

Willingness to Change Travel Mode in Response to On Street Parking Pricing-A Case Study of Dhaka City

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Abstract

Dhaka is facing severe on-street parking challenges as car ownership emerges. This situation has led traffic congestion not only in local roads but also in collector and arterial roads. In Dhaka city most of the on-street parking spaces are free which persuades car users to park their car randomly. The objective of this research is to examine car users' behavior if on-street parking pricing is implemented. A questionnaire survey was conducted at 16 locations in Dhaka. A multinomial logistic regression model was developed from the 500 samples. Result shows that the probability of changing mode in response to on-street parking pricing is low. Educational qualification is the most important variable for switching mode from car to other if on-street parking charge is applied. Most of the users whose parking is associated with education and work trips will not change their transport mode if on-street parking charge is put into operation.

Keywords:

Parking pricing, multinomial logistic regression model, mode change

1 INTRODUCTION

Concern over on-street parking drives much of attention in developing as well as in developed countries. Parking challenges are often acute in Asian region because of rapid urbanization and motorization and the high density of much of the urban fabric (ADB, 2011). Very few Asian cities have policies to constrain parking supply, even in city centers where the alternatives to driving are richest (ADB, 2011). As one of the effective tools of traffic demand management (TDM), parking pricing has been widely implemented by metropolitan policy makers around the world. On the other hand the returns of the parking operators and travelers' choices on modes, routes, and parking facilities (Lam et al., 2006; Glazer and Niskanen 1992) depend on the parking price. On street parking management is essential particularly with roads of high vehicular demand. Due to on street parking overall speed of the stream decreases and it obstructs other vehicles.

Dhaka is the capital city of Bangladesh and one of the major cities of south Asia. It is the 10th largest city in the world with a population of more than 18 million. It is the main center of trade, industries, business, and education etc. With the increase of population the number of private car is also growing. Dhaka is facing severe on-street parking challenges as car ownership emerges. This situation has led traffic congestion not only in local roads but also in collector and arterial roads. Total number of registered private passenger car in Dhaka from 2009 to 2015 is 209531 (BRTA, 2015). These cars had been used mostly for private purposes and constituted almost 25% of all motorized vehicles registered within Dhaka city. The slow paced city

planning has increased the problem even more (Wenzhi and Bai, 2006).

Parking plays a crucial role in the management of traffic congestion. Parking management usually has multiple objectives for example, efficiency, reducing parking conflict, revenue, urban regeneration, and mobility management (Marsden 2006; McShane and Meyer 1982). With rapidly developing cities, parking management and parking allotment should function collectively with the increasing number of vehicular usage (Tumlin, 2012). Attempts may also contain to avoid all-day parking from demanding the most convenient spaces, so that these can be managed to support short term visitor parking. Facilitating residents over visitors is also common. Priority setting in parking management is always challenged, with successes and failures, making it inherently controversial.

Among the parking management techniques parking pricing is an example of means motorists pay directly for using parking facilities (VTPI, 2005). This may be implemented as a parking management strategy (to reduce parking problems), as a mobility management strategy (to reduce transport problems), to recover parking facility costs, or to raise revenue for any purpose (such as funding local transport programs or downtown improvements). It is often intended to achieve a combination of objectives. Parking pricing is a most popular solution to control parking behavior on street. For on-street parking, Vickrey (1954), Roth (1965), and Shoup (2005) have argued that the right price at any particular time and place is that which ensures enough vacancies for zero parking search, thus minimizing external impacts on traffic. This would help in a market-based approach by providing a responsive price indicator for operators in the local parking system. This paper is the first attempt to look at pricing for parking for congestion perspective. It provides a model that can be employed to evaluate respondents' willingness to change mode if on street parking pricing is in action.

Todd Litman (2006) represents parking management as a "paradigm shift," that is, a fundamental change in how a problem is perceived and solutions evaluated. Under the old paradigm, parking problem means that not enough free parking is available at each destination. It strives to maximize supply and minimize price. The new paradigm strives to provide optimal parking supply and price. It considers too much supply as harmful as too little, and prices that are too low as harmful as those that are too high.

Observed on-street parking prices were very low in Dhaka compared to other Asian cities like Taipei city and Seoul with relatively high on-street parking prices and with prices that vary from place to place. Hong Kong, Singapore, and Tokyo have surprisingly moderate on-street parking prices. However, Tokyo and Hong Kong complement their on-street pricing with time limits (ADB, 2011). Dhaka city lacks of off street parking facilities. This is based on the hypothesis that such on-street parking is the result of inadequate spaces off-street. Conversely, it is evident that plentiful off-street parking cannot assure of orderly on-street parking or of less on-street parking. There are around 3,000 roadside shopping centers in Dhaka, and most of them do not have adequate provisions for parking (Rahman, 2010). Most of the time car users are not concerned about the period and cost when they park their car at roadside. Due to uncontrolled on-street parking system traffic jam and pollution is very common scene in Dhaka city.

Parking choice depending upon the availability of parking provisions may influence the activity travel scheduling process, such as travel time, activity duration, and activity place (Habib et al. 2012). Besides, there is an evident link between parking availability, parking charge, and mode choice, and it is a critical issue for policy-makers to manage the parking space in a multi-modal transportation system (Rye et al. 2008, Weinberger et al. 2009).

