

DETERMINANTS OF CHILDREN'S SCHOOL TRAVEL MODE USE IN DAR ES SALAAM

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Abstract: Numerous factors affecting school children travel mode choice and usage have been reported in many studies. However, very little has been reported in similar studies undertaken in developing countries with little evidence from African cities where vehicle ownership is still very low and conditions in support of walking, cycling and public transport services are very poor. The study reported in this paper contains econometric analysis of school children's behaviour with regards to their choice between motorised transport and non-motorised transport modes for school travel in the Dar es Salaam city. Using data collected from an experimental survey, a binary Logit model and its marginal effects were estimated. The study reported in this paper attempts to add to the existing literature by providing additional insights into the association of some of the factors that have been reported in previous studies with motorised modes of travel and non-motorised modes which are commonly used by children to travel to/ from school in Dar es Salaam.

Keywords: econometric analysis, binary Logit model, motorized modes, non-motorised modes.

1. Introduction

Transport is an important component of the socioeconomic status of any country and a common tool used to facilitate socioeconomic development. This is even more so in a global economy where economic opportunities have been increasingly related to the mobility of people, goods and information. However, transport, especially in cities, causes a number of problems such as environmental problems and human health problems due to emissions of noise or vibrations, and road crashes. Walking and cycling modes cause virtually no noise or air pollution, and are ideal means of travel around cities. They don't require much space

and are quite economical, costing much less than the car and public transport (Pucher and Dijkstra, 2000; Rwebangira, 2001; De Langen and Tembele, 2001), both in direct user costs and infrastructure provision costs (Pucher and Dijkstra, 2000). Despite the fact that the growth of cities and towns and the change of lifestyles and preferences have made it possible to have workplaces and residences in different locations, walking and cycling modes are still important modes of transport due to its positive impacts on the urban environment, transport system, safety, and health behaviours. Additionally, walking and cycling are even more important to children due to the fact that children are a growing population segment in

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many urban areas around the world. In terms of transport, however, children are an overlooked and vulnerable population segment especially in developing countries. Europe, New Zealand and the US have long recognised the importance of cycling and walking to school trips. These countries have implemented a wide range of measures to improve safety of routes to school and as a result, they have developed the necessary technology and methods for implementation of cycling and walking programmes (Pucher and Dijkstra, 2000). Likewise, it is from the aforementioned countries where numerous studies and hence literature can be found on factors affecting school travel mode choice (Beck *et al.*, 2008). Subsequently, a considerable amount of research aimed at studying children's school travel mode choice behaviour has been conducted in these countries. Consequently, numerous factors affecting school travel mode choice have been identified.

Existing studies show that travel distance, and hence travel time, has been found to be the most significant determinant factor in the school travel mode choice (Ermagun and Samimi, 2012; McDonald, 2008; McMillan, 2007; Ewing *et al.*, 2004; Cervero and Duncan, 2003). Studies conducted by Krizek (2003) and McCormack *et al.* (2008) have shown that a distance of 400 m which is about five-minute walk is often used as an acceptable walking distance. McMillan (2007) observed that school children who live within 1.6 kms from their school are more likely to choose non-motorised modes of transport than those who live farther than 1.6 km from school. This is because many school children are not willing to walk long distances and therefore are much more sensitive to walk travel time than car travel time. Ewing *et al.* (2004) found that school

children with shorter walk and bike times to and from school are more likely to walk and bike. Generally, as reported by Hatamzadeh *et al.* (2017) travel distance has a negative sign in school travel mode choice models and diversely affects walking tendency.

Age has also been reported as an important determinant of walking travel behaviour. Some previous studies have shown that the age variable has a significant and negative effect on walking mode (McDonald, 2008; Wilson *et al.*, 2010), while other studies found that the probability of choosing walking and cycling increases as age increases (Yeung *et al.*, 2008; Pabayo *et al.*, 2011; Su *et al.*, 2013). McDonald (2008) noted that the probability of choosing walking declines when children get older (during high school) but with insignificant effect, while the age variable was only significant for children between 5 and 14 years (elementary and middle school children). However, studies such as Hatamzadeh *et al.* (2017) found that the age variable has a significant and negative effect on walking to school among high school students, but no significant effect on walking mode choice of children between 5 and 14 years. Other studies such as Ermagun and Samimi (2012) found no significant relation between age and choosing non-motorised modes of transport for school travel.

