PERIODICA POLYTECHNICA SER. TRANSP. ENG. VOL. 33, NO. 1–2, PP. 125–137 (2005)

TRAFFIC INFORMATION USE MODELING IN THE CONTEXT OF A DEVELOPING COUNTRY

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Received: Nov. 5, 2004

Abstract

The use of traffic information in the form of radio reports, as a solution to the problem of congestion, is one of the issues, which are of particular importance for large cities like Tehran. In this study, factors affecting the use of traffic information in the context of a developing country are examined for commuters in the city of Tehran using ordered logit models. Results based on the particular survey designed for this purpose are compared to those of a developed country.

Regarding the use of information in the form of listening to the radio traffic reports, the models show that older commuters, commuters who adjust their departure time according to traffic conditions (those who are sensitive to traffic congestion), commuters with longer preferred arrival time at work, and those with longer total travel time, have a greater propensity to listen to traffic reports and to use them.

Keywords: traffic information use, ordered logit model.

1. Introduction

The traffic congestion is considered one of the major urban problems whose solution has long been sought for by different engineers, planners, and researchers. The importance and urgency of the problem, particularly due to its consequences like the fuel crisis and pollution impacts cannot be overemphasized. The problem has been approached in many different ways. In recent years, attention has been focused on the demand and supply management policies and strategies due to their far less expenses, compared with highway construction, which no longer is considered a very good solution. In fact, some planners believe that transportation demand and supply management policies are the appropriate substitutes for highway construction (KANAFANI et al. [6]; WALL [17]; OLSZEWSKI–LAM [14]). For developing countries, these issues seem even more crucial due to tighter constraints. Planning and implementing particularly transportation demand management policies and strategies, however, necessitate careful examination and detailed analysis of commuter behaviour and tendencies.

Using traffic information to alleviate urban traffic congestion is one of the feasible solutions, which due to the advanced technology nowadays, seem quite practical and economical. Expanding and developing traffic information systems for the guidance of drivers in their commute decisions have attracted much attention in recent years. Better design and use of Advanced Traveller Information Systems (ATIS) require concise knowledge of factors affecting commuter decision-making process.

The role of traffic information in the process of commuter decision-making cannot be overemphasized. More specifically, the use of traffic information in the form of radio reports is one of the common and inexpensive strategies in travel demand management. The availability of the not very high technology in even the developing countries and the related very low costs make this alternative very attractive and despite the relatively limited benefits, worthy of planning. SPYRIDAKIS et al. [15, 16] in their study of commuter behaviour and design of motorist information systems concluded that commercial radio is most useful for receipt of traffic information. Their sample is from commuters in Seattle, Washington. They found out that a majority of motorists prefer radio even to television and telephone. On the other hand, further development and expansion of this system requires the identification of the factors affecting its use. Previous studies have shown that longer travel time, older age, and longer preferred arrival time increase the propensity to listen to radio traffic reports (KIRKEMO et al. [7]).

MAHMASSANI et al. [10] have examined characteristics of urban commuter behaviour in terms of departure time and route switching propensity and use of traffic information for both morning home-to-work and evening work-to-home trips. They calibrated models of propensity for switching departure time and route for a sample of 638 work commuters from Austin, Texas. Their models used four groups of variables: geographic and network condition variables, workplace characteristics, individual attributes, and use of information (radio traffic reports). Since their study is an exploratory one, it provides useful insights into the mechanisms underlying commuter decision-making behaviour.

In a separate and rather similar study, CAPLICE–MAHMASSANI [3] examined three aspects of commuting behaviour, namely preferred arrival time (PAT), use of information, and switching propensity. They used Poisson regression for modelling PAT and found the importance of permitted delay in their models. Whether the commuters use radio traffic information in their switching decisions, was modelled by binary logit model. They concluded that females, older commuters, commuters with longer travel times, and commuters with longer PAT exhibit higher tendency to listen to traffic reports. MAHMASSANI–CHANG [11] and MAHMASSANI–HERMAN [12] were the first to suggest and measure PAT as a key variable in commuter behaviour.

