INVESTIGATING THE EFFECTS OF OFF-STREET PARKING INFORMATION PROVISION SYSTEM IN MOTORISTS' PARKING CHOICE BEHAVIOR

○ University of Miyazaki, Student Member, Mohammad Emran NASERY
University of Miyazaki, Member, Hiroshi SHIMAMOTO

INTRODUCTION

According to several transportation planners, providing information about a specific type of parking can increase the attractiveness for its usage. As stated by (Bonsall & Parry 1990) Parking information can support travel decisions, and travelers have found such information to be useful. However, as navigation and searching locations in Kabul city have not been mounted with google maps or any other digital GIS data, it is very hard for users to find off-street parking which are not in obvious eye sight in the central business district (CBD) area of the city. This issue has convinced motorists that there aren't sufficient off-street parking lots available. According to a survey conducted in March 2015, the average number of off-street parking locations that were known by road users in CBD area were 3-5, while according to an interview with an official from Kabul municipality, there are 20+ off-street parking available. In addition, the survey results showed that, in spite of being illegal, on-street parking was being used by 63% of the respondents at least twice a week and 14% of them were using on-street parking 7 times or more in a week.

The aim of this research is to investigate how bringing convenience in finding off-street parking by providing information about off-street parking will affect peoples' parking choice behavior and what factors affect their choice the most and how can we make using on-street parking in the CBD area be less attractive choice for parking vehicle. We assume that, by providing information about off-street parking through a smartphone application or social media, we will be able to, not only reduce the demand for on-street parking in the CBD area and promote off-street parking usage, but also minimize the cruising time for searching parking which will consequently prevent unnecessary traffic flow that results in congestion.
This research is the first research ever in the context of Kabul city to evaluate, will this off-street parking information provision system reduce on-street parking demand, and promote usage of off-street parking or not?

METHODOLOGY

In order to investigate people's reaction to the implementation of the above policy and how the demand for each type of parking will change, we have proposed an imaginary situation through a stated preference survey. In this survey, we asked the respondents to assume, "if information about location, directions to, real time availability and price of the off-street parking will be provided through a smart phone application or a social media page, at the same time, respondents were asked to assume that on-street parking in CBD area will be legal but highly priced", which of the given alternative would they choose?

The respondents had option to choose between three alternatives namely, using on-street parking without information (ONPW/O), Off-street parking using the information (OFPW) and off-street parking without information (OFPW/O). Three attributes namely, time required for parking, average travel cost and convenience in finding parking were associated with each alternative so that the users can prefer one of the choice based on the attribute values as two levels (a minimum and a maximum value) were provided for each attribute. In addition, some socio-economic dummy variables were included as well.

In order to manipulate the combinations of the values for each attribute we have used a fractional factorial design of type $2^{(9-5)}$ which generated a 16 scenario choice set. For convenience we have blocked the experimental design into two parts each set having 8 scenarios. We have collected 227 samples, each sample included 8 choice scenarios (totally 1816 scenarios). The attribute parameters were estimated using Maximum likelihood estimation (MLE) method as in Eq. (1).

$$L(\theta 1, \theta 2, \ldots \theta m) = \prod_{i=1}^{n} f(xi; \theta 1, \theta 2 \ldots, \theta m) \qquad (1)$$

Table 1 **[Summary of parameter (attribute coefficients) estimation]**

	Parameter Name	Value	t_stat	Dummy Parameters	Value	t_stat
ONPW/O	Time for parking	-0.147	-7.00	OFPW constant	-5.970	-0.16
	Average Travel Cost	-0.034	-5.42	internet access in phone	0.403	3.31
	Ease in finding parking	0.032	2.45	survey type	2.95	13.28
OFPW	Time for parking	-0.257	-4.55	high income	0.473	3.21
	Average Travel Cost	-0.006	-1.15	home location	0.042	0.16
	Ease in finding parking	0.014	0.04	**Summary Statistic**		
OFPW/O	Time for parking	-0.008	-0.37	Observations = 227	ρ^2 = 0.314	
	Average Travel Cost	-0.048	-5.33	$\mathscr{L}(\mathbf{0})$ = -2003.7	ρ^{-2} = 0.306	
	Ease in finding parking	0.024	2.13	$\mathscr{L}(\boldsymbol{\beta})$ = -1382.4	Deviance = 1242.7	

The choice probabilities for each alternative were estimated by developing a multinomial logit model as shown in the Eq. (2)

$$Pn(i) = \frac{e^{Vin}}{\sum_{j\,\varepsilon C(n)} e^{Vjn}} \qquad (2)$$

DATA ANALYSIS

The parameter estimation and model development were conducted using the statistical software R. Table 1 illustrates the parameter values, t-statics and some other statistical test to validate the accuracy of the model.

