

# Likelihood of Motorcyclists Transferring to Safer Mode of Transport in Cairo, Egypt

Mohamed Elsokkary, Hussain Hamid, Law Hua, Fauzan Jakarni, Akram Koth



**Abstract:** Road traffic injuries and mortality are mainly caused by motorcycle crashes. Practically, 50% of people who meet their death in road traffic accidents (RTAs) are motorcyclists. The issue is increasingly articulated in progressing nations where the use of motorcycles has gained popularity in the past decades. Moreover, death and fatalities caused by accidents involving motorcyclists are also in the rise due to the increasing trend. Hence, motorcyclists are encouraged to use alternative modes of transportation that are safer in the attempt to minimise losses. As a result, a policy ought to be created to enhance urban transportation service and control motorcycle proprietorship. The current research that lays the groundwork aims to contribute a more elaborated analysis on motorcycle user mode decision conduct as well as an excellent comprehension of the conceivable efforts that can be taken to support motorcyclists to shift to a safer mode of transportation, particularly bus. In the current research work, the binary logit mode choice model was created for two elective modes in order to distinguish the separate practices of motorcyclists and bus users and assess their reactions to a situation that can minimize both time and expenses involved in bus travel. In addition, it should be noted that this paper surveyed a total of 327 travellers from Greater Cairo Region (GCR) in Egypt, the bus users were identified through revealed preference, while the motorcyclists were identified through revealed and stated preference surveys. In this case, travel time, travel cost, age, sexual orientation, income level, trip purpose, education level, and privacy significantly influence motorcycle user mode decision conduct. The likelihood of motorcyclists to utilize the use of buses was additionally analyzed dependent on a situation of minimized bus travel time and travel cost. These elements are very important in a program that attempts to draw in motorcyclists to utilize public transport, particularly bus. The outcomes can help the process of decision making on all levels in assigning the necessary assets prudently for the advancement of urban transportation services, reduced number of road traffic crashes, and increased road safety. This examination, which is the first of its sort in Egypt, assesses the model choice behaviour for motorcyclists.

**Keywords:** Binary logit model, Motorcyclist(s), Mode choice

## I. INTRODUCTION

The Eastern Mediterranean Region holds the third highest road traffic death rate in the world after the African and South-East Asian regions according to 2016 information [1], with road traffic injuries (RTIs) representing 27% of the entire injury deaths in the district [2]. Although RTIs are the eighth leading cause of death worldwide [1], it is the fourth leading cause of death in Egypt [3]. Moreover, it is assessed that 3000 individuals are killed, while 30,000 are severely harmed around the world consistently with most of the losses originating from middle-income nations [4]; hence, this clearly indicates that RTIs are a noteworthy general medical issue all around the world. Hence, collaborative efforts are required to develop appropriate preventive interventions in underdeveloped and developing countries that recorded high numbers of accidents. In addition, [5–7] further emphasized that nearly a quarter of the people killed in road traffic accidents are motorcyclists and most of the motorcycle accidents lead to road traffic injuries and deaths. On the other hand, a considerable number of past researches revealed that motorcyclists are a standout amongst the most unsafe types of mechanized transportation because the size of their vehicles is small, thus they are part of road users who are critically exposed to danger [8]. Regarding this matter, data obtained from Great Britain demonstrate that motorcyclists are more in danger of death risks or suffer non-fatal injuries in a road traffic crash compared to other vehicle users [9]. Furthermore, according to [8,10], motorcyclists have thrice the potential of being harmed in an accident as well as 16 times bound to have their lives cut short compared to car occupants. Generally, this scenario can only be changed and improved by means of immediately implementing effective measures that focus on motorcyclists [11]. In Egypt, although the number of motorcyclists has increased from about 1.1 million in 2011 to nearly 3 million in 2017 [12], which means less than 3 times, the mortality rate from motorcycle accidents has increased dramatically. About 6 times in the last three years by comparing the WHO statistics for 2015 and 2018 [1,5]. In response to this issue, [13] implemented the Motorcycle Safety Program (MSP) in the attempt of reducing road fatalities and injuries which involved five main categories of road traffic safety strategy: exposure control, crash prevention, injury control, behaviour modification, and post-injury management.