The objective of this research is to examine the car users' behavior if on-street parking pricing is implemented. The rest of this paper is represented as follows. This article provides a brief literature review followed by methodology and explanation of model development. Finally, conclusive remarks are made along with recommendations for future researches.

Present condition of parking facilities in Dhaka City

Recently motorizing cities around Asia is facing distressing difficulties over parking. If it is considered the scenario of Dhaka it can be observed that commercial streets are blocked with motor vehicles. Numerous cars are parked at the roadside and around curbs, and on many parts of footpaths. At times cars are double- parked. While, off-street (i.e. basement) parking lots of several buildings along the street remain unoccupied. These lots charge a small fee for parking in an attempt to recoup some of their costs. The fees are slightly higher than that of streets. Municipal regulations require these parking spaces to be provided as a condition for building approval. However, some buildings have shops in their basements instead of parking (ADB, 2011).

Dhaka has very limited off-street parking facilities compared to its demand. Most on-street parking concerned areas in Dhaka city are Mirpur, Banani, Gulistan, Farmgate, Dainik Bangla – Shapla Square; which are also known for their huge congestion problem as being the major arterial road. According to the Dhaka South City Corporation, the city has a parking lot near the South Gate of New Market but a large number of vehicles are seen parked randomly on the road. Although a multi-storied parking lot is present at Motijheel having capacity of accommodating over 1,000 cars, on street parking is very frequent in that area (The news today, 2015). The road space management of the existing roads is badly exercised. There is lack of discipline on lanes and random parking and stopping on the moving lanes is a common scene. As a result a substantial loss in available roadway capacity is observed. It is estimated that up to 50% of the capacity of the arterial system is wasted due to poor operating conditions (STP, 2006). It is a massive work for Dhaka Metropolitan Police (DMP) to control of the violations which occurring frequently.

Dhaka South City Corporation has a multi-storied off-street parking (fig 1) lot at Motijheel Commercial Area. It remains partially empty, despite continued super-saturation of the much cheaper on-street parking nearby. An off-street parking near Motsho Shompod Bhaban (fig 1) is present for official purpose only and it is free of cost. Rajuk's off-street parking building at Gulshan-1 has capacity for 228 vehicles at a time, is yet to popularize the space as a parking place. Dhaka North City Corporation has four authorized car Parking lots - Mohammadpur Town Hall, Mohammadpur Kitchen Market, Banani Kitchen Market and Karwan Bazar kitchen markets. Still with this available space the massive traffic can't be accommodated. The objective of this research is to develop a discrete choice model to reveal the parking users behavior if on-street parking pricing is applied.

Bari and Efrogmson showed that in 95% of their schedule on road, cars remain standing consuming large volume of road space (2006). Due to limited supply and lack of parking provision, Dhaka city is unable to meet up with the required parking challenge. The increase of and reliance on on-street parking would then contribute to traffic congestion as the effective width of roadway is decreasing for the movement of traffic. Inadequate parking supply contributes to the traffic congestion along a busy street network because motorists may cruise around the area looking for a parking space. Moreover, as motorists look for a parking space, they tend to travel at a slower speed compared to the moving traffic stream which in turn affects and delimits the mobility of the vehicles in the area (Shoup, 2006). In Dhaka city most of the on-street parking spaces are free or very low priced which persuades car users to park their car randomly. In Dhaka city most of the on-street parking spaces are free or very low priced which persuades car users to park their car randomly. Parking system presently used is not an efficient one; as the drivers are allowed to park with little or no restriction, and hence the off-street parking facility cannot be used to its full extent.

2 Literature Review

Sometimes inadequate number of parking facilities results vehicles being parked along the streets. As a result congestions may occur obstructing the flow of traffic. Parking pricing would help improve the vehicular flow as well as may become a source of revenue generation for the city. Regarding the on-street parking condition of Motijheel area, Dhaka Akter et al. (2013) revealed that overall demand is 2.73 times greater than available supply. This is happening due to comparatively extensive duration of parking. Zannat et al. (2013) elucidated the parking scenario of New Market, Dhaka and showed that average duration of parking is about 45 minutes while a significant portion of cars occupy the parking area up to 3 to 5 hours. An extensive study of Barter (2011) regarding the parking policy in Asian cities demonstrates that severe on-street parking problem exists in Dhaka city and lack of proper administration further deteriorates the situation. Chowdhury (2014) showed some faulty decisions of the authority. She emphasized on amendment of the approving guidelines of commercial buildings. Moreover, she critiqued the position of an off-street parking structure which would rather act as a congestion generator than mitigating as this did not consider self-induced parking demand.

Sudipta et al. (2014) expanded the study area at Agrabad in Chittagong, Bangladesh which is one of the most commercial activity centers of Chittagong. This study is mainly focused on the demand and supply of parking system analysis.

