

MODE CHOICE BEHAVIOR OF COMMUTERS IN KANDY, SRI LANKA

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ABSTRACT: Public transport mode share is the key contributory factor for the efficiency of an urban transportation system. However, commuters tend to shift from public transport modes to private modes due to various reasons. This causes an increase in traffic congestion in the road network resulting in a huge economic loss and environmental pollution. With the aim of providing a productive solution for these problems, this study is set to examine the factors that affect transport mode choice. Online and face-to-face interviews are carried out in Kandy district, Sri Lanka by using a structured questionnaire to obtain the mode choices of commuters and used to estimate the travel behaviour parameters in the multinomial logit (MNL) model. The respective coding was done in the RStudio platform, and the parameters were estimated based on the utility maximization theory. Adjusted likelihood ratio index, t-statistics and the respective sign of parameters are used to show the model accuracy. The outcome of the analysis shows that travel time, access time, waiting time, egress time and travel cost are the significant factors affecting the mode choice behaviour of commuters. All the parameters are obtained with a negative sign which implies that increasing the value of each parameter decreases the likelihood of choosing the relevant mode. The results of the scrutinized cross-sectional analysis and the estimated parameters suggest appropriate recommendations which can be used to improve the quality of local transportation planning.

Keywords: Travel Behavior; Mode Choice; Parameter Estimation; Utility Maximization; MNL Modeling

1. INTRODUCTION

The development of the transportation system is a crucial factor that has a major impact on the civilized life of a country. Ensuring that transport development is aligned with the overall development of the country will have far more benefits and conversely failing to do so will have far more adverse effects on their development (Lles, 2005). With these developments, the population is also rapidly increasing faster than car ownership and the majority of the increased population depends on public transportation (Noor, 2018). In many developing countries, families tend to be large and the public transport system is an alternative to them though they own their private vehicles. Therefore, even if the household owns a car, most members of the family are still likely to use the public transport system. Though this situation makes people use the public transport system more frequently, people are converting their mode of transport to private modes for various reasons creating adverse effects on society. Among them, traffic congestion is one of the main problems that people suffered a lot. In Sri Lanka, there has been great concern about traffic congestion as it occurs in the road network and the government seeks possible remedies to control this problem. Traffic congestion tends to grow as people are switching to private transport modes from public transport modes. Other modes of transport services such as taxi and three-wheeler services by the private sector are also expanding rapidly encouraging passengers to leave the public transport services. This has been well revealed by the Kandy traffic study which was carried out in 2016 (Kandy City transport study, 2016). It revealed that public transport usage has decreased from 78.3% in 1999 to 62.4% in 2016. One of the reasons for this drop is the rapid increase in car ownership. A compromise 'car ownership' may be considered at around 46 'cars' per 1000 people when only cars, vans and three-wheelers are included in the definition. This is still a higher VOR than most of the other countries [5]. Furthermore, the forecast

from the Demand Estimation Model for Inter-District Passenger Travel (DEMIDEPT) shows that bus transport shares would reduce from 55 % to 20 % by 2031 (Kumarage, 2012). This will create more traffic congestion, accidents and more air pollution. Hence, to minimize these problems, switching people from private vehicles to public transport services becomes more and more important.

The factors which affect the mode choice behaviour of commuters can be categorized into three main categories as socio-economic characteristics, transport system variables and attitudinal variables (Ashalatha et al., 2013). Among the three categories, socioeconomic characteristics and transportation system variables have a significant effect on the mode choice behaviour of the commuters. Therefore, this research is focusing on the effect of socioeconomic characteristics and transportation system variables on the mode choice behaviour of the commuters in Kandy, Sri Lanka by creating a discrete choice model based on a well establish utility function.

2. RESULTS AND DISCUSSION

A well-developed discrete choice model is used to analyze the mode choice behaviour of the commuters within the Kandy district. The travel data of the commuters in Kandy district is collected through online and face to face questionnaire surveys for the model. The questionnaire included three main parts. The first part was about the social demographic characteristics of the commuters to gain a general view of the personal profile. The second part considered the travel behaviour of the commuters, and the third part considered the public opinion about the bus-based public transportation system. The minimum sample size for the model was identified as 400 respondents and a sample size of 513 respondents was used for the model.

The parameter estimation was done using RStudio statistical software for the parameters, travel time, travel cost, access time, waiting time and egress time. Bus, car and motor bicycle modes were used for the parameter estimation as they are the governing transport modes of the city. The respective estimation results are shown in Table 1.

Table 1. Model Estimation Results

	Estimate	t-statistic value
Travel Time	-0.104791	-5.20
Travel Cost	-0.004499	-4.73
Access Time	-0.001620	-2.30
Waiting Time	-0.000887	-2.19
Egress Time	-0.001257	-2.28
Sample		378
Initial LL		-216.0034
Final LL		-161.0654
ρ^2		0.254
$\bar{\rho}^2$		0.222

The absolute value of the t-statistics is greater than 1.96 for each parameter and that implies the parameters are significant with more than 95% significant threshold. The respective sign of the parameters is also used to show the accuracy of the model along with the rho square and t-statistic values. The positive sign of a parameter implies that the option has a beneficial effect on the choice and the option is likely to choose. The negative sign of the parameter implies that the option is not likely to choose. The likelihood ratio index of the model is 0.254 and the adjusted likelihood ratio index is 0.222 which

represents a decent model fit for a discrete choice model.

Parameters, access time, waiting time, travel time, and egress time shows negative signs. Commuters are always trying to reduce these parameters in their trips in order to save time. Therefore, when the total travel time increases, the likelihood of the choice of that mode will decrease. The next considering factor is the travel cost. Commuters are more likely to use a mode with the lowest travel

cost. When the travel cost increases, the likelihood of the mode choice decreases. The negative sign of the travel cost parameter in Table 1 implies this phenomenon.

The parameters, access time, waiting time and egress time are related only to the public transport. But travel time and travel cost are related to both public and private transport modes. Therefore, more attention should be paid to these three parameters in order to attract more commuters towards public transport modes. Route coverage of public transportation can be increased to reduce the access time and egress time of commuters. More public transport services can be implemented in rural areas to increase route coverage. With that, people may get the chance to use alternative routes for their trips with public transport modes. Waiting time of the passengers can reduce by increasing the frequency of the public transport service.

3. CONCLUSION

The study is conducted to identify the mode choice behaviour of commuters in Kandy district, Sri Lanka. Trip data collection was done by using online and face-to-face interviews through a structured questionnaire. According to the findings, the highest percentage of people are using buses, cars and motor bicycles as their mode of transportation. About one-third of the population is using public transport modes for their travel purposes within the district. Kandy is attracting more work and educational trips with considering other purposes.

The multinomial logit model was used for the parameter estimation with the utility maximization theory. Travel time, travel cost, access time, waiting time and egress time were identified as the key parameters for the mode choice behaviour. All the estimated parameters were significant and have achieved the expected negative sign which implies that increasing the value of each parameter decreases the likelihood of choosing the relevant mode.

Accordingly, the relevant authorities can use these results to identify the improvements which have to be done in public transport service to attract more commuters towards public transportation. Some studies can be done to identify the service intensity of public transport service in the Kandy district and to identify the measures which can be taken to provide a better public transport service to the people. An elasticity analysis can be done with the parameters to forecast the travel behaviour of the commuters with the changes in the transportation system. Furthermore, the results can be improved with more trips and some more modes can be used for the estimation.

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