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It should be noted that there are many exposure control measures that can reduce motorcycle deaths such as banning the use of motorcycles, increasing the minimum age for motorcycle licensing and providing alternative transportation mode. Based on these categories, the present study focuses on exposure control initiatives whereby motorcycle users are encouraged to utilize safer modes of transport to reduce the possibilities of casualties. In the case of the current research, the bus was chosen as an option and a more secure method of transportation based on the assumption that the salary scale of bus and motorcycle users are almost alike. Therefore, the present study further investigates and compares the features of the bus and motorcycle with the aim of developing the hypotheses for the current work. Regarding this matter, it is crucial to note that the main hypothesis of the present study refers to whether motorcycles outperform buses, particularly regarding the main attributes which include travel times and expenses. Following this, a binary logit model was adopted to distinguish important components affecting the decision of using a transport based on the key attributes as well as to estimate the likelihood of users who prefer buses over motorcycles. Therefore, this is believed to be a step forward that leads to the implementation of appropriate exposure control policies in the effort of reducing the risk of road injuries and deaths among the population.

### II. METHODOLOGY

The revealed and stated preferences methods for gathering information have been adopted because of their successful previous use [14–16]. In the case of the current research, a cross-sectional survey was conducted in GCR, the capital and the largest metropolitan area in Egypt which are filled with bus and motorcycle users in order to establish the attributes that influence the preferred transport mode of consumers. In addition, it should be noted that GCR was selected as a study site because it has been reported to have the highest cases of road accidents in Egypt which is approximately 39% compared to other cities [17]. In 2018, a number of 327 respondents were approached over time of a half year (March to September). The revealed and stated preferences survey was intended to fulfil the prerequisites in order to enhance the mode choice behaviour model as well as to explore the main elements that impact the selection of motorcyclists' travel mode. The selection of respondents was performed in a random manner using a stratified sampling approach of family units in order to accomplish a representative sample that reflects the demographic and socioeconomic profiles. The questionnaires developed for the purpose of the present study are incorporated with various scope of factors which portray the trip (method of travel, trip purpose), the service qualities of the selected mode and the apparent attributes of other accessible modes (travel time, cost, and others), the traveler's qualities (age, sex, income, occupation, vehicle proprietorship, and educational background, and others), and travel behavior. The questions related to bus users are presented in the revealed preference survey and associated with the demographic and socioeconomic characteristics and mode attributes. In this case, the respondents were asked to provide information on their present travel situation by answering a number of questions. On the other hand, the questions for motorcyclists focused on the revealed and stated preferences. The survey data consisted of the individuals'

financial attribute, trip information, and attitudes and perceptions on travel. The best way to guarantee the usability and reliability of the survey is to test it on real respondents. Consequently, a pilot study was performed before the process of formal data collection for the purpose of testing the items used in the main survey instrument. Meanwhile, random samples were gathered and cautiously examined from 46 travellers amid the examination time frame. The investigation uncovered that a few inquiries need to be adjusted or revamped. The required data for the fundamental survey were gathered with the response rate of 95% following the development of the questionnaire. Next, the respondents were asked to rate specific statements related to their attitudes and preferences towards the mode of transport. Respondents who travelled by motorcycle were also asked their perception and opinions towards various aspects of public transport such as travel cost, trip time, safety, privacy, and comfort. As well, they were asked whether they would consider shifting to the bus mode of travel. A five-point Likert-scale ranging from "strongly disagree" to "strongly agree" were utilized to show the dimension of agreement for all the statements that were further characterized into three main classes, namely Disagree, Neither Agree nor Disagree (NAD) and Agree.