Several models are applied by researchers to solve parking issues from various aspects. A Logit model regarding the parking capacities and parking rationing constraints was developed by Bagloee and Asadi. Axhausen et al. (1991) used stated preference data on responses of travelers to changes in parking attributes and built logit models on parking type choices. Waraich and Axhausen employed a simple parking model into an existing agent based traffic simulation, which is able to capture the parking capacity and pricing. Hess et al. (2009) constructed a mixed multinomial logit model that considers the potential correlative structure and personal heterogeneity. Ma *et al.* (2013) developed a multinomial logit model and revealed the relationship between parking choice and purpose at the Beijing, Lama Temple. Lam et al. (2006) proposed a time dependent network equilibrium model and obtained that parking behavior is considerably affected by travel demand, walking distance, parking capacity, and parking charge. Hensher et al. (2001) estimated a nested logit model of mode and parking choices and simulated a sensitive analysis on parking share in the Sydney central business district.

Box (2004) encapsulated several operational and safety studies and pointed out that curb parking represents a potentially hazardous and congestion producing issue. Albert and Mahalel (2006) assessed different viewpoints toward congestion tolls and parking fees to explore their effects on travel time. They observed that drivers are willing to change their trip schedule to avoid congestion charges. Hess evaluated the effect of free parking on travel mode choice and parking demand for the work trip in Portland's (Oregon) central business district (CBD). If the parking charge at work sites is increased the mode split ratio of drive alone will reduce. Qian et al. (2012) examined how to design the parking capacities, parking charge, and accessibility to reduce total social costs.

Teknomo and Hokao (1997) studied to understand parkers' behavior in choosing a parking location in the CBD of Surabaya. Three types of parking location choice models were developed, namely Parking Demand Regression Models, Analytic Hierarchy Process and Multinomial Logistic Models. Result demonstrated that the parkers' behavior in choosing a parking location is primarily motivated by the availability of parking spaces, trip purpose, search and queue time, walking time, parking fee, security, and comfort ability.

Where curb parking is underpriced and overcrowded, some drivers search for a curb space

rather than pay to park off-street. Research throughout the last century showed that cruising is common in congested traffic, and a model of how drivers decide whether to cruise or to pay predicts that charging the fair market price for curb parking can eliminate cruising. City governments therefore play a large part in choosing whether drivers cruise, because they set the prices for curb parking. Cruising is simply a driver's individual response to the public pricing policy (ADB, 2011).

Glazer and Niskanen (1992) showed that conventional techniques, which usually determine the optimum pricing by marginal cost pricing model are not always adequate to evaluate these impacts on travelers' choices and subsequent variants of parking demand and network performance. In addition, the development of park and ride (P & R) facilities as a new type of parking facility adds more complication to the situation, of which parking lots are located on the edge of urban area to encourage car drivers park and enter the city by public transport. If off-street parking is unavailable or expensive, many drivers will hunt for curb parking, an entirely rational response to prices.

Parking in Asian cities become particularly significant and problematic due to fast increase of motor vehicle appeared in many countries. This, at the same time with uncertainties about its pace, makes parking policy difficult. Many of the cities of the region are remarkably dense by world standards. This can be an opportunity for achieving rich mode selections. However, high densities make parking problems remarkably severe. High density and associated high property prices are impracticable to bring together with the desire among new car owners for parking to be low-priced and ample (ADB, 2011).

Rahman (2007) pointed that 60% of the vehicles parked in Motijheel, the business district of Dhaka city are private cars. Thus the workability of these commercial areas is governed by either the accessibility of convenient parking facilities nearby or availability of off-street parking facilities. Mahmud et al. (2012) revealed that the problem is worsened by the absence of any effective parking policy for Dhaka where illegal on-street parking is a common scenario in every single busy street. This constricts the available carriageway for traffic, thus posing as one of the major contributor to traffic jam. Studies show that the vehicles cruising for on-street parking create 8-74% of the traffic congestion (Shoup, 2007). Shoup (2007) also found that underpricing of on-street parking is the main cause behind increased tendency to cruise rather than parking on a vacant off-street parking. Mahmood et al. (2009) recommended amending the parking problems of Dhaka city by ascertaining vacant parking spaces and commencing metered parking or monthly-parking permits to control parking trend.

3 Materials and Methods

A questionnaire survey was conducted in arterial, feeder (or collector) and in local roads at 16 locations in Dhaka city. An in depth literature review was undertaken to set questions in the questionnaire. It contains three sections. Section A of the questionnaire comprises respondent's demographic information such as their gender, age, occupation, educational status, and respondent's main mode of travel. Section B deals with the existing parking condition in six different areas: reason for on street parking, reason for on-street parking rather than using off-street car parking, selection of parking provisions and its frequency, ease to find spaces for parking, parking duration and safety for cars. Section C is about opinion/willingness of parkers to pay for parking facilities. It includes opinion of driver about willingness to change transport mode if on-street parking pricing is applied and the amount/charge they are willing to pay. Attention was drawn to confirm that the survey could deal with either professional drivers or motorists driving their own car as respondents.

Data collection was conducted for seven hours starting from 8.00 a.m. to 3.00 p.m. for four

days during September 20th to 23rd 2015. Out of 530 questionnaires 500 complete samples were found. To collect the data some major on-street parking roads were selected. A detailed description of the study sites along with the rationales of selecting these locations are shown in Table 1. Road width and width occupied by car parking were also measured. This study considers respondents whose main mode of travel is car and counts all types of trips. The respondents who parked their cars for any purposes as to get to work, educational institutions, shopping, leisure, and entertainment were asked about their most recent trip. The areas were chosen because on-street parking was perceived to be a problem there causing severe congestion during most of the time of a day.