Gender has also been noted to be a significant factor on walking behaviour of school children. Many studies on school travel have found that girls are less likely to walk than boys (Cooper *et al.*, 2003; Marten and Olds, 2004; McMillan *et al.*, 2006; McDonald, 2008; Johnson *et al.*, 2010; Hatamzadeh *et al.*, 2017). Additionally, Evenson *et al.* (2003) observed that rates of walking were generally higher for older boys (in high school) who had a lower body mass index and had

parents that were infrequently home after school. However, studies done by Wilson *et al.* (2010), Ermagun and Samimi (2012), Bopp *et al.* (2012) do not support the finding that boys are more likely to walk to school than girls, while other studies on elementary school children travel behaviour have found no relation between gender and children's walking to school (Su *et al.*, 2013; Carlin *et al.*, 1997). Su *et al.* (2013) argued that gender differences at the age for elementary school may not yet be a determinant factor in influencing children's walking to school rates.

There are also some studies that have investigated the effects of household socioeconomic characteristics on the use and choice of transport modes of school children. Numerous studies such as Spallek *et al.* (2006), McMillan (2007), Pabayo *et al.* (2011) and Ermagun and Samimi (2012) have shown that children of parents with lower income level are more likely to choose walking and cycling modes for school travel than those with higher income. Other studies (Copperman and Bhat, 2007; Wilson *et al.*, 2010; Mackett, 2011; Park *et al.*, 2013), have reported households' access to private cars with a negative effect on non-motorised modes of transport for school travel. McMillan (2007) observed that the number of cars per driver in the household had no effect on the school travel mode choice. Ewing *et al.* (2004) found that students from households with more vehicles per capita and higher incomes are less likely to walk to school than to take a car, school bus or bicycle. This result is supported by Hatamzadeh *et al.* (2017) who reported that regardless of age, school children who have a car in their household are less motivated to walk to school.

The influence of the built environment and urban form on school travel mode choice have also been investigated. The results are somehow mixed; the built environment has been found to exert a small, but significant, effect on walking to school (McDonald, 2008). Srinivasan and Rogers (2005) found the location to be one of the factors influencing travel mode choice. Braza *et al.* (2004) found that walking and biking rates were associated with neighbourhood density (positively) and school size (negatively). Similarly, it has been found that urban form variables have a relatively less impact on mode choice compared to other variables like socioeconomic attributes, distance, and vehicular traffic conditions (McMillan *et al.*, 2006). Boarnet *et al.* (2005) found a sidewalk improvement, crossing improvements and traffic control enhancements, increased walking and cycling among school children. Likewise, Ewing *et al.* (2004) found the street sidewalk coverage to have the most significance influence on walking. However, they also found that none of the other urban form variables that proved important in earlier studies, such as neighbourhood population density and street tree coverage, proved significant.

Other factors influencing children travel behaviour include traffic safety and parental perception about traffic danger and the risk of abduction or harassment (McDonald, 2008). Ridgewell *et al.* (2009) noted that perceived stranger danger or a danger of assault and the danger from the increase in traffic as the most significant factors influencing the choice of car instead of bicycles for school trips. Transport mode safety plays a significant role in mode choice for many parents as they believe that driving

children to school is safer than having them use non-motorized transport modes (Rhoulac, 2005).

On the other hand, few studies have provided some insights into children's travel to school in Africa. For instance, AU *et al.* (2005), Porter and Blaufuss (2002) and Porter *et al.* (2011) noted that the majority of children in Africa travel to/from school on foot. AMEND and FIA (2016) observed that Africa has the most dangerous roads in the world. This is due to the neglect of pedestrians, absence of footpaths and safe crossings, the poor management or maintenance of those footpaths that do exist, the lack of street lighting, and the lack of speed control. Porter *et al.* (2011) also observed that the journey to school is usually perceived by parents and children to be hazardous due to the potential for human attack and harassment. Further, Porter *et al.* (2011) observed that parents or guardians in some African countries encourage their children to travel in a group so as to be sure of their safety and security. This result mirrors findings from Bwire *et al.* (2017) who reported that children felt safer when using the walking bus and cycle trains in their journey to or from school.