For all parameters, except 5 (OFPW travel cost, ease in finding parking and constant, OFPW/O time for parking, and dummy for home location) the null hypothesis that the true value is zero can be rejected at 0.05 significance level. In addition, the same null hypothesis can be rejected for seven out of fourteen parameters at 0.01 significance level. As for the goodness of fit index, the value of ρ^2 was 0.31. According to (McFadden, 1974) a ρ^2 having value between 0.2 and 0.4 demonstrates an excellent fit, so does our model.

The average choice probabilities for each alternative were as follows:
ONPW/O: 14.97% OFPW: 63.63% OFPW/O: 21.4%

Moreover, we have simulated the attributes values to see how changes in the values affects the choice probabilities of each alternative. For this purpose, we have considered the time for parking of each alternative and changed the values of this attribute several times and plotted the results as it is illustrated in Fig.1

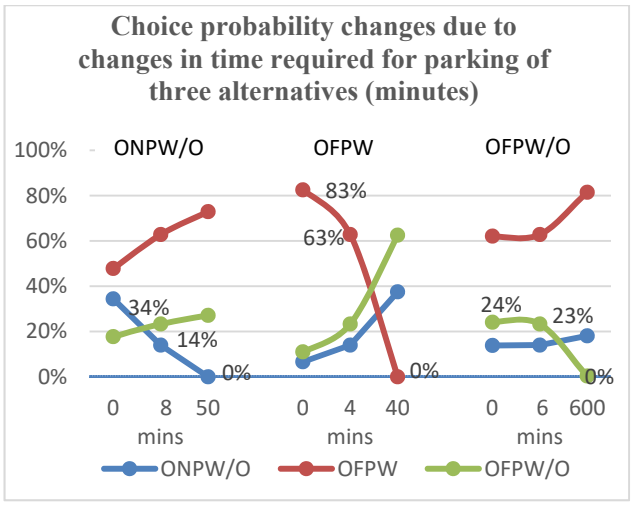

Fig. 1

For the simulation purpose, we have selected a choice probability close to the overall average choice probability as a reference and changed the time value several times. We have initially simulated the time required for ONPW/O alternative, when the value for time required to find a free space, park the car and walk to destination was chosen as zero, the choice probability for ONPW/O was 34%, while the value was increased to 8 minutes, the probability decreased to 14% and as the value was 50 minutes, the choice probability for this alternative decreased to 0%.
As for the time required for the OFPW, when the time was zero the choice probability for it was 83% and for the second value which was 4 minutes the probability was 63% and by the time the value was increased to 40 minutes, there was a 0% probability people would use this alternative for parking their car.

Lastly we evaluated the time required for OFPW/O information. As the value was zero, the choice probability for this alternative was 24% and for 6 minutes it was only decreased to 23%. In order to examine when will be a 0% probability that people will choose this option we could achieve that value when the time for using OFPW/O information was 600 minutes. This means that time for OFPW/O information had the least effect on people's choice behavior. Worth to be mentioned that the parameter for this attribute was not statistically significant as well.

CONCLUSIONS

As the result of the model shown, if this policy is implemented, the choice probability for three alternative would be as follow:
ONPW/O: 14.97% OFPW: 63.63% OFPW/O: 21.4%
This confirms that the demand for on-street parking will be drastically reduced from 63% current usage to a 14% probability of usage.
Seven out of fourteen of the given parameters in the model were statistically significant at the level of 0.01 and the likelihood ratio or the goodness of fit index of the model was 0.31 which represent an excellent model.
The choice probabilities of each alternative will be 0% if the time for ONPW/O information is 50 minutes, for OFPW information 40 minutes and for OFPW/O information is 600 minutes. This means that the time for OFPW/O information has the least effect on the people's choice behavior.

As a conclusion, implementing this policy will reduce the demand for on-street parking and promote usage of off-street parking which will eventually reduce traffic congestion in the CBD area.

REFERENCES

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