Table 1 Description of the survey locations

Name of location	Road classification	Road width (ft)	Width occupied by parking (ft)	Reasons for selection
Dhanmondi -9/A	Local Road	15	5	It is a local road which mainly connects one arterial road (Satmosjid road). This road contains good number of educational institutes and residential building. As a result high volume of on-street parking is generated
Dhanmondi -8	Local Road	15	5	It is a local road which mainly connects one arterial road (Mirpur road) and one feeder road (Green road). This road contains a large number of residential building, educational institutes and hospital. As a result high volume of on-street parking is generated
Dhanmondi -8/A	Local Road	18	10	It is a feeder road which connects four local road (Dhanmondi-9/A, Dhanmondi-10/A, Dhanmondi-11/A, Dhanmondi-12/A) and Satmosjid road. It is an important place which contains good number of educational institute, bank, office, residential building, park, hospital and mosque. As a result high volume of on-street parking is generated
Dhanmondi -7	Feeder Road	16	5	It is a feeder road which connects one arterial road (Mirpur road) and one feeder road (Green road). A number of educational institute, restaurant, residential building and Hospital are located. For that high volume of on-street parking is generate.
Dhanmondi -7/A	Feeder Road	16	5	It is a feeder road which connects a major arterial (Satmosjid road). It is an important place which contains good number of educational institute, workplaces, residential building and hospital. As a result on-street parking takes place at both side of the road.
Dhanmondi -6/A	Local Road	15	5	It is a local road. It is an important place because of mixed type of workplaces; educational institute, park and shopping mall are present. As a result high demand of on-street parking occurs.
Dhanmondi -3	Feeder Road	22	5	It is a feeder road which connects a major arterial road (Mirpur road). A number of educational institute and residential building are located. As a result high volume of on-street parking is generated
Dhanmondi -15/A	Local Road	17	5	It is a local road which connects a major arterial road (Satmosjid road). A number of educational institute, hospital, shopping mall and residential building are located. As a result high on-street parking takes place.
Satmosjid road	Arterial Road	34	10	It is an arterial road. It is an important place because of mixed type of educational institute, restaurant, hospital, stadium and shopping mall are found. So high amount of on-street parking takes place.
Kamal Ataturk Avenue	Arterial Road	32	10	It is a minor arterial road which connects a major arterial road (Gulshan Avenue). It is an important place because of mixed type of educational institute, workplaces, bank and shopping center are present. As a result on-street parking takes place at the road.

Banani Road No-18	Local Road	15	5	It is a local road which connects a major arterial road (Kamal Ataturk Avenue) and a local road (towards road-21). A number of educational institute, restaurant, and bank are located. So lots of car are found to park on-street.
Shaid Syed Nazrul Islam Sharani	Arteria l Road	30	10	It is a minor arterial road which connects major arterial road (Topkhana road) towards VIP road. It is an important place because of mixed type of workplace; hotel, bank and shopping center are present. As a result on-street parking occurs.
New Paltan	Arteria l Road	32	10	It is a minor arterial road which connects two major arterial roads (Topkhana Road and Motijheel road). It is an important place because of mixed type of workplace, and banks are present. As a result on-street parking occurs at the road
Motijheel	Arteria l Road	30	10	It is an arterial road which connects an intersection (Shapla chottor) connecting two arterial roads (Toyenbee circular road and Toyenbee road). It is an important place because of mixed type of workplace; bank and shopping center are present. As a result on-street parking occurs.
Mirpur road	Arteria l Road	34	10	It is a major arterial road. It is an important place because of mixed type of workplace; bank and shopping center are present. As a result the road has a high demand for on-street parking.
Shaymoli Ring road	Feeder Road	30	5	It is a feeder road which connects a major arterial road (Mirpur road). This road has a high demand of on-street parking as mixed type of workplace; bank, garments, restaurant and shopping center are present.

4 Data Analysis

Table 2 shows the general characteristics of the respondents. Majority of the respondents were male and most of them were professional driver. Most of the drivers had primary education. Respondents' main mode of travel was car/cng (three wheelers auto-rickshaws)/taxi. Users park their cars on-street for various reasons. Some park because the place is closer to their destinations, some park because they think off-street parking price is high and it is not much

Table 2 General characteristics of the respondents

Characteristics	Statistics
Gender	Male 95%, Female 5%
Occupation	Service holder/ student / businessman 7%, professional driver 93%,
Education qualification	Uneducated 35%, primary(j.s.c) 44%, s.s.c/h.s.c/post graduates/graduates 21%
Main mode of travel	Usage of car, cng or taxi 93%, Usage of cycle or rickshaw 7%
Main reason for on-street parking	Shopping 16%, educational purpose 42%, office/business 26%, leisure and others 5%, medical purpose 11%
Main reason for parking on-street rather than using public car parks	More convenient 24%, only want to park for a short time 43%, cost or availability of off-street parking 33%
If charge were made for car parks would you change mode of transport	Yes 7%, no 71%, sometimes 22%
If yes (change mode of transport) then shift to what	Shift to walk/ prefer not to make trip by car 22%, shift to taxi/ cng/cyclist/rickshaw 78%
Usual place of parking	Free car parks (on street) 86%, off street park/limited parking/valet parking 14%
Are you able to find space for park without difficulty	No 47%, yes 53%
How long do you normally stay	Less than one hour 54%, one to three hour 35%, three to six hours 10%. more than six hours 1%
How much you willing to pay	Up to 30 BDT* 100%, more than 30tk 0% (30 BDT=0.37 US \$)