Nevertheless, walking is still the dominant mode of travel in African cities. In 2015, the Sub-Saharan African Transport Policy Programme (SSATP) reported that walking makes up between 50% and 90% of daily trips (SSATP, 2015), while cycling constitutes a low percentage of trips varying between 0.05% and 2%. Additionally, a survey administered in 2008 by the African Centre of Excellence for Studies in Public and Non-Motorised Transport (ACET) – formed by the three partner universities of Cape Town, Dar es Salaam and Nairobi

– revealed that NMT as a main mode for travel accounts for 33.9% of all trips in Cape Town (n=2002 households), while Dar es Salaam (n=2009 households) and Nairobi (n=2002 households) have 48.4% and 61.3%, respectively (Vanderschuren and Jennings, 2017 in Mitullah *et al.*, 2017). The ACET study also showed that NMT is a dominant mode of travel to education places in all three cities. In Cape Town, 59.2% of travellers use NMT as their only (main) mode of travel to educational places, while 48.6% and 68.9% use only NMT in Dar es Salaam and Nairobi, respectively. Other studies have found that private school children rely extensively on motorized transport modes as compared to non-motorized modes in public schools (Adom-Asamoah *et al.*, 2015; Porter and Blaufuss, 2002). A very recent study of revision of Dar es Salaam urban transport master plan by MoWTC and JICA (2018) showed that NMT as a main mode of travel accounted for 39.5% of all trips, motorcycle 4.9%, car 3.7% and public transport (BRT, Daladala, bus, ferry and train) 51.9%. For school trips, it was revealed that 60.3% of school trips are made on foot and by cycling, while the remaining trips are made by motorcycle 2.2%, car 0.7%, public transport modes (BRT, Daladala, bus, ferry and train) 36.8%.

Numerous studies have evaluated the effect of a wide range of factors affecting children's school travel mode choice and suggested a range of policy measures for the decision-makers. Overall, previous studies usually focus on research on school children and walking, cycling and car travel modes. However, the study reported in this paper attempts to add to the existing literature by providing additional insights into the association of some of the factors that have been reported in previous studies with

motorised modes of travel (car and public transport modes – paratransit/Daladala bus services, school bus and motorcycle taxi) and non-motorised modes (walking and cycling), which are commonly used by children to travel to/ from school in Dar es Salaam.

2. Data and Methodology

2.1. Data

The study utilised data from the database that was created from a survey that was carried out between September and November, 2011 using a pen and paper self-completion questionnaire. The survey was completed by school children either at home with the help of parents/guardians or in class, depending on class teacher preference. Notes and instruction regarding the purpose of the research and the meaning of questions were provided during the survey, which used cross-sectional research design to explore factors influencing children’s choices of school travel mode in Dar es Salaam. Apart from questions related to walking bus and cycle train, the survey instrument also had survey questions

focusing on information about the child and parent/ guardian (age, gender, mode of travel to/ from school, reasons for not walking or cycling, distance to school, income group of parents/ guardians and car availability). It is this part of the travel survey data which is being analysed in this paper for school children between 5 and 15 years (primary school children). Survey data on walking bus and cycle train is analysed and discussed in Bwire *et al.* (2017) in Mitullah *et al.* (2017).

Tables 1 and 2 present summary statistics of the survey data analysed in this paper. It can be seen from Table 1 that the data contain 46.6% of girls and 53.4% of boys. The tables also show some descriptive statistics on safety concerns, household monthly income, parents’/guardians’ employment status and car availability. Table 2 shows that 64.8% of the school children walked/ cycled to school, a result which is not much different from the very recent modal split results; 60.3% reported by MoWTC and JICA (2018). Additionally, this result is also within the range of modal split reported by SSATP (2015) for Africa.

Table 1
Summary of School Children Travel Statistics used in Modelling

	Item	Number (%)
Gender	Male	373 (46.6)
	Female	428 (53.4)
Safety	Unsafe due to too many vehicles on the road	95 (11.9)
	Unsafe due to other reasons	708 (88.1)
Monthly Income	Less than 300,000/= Tshs. (115.25 EUR)	569 (71.0)
	300,000/= - 1,000,000/= Tshs. (115.25 – 384.16 EUR)	150 (18.7)
	1,000,000/= - 1,500,000/= Tshs. (384.16 – 576.24 EUR)	82 (10.2)
Employment	Employed/ self-employed	351 (43.8)
	Unemployed	450 (56.2)
Car availability	0 cars	115 (14.4)
	1 car	366 (45.7)
	2 or more	320 (39.9)

N=801

Additionally, Table 2 shows that at a distance less than 3.0 km, walking most of/all the way is most widely used by school children to travel to/from school and beyond this distance motorised transport modes, and more particularly Daladala is more widely used for school travel. Some school children do walk and cycle over greater

distances than 5.0 km, even if cycling and walking seem to be an unattractive travel option among the children at distances of 3.0 km and beyond. Further, Table 2 shows that even at a distance less than 1.0 km Daladala, and in general motorized transport is commonly used by some school children.

