. Number of school-going children	-0.281 (0.308)	**-0.851 (0.303)***	-0.249 (0.264)	-0.736 (1.077)	-0.069 (0.548)	-0.156 (0.379)	-0.427 (0.404)
Characteristics of Family Members	**1.026 (0.348)***	**0.802 (0.295)***	**1.165 (0.286)***	0.789 (1.12)	**1.403 (0.398)***	**1.178 (0.296)***	0.431 (0.306)
Distance	**-0.579 (0.086)***	**-0.268 (0.05)***	-0.011 (0.009)	**-0.816 (0.276)***	**-0.069 (0.018)***	0.00 (0.006)	0.013 (0.007)
Constant	-0.268 (1.837)	**-7.422 (1.877)***	**-11.5 (1.858)***	**53.59 (12.814)***	**28.02 (5.581)***	**21.347 (4.836)***	**25.22 (4.959)***
Log-likelihood	-218.207			-236.077			

Bold indicates the parameter is statistically significant at the 95% level, whereas * is statistically significant at the 99% level. Standard errors of the estimated coefficients are in parentheses.
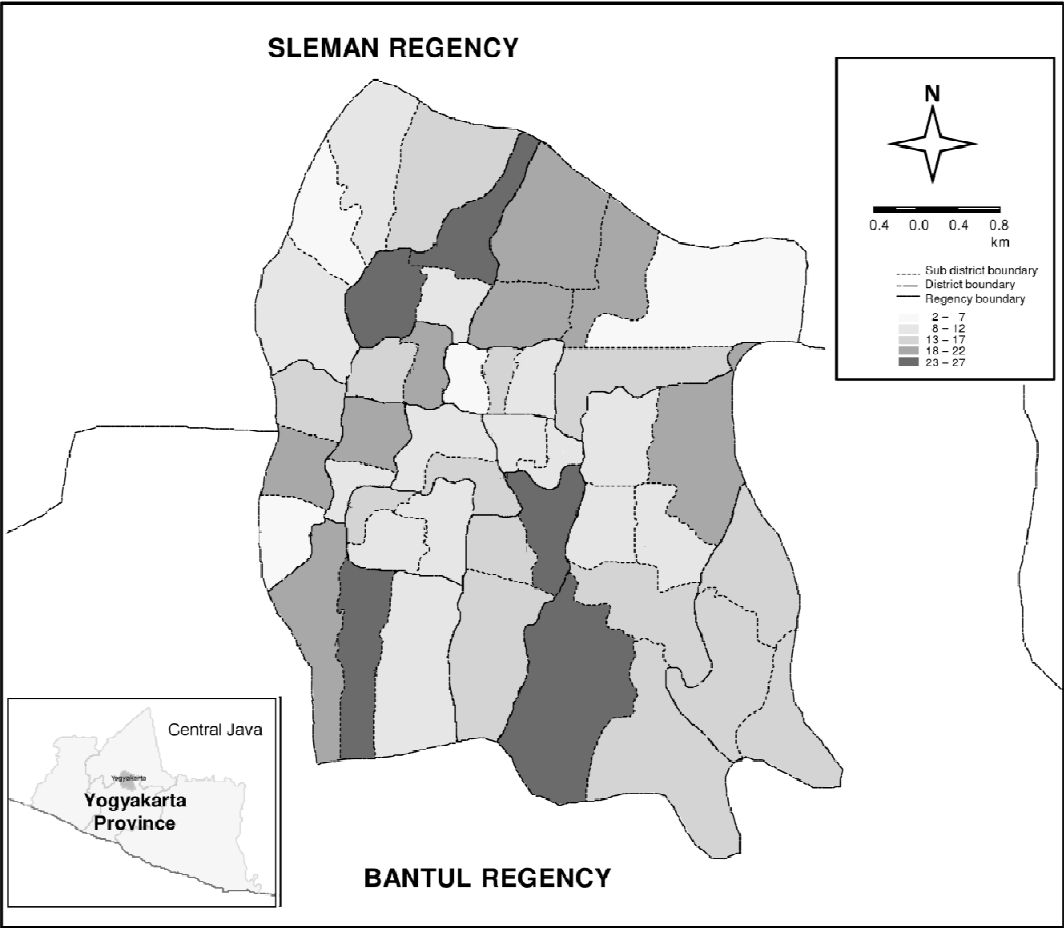
Figure 1. The City of Yogyakarta: Number of School and Its Deployment Location