*One can travel around 7-10 km by paying 30 BDT in public buses

available or simply to save that money. Respondents' main reason for on-street parking is associated with educational purpose. The most important issue is that whether the users will change their mode if charges were applied for on-street parking. The majority of the users said that they will not change their mode even if charges were applied. For users who are willing to change or shift their mode of transport will use car/cng (three wheelers auto-rickshaws)/taxi or walk or prefer not to make the trip. It was found that most of the users will shift to cycle or rickshaw.

4.1 Multinomial Logistics Regression model

The Multinomial Logistic Regression (MLR) model is generally effective where the dependent variable is composed of a polytomous category having multiple choices. MLR is used to describe data and to explain the relationship between one dependent variable and one or more continuous-level independent variables. The logistic regression is powerful in its ability to estimate the individual effects of continuous or categorical independent variables on categorical dependent variables (Wright 1995). In a multinomial logistic regression model, the estimates for the parameter can be identified compared to a baseline category (Long, 1997). In the literature, logistic regression is used to describe and test hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictor variables (Lee et al., 2002). There has been use of logistic regression in literature for different types of behavioral and decision analysis (Johnson and Parrot, 1995).

A multinomial logistic regression (MLR) model was developed to assess on-street parking user's willingness to change transport mode in response to on-street parking pricing. The survey results have been analyzed to explore the current behavior, reasons of choosing on-street parking over other parking facilities, and individuals' opinion about parking related issues.

In this study, response variable is "Choice" which is of three outcomes of choice of travel mode namely: change mode, will not change mode and sometimes change mode if parking pricing is implemented. The logistic model uses the baseline-category logits with a predictor. In this paper sometimes was specified as the baseline category; in which the log odds of the outcomes are modeled as a linear combination of the predictor variables. SP data are analyzed to determine the factors influencing mode change behavior of users. Their choice of travel modes was compared on the basis of values for parking fare, parking stay time, space finding difficulties and some other variables. These variables are determined by focusing the local context that is considered to influence on the choice of users' daily travel mode. Relationships among variables were tested empirically using the multinomial logistic regression in SPSS. The various variable used in this study are shown in Table 3 along with their respective definitions.

The models have been assessed to identify, which requirements most effectively strengthens the data for various mode for trip if on-street parking pricing is applied. In this research, specific parameters are predicted to impact car owner's behavior, when they have different choice of transportation modes.

Some of the parameters (such as, travel cost and travel time) are considered to be substantial in literature, while other variables presented are exclusively to deal with specific research issues. Quite a number of models were analyzed which revealed inadequate statistical goodness-of-fit or had counter-perceptive signs; and hence they all were discarded.

Table 3 Variables incorporated in the multinomial logistic regression model

Variables	Explanation
v1	Gender (1 if male, 0 if female)
v2	Occupation (1 if professional driver, 0 if service holder/student/businessman)
v3	Education qualification (1 if uneducated, 2 if Primary/J.S.C, 3 if S.S.C or higher)
v4	Main mode of travel (1 if use car, cng or taxi, 0 if use Cycle or rickshaw)
v5	Main reason of on-site parking (1 if shopping, 2 if educational purpose, 3 if Office/business, 4 if leisure, 5 if medical purpose)
v6	Main reason for on-street parking rather than off-street (1 if more convenient, 2 if park for short time, 3 if off-street parking is less available or overpriced)
v7	Would you change travel mode from car to other if charges are applied (1 if yes, 2 if no, 3 if sometimes)
v8	If change mode, shift to which transport (1 if shift to taxi/cng/rickshaw, 0 if shift to walk/not to make trip)
v9	Which parking would you use (1 if on street parking, 0 if off street parking)
v10	Are you able to find space without difficulties (1 if yes, 0 if no)
v11	How long do you stay (1 if less than an hour, 2 if one to three hour, 3 if three to six hour)
v12	Is this place safe for parking (1 if yes, 0 if no)
v13	How much are you willing to pay (1 if up to 30 BDT, 2 if more than 30 BDT)

Table 4 represents the most illustrative one. The basic idea behind the mode change model estimation was to identify factors influencing the people of Dhaka to park on street, and the circumstances of parking pricing that may persuade them to use other modes of transport. The chi-square value has been employed to evaluate the complete relevance of the logit model. It has been calculated as -2LL (Log Likelihood) for the null model with only constants used as the explanatory variables, without -2LL for the completely specified model. The coefficients of the model were significant ($P < 0.05$), and the null hypothesis was invalidated, indicating that, the independent variables created no distinction in forecasting the dependent variable. The -2LL gauges how better the model suits the data. The chi-square value was found 72.636 for the logit model. In this research, the demographic variables such as age and gender did not substantially contributed to explain the mode change behavior. From the survey percentage of male respondent were way more than female respondent. The occupation was found significant.