A binary logit model was developed to assess the effectiveness of a bus and a motorcycle as well as to determine the elements that can convince the motorcyclists to choose to ride a bus over a motorcycle. Specifically, it should be noted that this model represents dependent variables as "0" and "1" for respondents travelling by motorcycle and bus, respectively. On another note, the independent variables consisted of age, gender, income, trip purpose, education level, privacy, travel time, and weekly travel cost. Other than that, certain independent variables which include gender, age, monthly income, purpose of trip, education level, and privacy were also categorized as follows: (1) age as less than 21, 21–25, 26–30, 31–35, 36–40, 41–45, and above 45, (2) gender as "0" for female and "1" for male, (3) education level as "1" for those who have a post-secondary level (bachelor's degree) and "0" for otherwise, (4) purpose of trip as "1" for workplace and "0" for other places, and (5) monthly income as <LE 3000, LE 3001-5000, LE 5001-7000, LE 7001-9000, and >LE 9000 (1USD = LE17.8).

### III. RESULTS

Table I presents the descriptive attributes of the samples whereby it can be observed that 71.6% of the respondents are male, while 78% of them possess a post-secondary level. In addition, it can be seen that the average total travel time is 31 minutes for motorcyclists with an average weekly travel cost of LE 106. Meanwhile, the total travel time for bus users is 74 minutes with an average weekly trip of LE 46. Comparatively, it is clear that motorcycle users earn an average monthly income of LE 3000, while the bus users are paid LE 4500 per month.

**Table I: Characteristics of respondents**

Category	Attributes	Motorcyclist	Bus	Total	Percentage
Age group	Less than 21	10	0	10	3.1%
	21 -25	57	31	88	26.9%
	26- 30	67	38	105	32.1%
	31 -35	41	13	54	16.5%
	36- 40	17	19	36	11.0%
	41 – 45	19	6	25	7.6%
	Above 45	0	9	9	2.8%
Gender	Male	170	64	234	71.6%
	Female	41	52	93	28.4%
Education	Post-secondary	155	100	255	78.0%
	Otherwise	56	16	72	22.0%
Trip purpose	Workplace	137	95	232	70.9%
	Other places	74	21	95	29.1%
Average bus user's income					LE 4500
Average motorcyclist's income					LE 3000
Average weekly travel cost (bus)					LE 46
Average weekly travel cost (motorcycle)					LE 106
Average travel time (bus)					74 minutes
Average travel time (motorcycle)					31 minutes

According to the average travel time across the modes, the motorcyclists have the minimum average travel time compared to the bus mode. Hence, this shows the reason why motorcyclists prefer their current mode of transportation because the travel time of the bus is very high compared to travelling by a motorcycle that is usually more than twice the travel time by motorcycle for the same destination even though the average travel cost by motorcycle is higher than the bus. Therefore, it is deemed necessary to reduce the travelling time of a bus whether with the same bus fare or a slight increase in the fare. Overall, it can be concluded that these two factors (travel time and travel cost) strongly influence the choice of travel mode among motorcyclists.

**A. Alternative Mode of Transport for Motorcyclist**

The information provided by motorcyclist respondents showed that approximately 44% of them have access to a car, 9.7% to buses, 17.5% to shared-taxi (known as microbus in Egypt), and 8.2% to subway as an alternative mode of transportation. On the other hand, 20.6% claimed that they have no access to these modes of transport. Therefore, this indicates that majority of the respondents could shift to alternate modes of transport such as private cars or public transportation; however, a total shift to an alternative mode of transport is impossible.

**B. Alternative Mode of Transport for Bus Users**

On another note, bus users also shared their options on the alternative modes of transportation. In this case, 9.2% from a total of 116 bus users have no alternative mode of transportation other than the bus. On the other hand, 66.2%, 5.4%, 17.7%, and 1.5% are capable of using a private car, motorcycle, microbus, and subway as an alternative mode of transportation, respectively.