Table 2

School Travel Mode Use Characteristics (in Number of Respondents)

Distance (km)	Walked Most of/all the Way	Cycled	Daladala	School bus	Parent Driver on Way to Work	Parent Driver Specifically for School Trip	Motorcycle	Total
< 0.5	70	06	25	0	3	1	2	107
0.5-1.0	152	13	13	2	4	0	2	186
1.0-2.0	72	15	31	2	3	3	2	128
2.0-3.0	47	13	25	1	3	0	1	90
3.0-4.0	21	7	30	3	2	0	1	64
4.0-5.0	39	1	29	1	2	0	3	75
> 5.0	56	7	72	4	9	10	2	151
Total	457	62	225	13	26	5	13	801

2.2. Methodology

Binary choice (MT - motorized transport modes and NMT - non-motorised transport modes) was considered, and each choice has four categories of variables as shown in Table 3.

Table 3

Variables Definition for Binary Logit Model Estimation

Description of Variable Categories	Variable Name
Modes	NMT (walking and cycling) and MT (car, Daladala, school bus and motorcycle)
Travel Characteristics	Travel time (continuous variable)
	Safety (1=unsafe because of traffic volume; 2=unsafe because of other reasons)
	Distance (continuous variable)
Child Characteristics	Gender (1=Male; 2=Female)
	Age (5 to 15 years)
Household Socio-economic Characteristics	Household income (continuous variable)
	Car availability (0 = No; 1= Yes)
	Employment (1=employed/self-employed, 2=unemployed (seeking work, retired, students, etc.)

Travel modes were considered as dependent variables and travel, child as well as household socioeconomic characteristics were considered as independent variables. The MT category covered Daladala, school bus and car modes, while the NMT covered walking and cycling. A binary Logit model was used to investigate the influence of variables affecting the choice and usage of MT and NMT modes, and determine the probability of choosing a mode.

2.3. Study Limitations

The analysis results are not regarded as fully representative of all school children in Dar es Salaam city, nor of the participating schools in the study area for the following reasons. The number of sampled primary schools and secondary schools represents 1.2% and 1.0% of all primary and secondary schools in the city, respectively, and only 12.8% of the total school children population of the selected schools participated in the survey and therefore it cannot be claimed that the results of the study are representative of all school children. Moreover, the majority

of children who participated in the survey belonged to primary school classes 4, 5 and 6 as well as Form 2 and Form 3 in secondary schools. Thus, the selection of the children may have introduced some bias. On the other hand, the choice of schools surveyed were only those that had already received cycling and road safety training.

3. Results and Discussion

As it can be noted from Table 4, all significant coefficients in the model have expected sign and they are in agreement with the actual condition of the case study area and the existing literature. The distance variable contributes greatly to a decision to use MT mode (Daladala and School bus). The variable increases the utility associated with the choice and or use of public buses by 0.28163 to non-motorised modes of transport. In effect, school children prefer MT modes (public transport modes) over NMT modes when encountering longer distances. Likewise, the time variable has a positive sign and increase the utility associated with the choice and usage of MT modes by 0.03002.

Table 4
Binary Logit Model Estimation Results

Choice	Variable	Coefficient	Z value	P> Z	[95% Conf. Interval]	
MT	Female	0.24406	1.48	0.139	-0.07935	0.56747
	Age	-0.06260	-0.97	0.333	-0.18933	0.06413
	Time	0.03002	5.64	0.000	0.01959	0.04044
	Distance	0.28163	6.43	0.000	0.19585	0.36741
	Unemployed	-0.13861	-0.83	0.409	-0.46785	0.19064
	Car available	0.20485	0.8	0.423	-0.29621	0.70590
	Unsafe (other reasons)	0.15051	0.88	0.380	-0.18560	0.48662
	Income	-0.00609	-0.25	0.800	-0.05328	0.04111
	Constant	-1.58510	-1.85	0.064	-3.26463	0.09444
	Number of observations	801				
	Prob> χ^2	0.000				
	Likelihood χ^2	112.04				
	Pseudo R ²	0.1099				

However, female, age, unemployment and non-availability of car, safety concerns about other issues other than traffic volume, and income variables are insignificant. Even though insignificant the negative sign associated with age, unemployment and income shows that an increase of these variables will result in the disutility of MT modes. This means that as age increases children are motivated to use NMT modes over MT modes. Although the age variable is insignificant, this result is not in line with previous findings reported by McDonald (2008), Wilson *et al.* (2010) and Hatamzadeh *et al.* (2017). However, the result supports the findings reported by Yeung *et al.* (2008) Pabayo *et al.* (2011) and Su *et al.* (2013). The results also show that school children whose parents and or guardians are unemployed are less likely to use MT over NMT modes. Although the household income variable is also insignificant, it is surprising to note that it has a negative effect on the use MT modes. An explanation behind this result could be due to a small sample of children who use car for school travel, while the majority use public transport, which in effect could be indicating that an increase in income is more likely to cause a reduction in public transport (Daladala, school bus and motorcycle) patronage among school children. A further explanation is that a reduction in trips by MT modes (Daladala, school bus, car use and motorcycle) may also be associated with the fact that children who would prefer to cycle do not have bicycle because they cannot afford to buy it. Therefore, an increase in income is likely to motivate them to acquire a bicycle.