Respondent's whose main mode of travel was private cars or cng/taxi has a probability to change mode. Education played significant role for changing mode if on-street parking pricing is applied. Most of the cars were driven by professional drivers who are mostly illiterate. For this reason the rules of parking weren't followed in most of the cases. Result signifies that if the drivers (on-street parking users) don't find a place to park or if they are forced to leave the parking place they will park another place in the vicinity, which may cause congestion. Result shows that if they are able to find space without difficulty then they will change their mode if parking pricing is employed.

Space finding difficulties' were also a reason for car users to change their modes. For car users who drive their own cars do not willing to park far from their destination for which they need both secure and close ranged parking place which makes them incapable to stay in their particular mode. Cars which are driven by drivers saved from this issue because drivers can take cars far and can bring it back on time. Result indicated that car users who usually come and park their cars on a regular basis will not change mode if on-street parking charges are applied. Users whose cars are driven by professional drivers but not owners will also not change mode due to charges. Those who come for short period showed willingness to change mode. Respondents who are willing to change their mode, would like to choice either taxi or rickshaw. Respondents whose occupation is professional driver have a probability to change mode.

Table 4 Multinomial logit model

Willing to change mode of transport	Variables	B	Std. error	Sig.	Exp(B)	95% C.I.	
						Lower	Upper
Yes	Intercept	-3.41	0.95	0.00			
	Occupation (Professional Driver)	1.65	0.78	0.03	5.18	1.13	23.80
	Uneducated	1.22	0.60	0.04	3.38	1.05	10.92
	Main mode of travel (Car/taxi/cng)	2.86	0.64	0.00	17.53	4.99	61.55
	Educational purpose	1.14	0.47	0.01	3.14	1.26	7.82
	Able to find space without difficulty	-0.98	0.48	0.04	0.38	0.15	0.95
No	Intercept	0.50	0.41	0.22			
	Occupation (Professional Driver)	0.82	0.57	0.15	2.26	0.74	6.92
	Uneducated	0.01	0.24	0.96	1.01	0.64	1.61
	Main mode of travel (Car/taxi/cng)	0.23	0.58	0.69	1.26	0.41	3.89
	Educational Purpose	0.80	0.23	0.00	2.24	1.43	3.50
	Able to find space without difficulty	-0.38	0.24	0.11	0.68	0.43	1.09
Summary of Statistics							
Number of observations		500					
(-2)Initial LL		349.936					
Chi Square		72.636					
(-2) Final LL		277.300					
Cox & Snell's R ²		.135					
Nagelkerke value		.173					
McFadden's value		.096					

From the model it can be seen that respondents who come for educational purpose do not have probability to change the mode. Most of the areas of this study are occupied with numerous educational institutes although their land use claimed them as residential. Lots of students usually use cars for commuting to the educational institutions. This is why roads are heavily occupied with private cars and hence probability of changing mode in these cases has very insignificant probability.

The reasons for individuals to change mode or not are investigated in this research. Parking fare does not have significant influence for individual commuters to change modes whereas main mode of travel and purpose of parking was more significant for the model. On the other hand, finding space was more important for users than parking fare. Respondents who have difficulties in finding parking space have the most possibilities to change modes. For car users who drive their own cars can't park far from their destination for which they need both secure and close ranged parking place. Educational facts and occupation was important factor affecting peoples' change of mode.

4.2 Estimating response probabilities

The MLR model has an alternative expression in terms of the responses probabilities, that is $\pi_j = \frac{e^{\alpha_j + \beta_j x}}{\sum_h e^{\alpha_h + \beta_h x}}$, $j=1 \dots J$. In this model, probability of sometimes (baseline category) was taken as π_0 and the estimated value was $\hat{\pi}_0$, Yes was π_1 and the estimated value was $\hat{\pi}_1$, No was π_2 and the estimated value was $\hat{\pi}_2$. We can calculate these probabilities by two steps:

First, we can calculate $\log \frac{\hat{\pi}_1}{\hat{\pi}_0}$, $\log \frac{\hat{\pi}_2}{\hat{\pi}_0}$ as the response variable has three categories (J=3), which means that there are 2 equations as following:

Let $y_1 = \log \frac{\hat{\pi}_1}{\hat{\pi}_0}$ and $y_2 = \log \frac{\hat{\pi}_2}{\hat{\pi}_0}$, so

$$y_1 = -3.406 + 1.645(\text{Occupation}) + 1.218(\text{Uneducated}) + 2.864(\text{Main mode of travel}) + 1.144(\text{Educational purpose}) - 0.982(\text{Able to find space without difficulty}) \dots \dots \dots (4.1)$$

$$y_2 = 0.500 + 0.817(\text{Occupation}) + 0.011(\text{Uneducated}) + 0.228(\text{Main mode of travel}) + 0.804(\text{Educational purpose}) - 0.384(\text{Able to find space without difficulty}) \dots \dots \dots (4.2)$$