**C. Factors Contributing to Motorcycle Popularity**

The present study drew out specific questions to disclose the factors that contributed to motorcycle use instead of bus use. The main variables are as follows: (a) reduced travel time, (b)

easy to park, (c) cost savings, (d) maneuverability, and (e) enjoy to ride (Table II). The main motivations that encouraged the utilization of motorcycle use include shortened travel time amid traffic jam, cost-effective, and reasonable. Moreover, about 89.6% of the respondents agreed that the explanation behind selecting motorcycle as a method of travel refers to its ability to decrease travel time amid traffic jam, 81.5% agreed that it is easy to park, and 80.1% admitted that it is cost effective because it requires less fuel consumption.

**Table II: Factors encourage riding motorcycle**

Factors	Disagree	NAD	Agree
It reduces travel time during traffic congestion	6.6%	3.8%	89.6%
It is easy to park	10.0%	8.5%	81.5%
It uses less fuel	10.4%	9.5%	80.1%
It is easier to maneuver	12.3%	10.9%	76.9%
It is enjoyable to ride	13.7%	17.1%	69.2%

**D. Factors Discouraging Motorcyclists from Using Public Transport**

The most important factor that demotivated motorcyclists from utilizing bus as a mode of transportation was that the "vehicles are too crowded" (Table III) with an average rating of 80%. Meanwhile, other critical variables to motorcyclists included "the bus takes a long time to arrive at the destination" (78%) and "infrequent public transport services" (73%).

**Table III: Factors prevent motorcyclists from shifting to public transport**

Factors	Disagree	NAD	Agree
Vehicles are too crowded	10%	10%	80%
Takes a long time to reach the destination	13%	9%	78%
Infrequent public transport services	12%	15%	73%
Public transport does not cover the desired road	19%	15%	66%

**E. Likelihood of Motorcyclists Switching to Bus**

Table IV illustrates the factors that are able to encourage motorcyclists to move from using motorcycles to utilizing buses. The results showed that the most significant factors that can encourage motorcyclists to use buses more often are "short waiting time", "buses arrive on time", "short travel time" and "less crowded buses". Therefore, it is evident that a way to reduce the use of motorcycles is by improving passenger transport services.

**Table IV: Likelihood of motorcyclists shifting to bus**

Factors	Disagree	NAD	Agree
Short waiting time	24%	4%	72%
Buses usually arrive on time	23%	11%	66%
Short travel time	29%	6%	65%



Buses are not too crowded	32%	3%	65%
Buses are clean	38%	6%	56%
Easy access to the bus	34%	10%	56%
Fare is low	29%	26%	45%

IV. MODE CHOICE MODEL

Table V presents the estimations for trips using motorcycle and bus based on the binary logit model. In this case, all variables hold significant parameter estimates and logical signs.

Table V: Estimations for binary mode choice model

Constants	B	S.E.	Sig.	Odd ratio
Age	.364	.168	.030	1.439
Gender	-1.932	.514	.000	.145
Travel Time (Minutes)	-.049	.018	.005	.952
Travel Cost (LE)	-.121	.017	.000	.886
Trip Purpose	2.291	.625	.000	9.888
Monthly Income	-.622	.163	.000	.537
Education	1.734	.623	.005	5.662
Privacy	.778	.266	.003	2.176
Constant	4.529	1.277	.000	92.711
Summary of Statistics				
(-2) log likelihood			136.674	
Model chi-square			4.998	
Cox & Snell R2			0.586	
Nagelkerke			0.806	
Number of observations			327	

The Logistic regression coefficients for a cumulative total of travel cost, and total travel time were negative, thus implying that an increase in these variables would further encourage the use of the motorcycle. Hence, a negative coefficient for a variable in selecting the mode of transportation suggests a decline in the utilization of bus whereby a higher negative value demonstrates lower bus utilization. Moreover, motorcyclists can change to taking buses provided that the travel time and complete travel cost can be minimized.