On the other hand, the positive sign of insignificant variables (female, non-availability of car and safety concerns due to non-traffic issues) shows that an increase of these variables will result in utility of MT modes. Even though insignificant the positive sign of female means that female school children would prefer to use MT modes over NMT modes, a result which resonates well with previous studies. Also, school children who do not have access to a car are more likely to use MT over NMT modes. This indicates that school children without access to a car are more likely to use public transport over NMT for school trips. Despite the insignificance, safety concerns due to non-traffic issues were more important than concerns due to traffic volume and have a positive effect on the utility of MT modes. The safety issue indicates that parents believe that it is safer for a child to travel to/from school by MT modes than having them use NMT modes in the unsafe road environment. This result is in line with previous findings (see, for instance, Rhoulac, 2005).

The results of the marginal effect from Table 5 show that an increase in distance and time variables increase the change in the probability of public transport mode patronage by 0.05385 and 0.00574 respectively and are all significant. Girls, non-availability of car and safety variables are insignificant even though they increase the change in the probability of public transport patronage, while age, unemployment and income decrease the change in the probability of public transport patronage.

Table 5
Marginal Effects After Logit Model

Choice	Variable	dy/dx	z	P> z	[95% Conf. Interval]	
MT	Female	0.04665	1.48	0.138	-0.01493	0.10824
	Age	-0.01197	-0.97	0.332	-0.03616	0.01222
	Time	0.00574	6.07	0.000	0.00389	0.00759
	Distance	0.05385	7.12	0.000	0.03903	0.06868
	Unemployed	-0.02650	-0.83	0.409	-0.08938	0.03638
	Car available	0.03834	0.82	0.412	-0.05322	0.12990
	Unsafe (other reasons)	0.02868	0.88	0.378	-0.03506	0.09242
	Income	-0.00116	-0.25	0.800	-0.01019	0.00786

4. Conclusion

This study sought to investigate the determinants of children's school travel mode choice between using an MT and NMT modes for school travel. The binary Logit model was employed to estimate the children's choices. The results show that children will resort to the use of NMT over MT modes when encountering longer distances. The result is in line with previous findings. However, female, age, unemployment and non-availability of car, safety concerns about other issues other than traffic volume, and income variables are insignificant, but some of findings support results reported in previous studies. The negative sign associated with age, unemployment and income shows that an increase of these variables will result in the disutility of MT modes. On the other hand, the positive sign of female, non-availability of car and safety concerns due to non-traffic issues shows that an increase of these variables will result in utility of MT modes.

Even though the age variable is insignificant, children are motivated to use NMT modes over MT modes as they get older.

This result is not in line with some of the previous findings. The study has also shown that school children whose parents and or guardians are unemployed are less likely to use MT modes. Although the household income variable is also insignificant, it is surprising to note that it has a negative effect on the use MT modes, which means that an increase in income is more likely to cause a reduction in trips by MT modes (Daladala, school bus, car use and motorcycle). This means that children who would prefer to cycle do not have bicycle because they cannot afford to buy it. Therefore, an increase in income is likely to enable them to acquire a bicycle. Moreover, despite the insignificance, safety concerns due to non-traffic issues were more important than concerns due to traffic volume and have a positive effect on the utility of MT modes. The safety issue indicates that parents believe that it is safer for a child to travel to/from school by MT modes than having them use NMT modes in the unsafe road environment.

One contribution of this study beyond that of other school children travel studies is the result which shows that even though the age variable is insignificant, children

are motivated to use NMT modes over MT modes as they get older. Further, the negative effect of income on the use MT modes, shows that households with children who would prefer to cycle are more likely to acquire a bicycle for their children.

The findings of this study may be used by transport operators and policy makers to improve the level of public transport services and infrastructures for walking and cycling with a view to enhance the safety and security of NMT modes. Further, means should be sought for making bicycles affordable to a common household and a policy of establishing primary and secondary schools in every ward should be implemented fully, where its justifiable, so as to reduce travel distances to schools.

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