As Agresti (2007) says statistical significance should not be the sole criterion for whether to include a term in a model. It is sensible to include a variable that is important for the purposes of the study and report its estimated effect even if it is not statistically significant. Keeping it in the model may help reduce bias in estimating effects of the other predictors and may make it possible to compare results with other studies where the effect is significant. Thou only few were significant still every variable was taken. Second we calculate $\hat{\pi}_1$, $\hat{\pi}_2$, $\hat{\pi}_0$ as following, where exp. or e = 2.71828 is the base of the system of natural logarithms

$$\hat{\pi}_1 = \frac{\exp(y_1)}{1 + \exp(y_1) + \exp(y_2)} \dots \dots \dots (4.3)$$

$$\hat{\pi}_2 = \frac{\exp(y_2)}{1 + \exp(y_1) + \exp(y_2)} \dots \dots \dots (4.4)$$

$$\hat{\pi}_0 = \frac{1}{1 + \exp(y_1) + \exp(y_2)} \dots \dots \dots (4.5)$$

4.3 Predications by using MLR model

Each case consists of a combination of explanatory variables. Prediction is based on classifying this combination in one of the three groups of the response variable. The model estimates the probabilities of the combination of the three response variable groups and then classifies the case based on probability. For the application of the model case no 102 was selected randomly. To estimate the three response probabilities (π_0 π_1 π_2) by using equations (4.1 to 4.5) and by using Parameter Estimates data: of case no-102

$y_1 = 1.483$, $y_2 = 1.965$ we can calculate the estimated probability to occur each category as following:

$$\hat{\pi}_1 = 0.351$$

$$\hat{\pi}_2 = 0.569$$

$$\hat{\pi}_0 = 0.079$$

This probability showed that case number 102 has 56.9% chance to state a negative answer towards mode change behaviors. In other words it can be said that, this case has the highest probability that user will not change mode if charge is applied.

5 Discussion

Due to illegally parked vehicles along the streets, congestion occurs obstructing the flow of traffic. Therefore, as a solution, a parking pricing would help improve the vehicular flow along the streets especially at peak periods and at the same time would introduce revenues for the city. The space occupied by only a small number of cars can cause a great deal of interruption if the parking is done on streets having heavy vehicular as well as pedestrian traffic for an extended period, such as the whole working day. Illegal parking jeopardizes the safety and livability of a street and thus charge may be applied to encourage users to change their mode and thereby to free the road space. This research may be an overview for taking decisions about implementing

charge for on-street parking.

This research is the first attempt which takes into account the car users' willingness to change their mode in response to parking pricing for developing country. In this paper, transport mode change behaviors of 500 respondents were analyzed at various locations in Dhaka, Bangladesh. Based on the conducted questionnaire survey, the significant factors affecting the on-street parking were identified. Respondents' main reason of parking has more significant impact on using on-street parking.

This paper also showed that parking users are willing to pay a fare between 20-30 BDT in the city to park. Users showed significant sign that they are willing to pay the parking price if fee is implied. Average time the car users wait in the parking area is less than an hour.

Result shows that majority of the respondent's main mode of travel is car, cng or taxi. Some car users said that if their destination is near to their home then sometimes they would use rickshaw instead of car. This study showed that car users parked their cars for different purposes namely for educational purpose, office/business, shopping, medical purpose and for leisure and other purposes. According to VTPI (2005) more accurate and flexible standards for the parking requirements at a particular location are adjusted to account for various factors such as geographic, demographic and management factors that affect parking demand and parking requirements; types of trips and users, including their urgency and ability to rely on alternatives; the cost and ease of adding parking capacity; the ability to implement parking management programs etc.

The result demonstrates the main reason of parking on-street instead of off-street or public parking. Car users expressed that they park on-street for a short time as it was more convenient for them while it is free of charge and off street car parking facilities needs to pay and they are not so common in those places. In the model, the occupation was found significant for mode change behavior. Result showed that users who parks on-street on a regular basis and cars that are driven by professional drivers but not owners will not change mode due to charges. Those who park for short period or come for some official work may change mode as they don't need to stay long and park. Respondents who are willing to change their mode would travel by either taxi or rickshaw. Education also played significant role in changing mode if on-street parking pricing is applied as majority of the cars were driven by professional drivers who are mostly illiterate. Parking regulations are not comprehended and obeyed by them in most of the cases. If on-street parking users are unable to find a place to park or driven from one location; they will change their parking position to nearby streets.

Space finding difficulties' may also influence car users to change their modes. For car users who drive their own cars can't park far from their destination for which they need both safe and close ranged parking place which makes them unable to stay in the car mode if on-street parking pricing is implemented.

6 Conclusion

In Dhaka city most of the on-street parking spaces are free which persuades car users to park their car randomly causing serious congestion. Parking plays a crucial role in the management of traffic and congestion. This paper shows that most of the respondent's operate their cars by drivers. If they don't find any parking place near to their destination they rather park in the nearby roads. Parking fare does not have significant influence for individual commuters to change modes whereas main mode of travel and purpose of parking was more significant for the model. On the other hand, finding space was more important for users then parking fare. Educational facts and occupation was important factor affecting peoples' choice of mode. Result shows that majority of the respondents' parked on-street. They also stated that the reason

may be due to the availability of these assortments of parking types around the survey area and it is more convenient as users can save time to reach destinations, and also can save cost. It can also be added that users parked along the street because of the limited availability of off-street parking facilities and due to the lack of enforcement. Therefore, parking demand and parking supplied by off-street parking facilities also influence on-street parking since individuals tend to find or explore other possible parking areas when bringing their vehicles.