According to the results, the demographic characteristics which include age, sex, monthly salary, and education level were revealed to be significantly related to the mode choice behaviour. In the aspect of gender, the model suggested that female prefers buses over motorcycles, which increased the odds of selecting buses by 14.5% among women. On another note, older people are bound to utilize the bus instead of a motorcycle. The odds ratio increases around one and a half times among older individuals in contrast to younger commuters. Meanwhile, in the aspect of monthly income, a household with higher incomes prefers to use motorcycle over the bus; hence, the odds of selecting buses decrease by 53.7% for higher income people compared to lower income individuals. On another note, those who possess a post-secondary level (bachelor's degree) (education factor) of education prefer using bus compared to a motorcycle with an increased odds ratio of approximately five times.

The two R-Square values calculated in the present study indicate the strong explanatory power of the model. The factors incorporated in this model account for 80.6% of the variation for the Nagelkerke, while Cox and Snell explained

58.6% of the variation. In addition, classification matrices were determined to evaluate whether the model fits the information as shown in Table VI. Moreover, it was discovered that the model effectively ordered about 92.9% of motorcycle cases and about 88.8% of the bus mode cases. The overall accuracy of the prediction model was 91.4%.

Table VI: Predicted vs. Observed

Observed		Predicted		
		Mode		Percentage Correct
		Motorcycle	Bus	
Mode	Motorcycle	196	15	92.9
	Bus	13	103	88.8
Overall Percentage		91.4		

The mode share probabilities were classified by different levels of travel time and travel expenses as presented in

Fig. 1. Mode choice probabilities were in the range of 89% probability of motorcycle use with the current travel duration of buses as well as current weekly travel expenses (74 minutes and LE = 46) to 1% probability of motorcycle use with a decrease of the entire weekly travel expenses and duration (10 minute, LE = 20). Meanwhile, the likelihood of bus ridership expanded from 11% with the bus current total time duration and weekly travel expenses (74 minutes, LE 46) to 99% of probability with a decrease in weekly total bus travel expenses and duration (LE 20 and 10 minute). A 50:50 split may be possible to be accomplished when the travel expenses and duration are set at LE 38 every week and 55 minutes for each journey for bus travel. Therefore, the advancement of appropriate policy in connection to travel duration and expenses will provide motorcyclists with the chances to mode shifts, which will consequently decrease their exposures as well as the risk of non-fatal injuries.

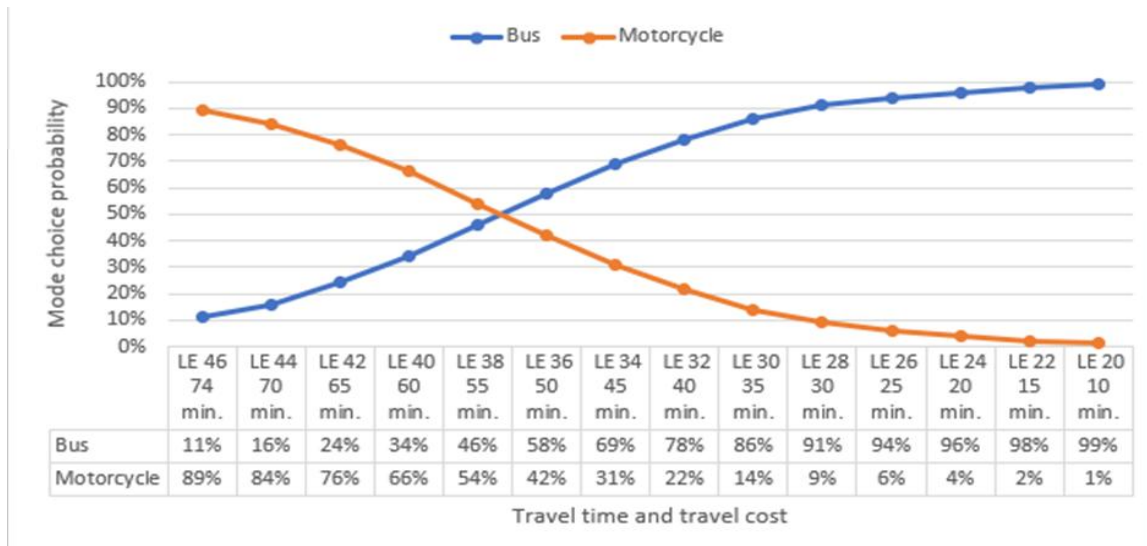


Fig. 1. Effect of reducing bus travel time and travel cost on motorcyclist mode choice probability