The present study seeks to identify the factors affecting the use of radio traffic information for the commuters in Tehran and compares the related behavioural patterns with those of cities in developed countries. Payam Radio Station, founded in 1993, is a channel comprised mostly of news and light music, reporting news headlines in every 15 minutes within the period from 7:00 to 21:00. The news are always followed by traffic news informing listeners on the overall traffic situation in the main corridors of Tehran; reporting car accidents, traffic jams and their clearance, advising substitute routes with less traffic. The broadcast of light relaxing music and frequent news has made this radio station attractive to drivers particularly those stuck in traffic in search of better less congested routes. This study aims at evaluating this radio station regarding its effectiveness and efficiency as a traffic information source.

One aim of the authors is to analyse the idea of information technology in its more or less nowadays, simplest form and widespread use as a solution to the heavily congested traffic in the city of Tehran. Radio traffic information is a very cheap (and already implemented) transportation demand management (TDM) strategy whose benefits depend on its characteristics and particularly on the characteristics of its market (the drivers). It is intended to identify the TDM related behavioural patterns in order to be able to utilize their potentials in a more effective and efficient way. Since traffic information has already been in use for about a decade, the data gathered are of revealed preference type as opposed to stated preference data. This paper gives only the results of the first phase in the project traffic information use. More researches in this field are underway.

2. Survey Administration

The analyses in this article are based on the data gathered from a questionnaire designed and developed for this purpose. In the questionnaire, car drivers are asked about their commute and socioeconomic characteristics. The questionnaire underwent an evolutionary process during which it was modified as a result of the feedback received from the pilot distributions. 3000 copies of the finalized questionnaire were distributed among car drivers in the main corridors of Tehran, which were already identified and selected for this purpose. The questionnaire consisted of only one page. The return stamp and the address were also provided on it for the ease of respondents in sending them back; they were only required to fill it in and drop it into the mailbox. The completion of the questionnaire needed about 10 to 15 minutes of concentration and that is why a postal survey was selected as the appropriate method for the purposes of the study. After about three weeks, 447 of the questionnaires (about 15% of the total number distributed) were posted back.

After validation and coding of the questionnaires, the data were entered and the proper databases were made. It should be noted that not all questions were answered (not all questionnaires were completely filled in). In order to take full advantage of all pieces of the useful information provided by the respondents, the missing values were taken care of in a logical way where it was possible. Cases where this was not possible or logical were identified as unanswered questions. Thus, the sizes of the sample for different models are not necessarily always the same.

2.1. Variables Used in Modelling

In the questionnaire designed for this study, drivers are asked how often they listen to (use) Payam radio traffic information on their way to and from work. The four response items are: (they listen) *not at all*, *little*, *moderate*, and *much* (to this radio). This question forms the dependent variable in this study. It is obvious that there exists an ordered relationship between the response items, according to which they can be ranked. Therefore, ordered response model seems to be the proper tool for this aim. The superiority and advantages of these models over the others (like binary or multinomial logit and probit) are emphasized by different researchers (BHAT–PULUGURTA [2]; BHAT [1]; HAMED–EASA [5]).

The explanatory variables used in this study can be categorized in a broad sense into variables available directly from the questionnaires data, and (somehow) modified or constructed new variables. The direct variables from the questionnaire belong to one of the following groups: *individual socio-economic characteristics* like age, sex, education, job category and marital status; *individual driving or job related characteristics* like listening to traffic radio reports, preferred arrival time at work, familiarity with the transportation network, propensity to change route and departure time on the work trip; *work trip characteristics* like distance and travel times; and *job characteristics* like work start and end time, the level of permitted late arrival at work.

Constructed variables are generally new variables defined during the model development process for example the age groups obtained from the continuous variable AGE (Age1 $= 1$ if $19 \leq$ AGE ≤ 24, 0 otherwise) or MwoPD which is the product of Sex (1 if male, 0 otherwise) and Permitted Delay (1 if late arrival is allowed, 0 otherwise). *Table 1* presents the list of variables used in this study.