Parking demand of customers also influences the on-street parking since the tendency of individuals bringing cars are intended to explore for other possible parking areas when challenged with inadequate off-street parking facilities. Therefore, on-street parking tends to attract more people when off-street parking is least available. On the other hand even some regions provide ample supply of off-street parking; still on-street parking culture is very much common. This is because people choose their parking areas where it is near to their destination, and they also choose their parking places in response to easy parking accessibility and convenience and where penalty for parking on no parking region is very insignificant.

According to Shoup (2005) drivers can use several strategies to economize on curb parking without reducing their travel. They can drive at off-peak hours when curb parking is cheaper; park where prices are lower and walk farther to their destinations; park for a shorter time; park off-street; carpool and split the cost of parking; or take public transit, ride a bike, or walk all the way to their destinations. Without reducing human travel and all real travel by people, not cars carpools, public transit, cycling, and walking will reduce vehicle travel.

Around half of the respondents don't park on-street for financial reason but to save time for commuting to parking lots which clearly supports that curb and off-street parking are not perfect substitutes for one another. Drivers do not choose between them only on the basis of price. The walking time from the parked car to the final destination and back must also be considered. Off-street parking may be less convenient than curb parking because the added driving and walking time needed to access the parking place may be significant, while the parking may unsafe sometimes. Vickrey (1954) explained that curb parking is in most cases more convenient than off-street parking, and said that curb parking prices would therefore have to be higher than the prices for off-street parking to create curb vacancies and discourage cruising. The right price for curb parking is thus the price that leads to a few vacant spaces, and this price may be higher than the price of adjacent off-street parking.

Where on-street parking is cheaper than off-street parking, wandering for parking is individually natural. Accordingly, traffic congestion takes place, accidents occurs, fuel wastes, pollutes the air, and degrades the pedestrian environment. Cities create all these problems when they underprice curb parking. If the curb parking is underpriced then it creates a shortage. Underpriced curb parking is gross in management of scarce urban land, with widespread effects for transportation, cities, the economy, and the environment (Shoup, 2006). Some authors (Chowdhury, 2006; Barter, 2011) described underpriced curb parking as vicious subsidies because it encourages drivers to harm other people and may not even benefit the drivers themselves. Cities must then arrange sufficient budget to settle the congestion and pollution problems they have. Comprehending the price of curb parking right will benefit everyone which may be pursued by cities.

The reasons why the car users are not interested to change their mode from car to others is that in Dhaka it is easily accessible and comfortable way to travel, and the users have privacy, feel safe and it saves time. Other reasons may include the lack of satisfactory public transportation and high prices of taxis in Dhaka. Moreover, the poor quality of walking and biking facilities do not encourage travelers to use them. Hence in Dhaka city, if parking users are to pay, comparatively high parking prices should be expected as respondents mentioned that they won't change their mode of travel if the parking charge is comparatively low. Some drivers may

take the chance of paying fine by parking on a prohibited curb space. There are also options beyond the simple choice between on-street parking and paying fines. One can move to a neighboring area where curb parking is eventually available or where off-street parking prices are lower, and then walk farther to their destination. But despite these, the simple message is that if cities cost nothing or too small for curb parking, motorists will park their car on street. Meanwhile, it is true that the time spent searching for free parking spaces could produce considerable environmental pollution.

Most of the users whose parking is associated with education and work trips will not change their transport mode if on-street parking charge is put into operation. Those trips are most closely associated with travel in peak periods and largely responsible for congestion. Parking associated with shopping, medical, leisure, and amusement tends to be associated with travel other than peak periods are usually between one to two hours. Car users usually face difficulties to find space for parking as suggested by result.

The city government is striving to build parking structures. The expensive projects have low returns. Moreover on-street parking is not prevented which creates chaos in their vicinities. Hence prevention of on-street parking is necessary to publicize off-street parking facilities. High density and associated high property prices are impossible to resolve with the desire among new car owners for parking to be cheap and abundant (ADB, 2011).

In conclusion, the results of this research, is distinguishing because, it is a first attempt at modeling on street parking pricing for developing countries. It may be expected that this research will be extremely useful for parking demand management. It will also assist government and public transportation organizations and private providers in making suitable choices and avoid under/over designing of required amenities and services. The outcomes of this study can be applied to assess current parking demand and future need also.

This study was done with a small sample size and hence only a few places inside Dhaka city were covered. More comprehensive data from a wide range of locations as well as respondents would be more helpful for a better model. For similar study in the future, it is suggested that, database with more comprehensive information about other transportation modes (bus, taxi, cng, rikshaw etc.) may be considered as main mode of travel. Policy makers should seriously focus on directing trips to public transportation considering the rapid growth of population as well as trips. Furthermore, the existing transport system in Dhaka does not successfully fulfill the need for the transporting people of all classes. This type of research can be neither attainable nor beneficial, without the understanding of related authorities and decision-makers, in contemplating the outcomes and suggestions of this research.

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