V. DISCUSSION

One of the most imperative utilizations of mode choice models refers to its capacity to anticipate the impacts of policy measures on consumers. Hence, the current research assessed the impact of motorcycle use provided that the total bus travel duration and expenses are decreased with the aim of encouraging more prominent utilization of urban transportation service. This was comprehended by solving the binomial logit equation for the probability of utilizing various preferences of travel duration and expenses situations. The outcomes proposed that travel duration and expenses are the attributes that identify why the utilization of motorcyclist is a preferred modal choice. This finding is in agreement with the discoveries made by [11] who examined elements that affect motorcycle use and their conduct in connection to their modal choice in Malaysia. Apart from that, it was discovered that travel duration and expenses are the most critical components affecting motorcyclists' mode choice behaviour as well as the decrease in the total travel duration and expenses for the bus mode that was developed as the most imperative components in a program that focused on drawing in motorcyclists towards urban transportation service and far from the motorcycle mode. In addition, [18] examined the factors affecting the behaviour of motorcyclists with regard to the monetary, social, environmental, and psychological parts of travellers in Taiwan. The researchers discovered that travel duration and expenses are the most vital motivations that influence individuals to be more inclined towards motorcycle use, while the improved urban transportation service framework ought to be employed as the essential procedure in reducing the use of the motorcycle. Other than that, [19] analyzed the impacts of road safety on a motorcycle in Brazil and emphasized that poor quality of public transport and lower operating costs for motorcycles will lead to an increase in motorcycle use.

A productive urban transportation service framework is undeniably required in order to advance more prominent utilization of urban transportation service and less dependency on motorcycles. In addition, the higher limit of transit systems, utilization of bus lanes, bus gates, and ITS frameworks are among the activities that can be executed to improve the urban transportation service system. The present study recommends that the urban transportation service must be improved into quick, dependable, and helpful system in order to increase the critical number of motorcyclists in utilizing the bus system for their day by day trip. Accordingly, advancing a move from motorcycling to a productive urban transportation service should be adopted as a model in sustainable transport policy in nations that have a high extent of motorcycles such as Egypt. In the meantime, the development of a thorough urban transportation service system will require government infrastructure financing because the system must be practical and will lead to higher road crash cost saving.

VI. CONCLUSION

The mode choice models help to anticipate the impacts of strategy measures on the desired range of consumers. As previously mentioned, the present study is the initial research of its type in Egypt which investigated the mode choice behaviour of motorcyclists for two methods of transport which are motorcycle and bus as well as to identify the trade-offs made by travellers in settling with their decisions. Apart from that, the critical purposes behind the decision of selecting a specific mode and the conditions behind the changes in their decisions were obtained based on the result of comparing the utilities of the two modes. In the case of the present study, the binary logit model inspected the attributes of motorcycles and bus in the aspects of trip qualities (method of travel, trip reason), the service attributes of the selected mode and the apparent attributes of other accessible modes (travel duration, expenses etc.), the traveler's qualities (age, sex, salary, occupation, vehicle proprietorship, and education level), and travel behavior with the aim of figuring out what influences motorcyclists' mode decision conduct.



According to the results of the present study, the major reasons that influence motorcycle users from taking the bus include travel duration, travel cost, age, gender, income level, trip purpose, education level, and privacy. On a more important note, the best way to empower a change from motorcycle to a more secure method of urban transportation service is through minimized bus travel duration and expenses. This situation was demonstrated with the assistance of the binomial logit equation for probability by utilizing a number of alternatives for bus travel duration and expenses situations. Overall, it can be concluded that the research hypotheses of the present study which stated that the motorcyclists tend to favour their method of transport over the bus as a result of its shortened travel duration and poor bus transport service managed to be proven.

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