3. Modelling Use of Traffic Information

The authors propose ordered response model as a proper tool for modelling the concept of traffic information use because of its nature as a continuum of levels and the accuracy and reliability of the responses. In its special case of 2-response category, ordered logit structure reduces to binary logit, which models the concept as a 0 or 1 phenomenon. That is, drivers either listen to (use) the radio traffic news or they do not (at all). Hence, binary logit model does not take into account the different levels of traffic information use (*little*, *moderate*, and *much*) and aggregates them all considered as 1 as opposed to 0; not listening at all.

The use of ordered response models (like the ordered logit model) is particularly useful in this context because the concept being modelled (levels of traffic information use) is ordinal by nature. In this case, the use of multinomial logit model (whose reduced form and special case is again binary logit) is not an appropriate idea since the different response categories indicate the choice of different levels of the same variable and not different unrelated choices (nominal categories).

Table 1: List of variables used in the modelling process

Individual socio-economic characteristics

AGE age of the respondent (years)		
AgeO age ordered variable:		
1 if 19 $\leq$ AGE $\leq$ 24	2 if 25 $\leq$ AGE $\leq$ 34	
3 if 35 $\leq$ AGE $\leq$ 44	4 if 45 $\leq$ AGE $\leq$ 60	
5 if 61 $\leq$ AGE		
Age1 age group dummy variable 1:	1 if 19 $\leq$ AGE $\leq$ 24	0 otherwise
Age2 age group dummy variable 2:	1 if 25 $\leq$ AGE $\leq$ 34	0 otherwise
Age3 age group dummy variable 3:	1 if 35 $\leq$ AGE $\leq$ 44	0 otherwise
Age4 age group dummy variable 4:	1 if 45 $\leq$ AGE $\leq$ 60	0 otherwise
Male sex of respondent:	1 if male	0 otherwise
Single marital status dummy variable:	1 if single	0 otherwise
EDU level of education:		
JOB job category:		

Individual driving or job related characteristics

DTChw departure time change due to congestion from home to work:	0 no	1 yes
DTCwh departure time change due to congestion from work to home:	0 no	1 yes
RChw route change due to congestion from home to work:	0 no	1 yes
RCwh route change due to congestion from work to home:	0 no	1 yes

PAT preferred arrival time at work (number of complete 5 minutes)

USE listening to (using) radio traffic reports:
0 not at all 1 little 2 moderate 3 much

FAMhw familiarity with parallel routes from home to work:
0 not at all 1 little 2 moderate 3 much

FAMwh familiarity with parallel routes from work to home:
0 not at all 1 little 2 moderate 3 much

Work trip characteristics

Thw driving travel time from home to work (minute)
Twh driving travel time from work to home (minute)
TTT total travel time (Thw + Twh)
Dist distance from home to work (kilometers)

Job characteristics

WST work start time in the form of hhmm (hh standing for hour and mm for minute)
WET work end time in the form of hhmm (hh standing for hour and mm for minute)
EW early work start time dummy variable:

1 if $630 \leq$ WST ≤ 730 0 otherwise
PD permitted delay dummy variable:
1 with permitted delay 0 without permitted delay
MwPD men commuters with permitted delay dummy variable:
1 if Male = 1 and PD = 1 0 otherwise
MwoPD men commuters without permitted delay dummy variable:
1 if Male = 1 and PD = 0 0 otherwise
FwPD women commuters with permitted delay dummy variable:
1 if Male = 0 and PD = 1 0 otherwise
EWw early work start time with permitted delay dummy variable:
1 if EW = 1 and PD = 1 0 otherwise

As ordered response (*not at all*, *little*, *moderate*, and *much*) is proposed to be the suitable data for the level of information use, asked in the questionnaire, it is a matter of choosing the level of using traffic information and thus, more detailed results can be obtained. In order to have a review of the underlying model, the following is a rather brief description of these models.

3.1. Ordered Response Models

The underlying assumption for ordered response models is that there exists an unobservable continuous variable (thus called latent), which represents the propensity to use traffic information. What is actually observed is a reflection of this latent propensity as a discrete variable. The ordered response models are classified into two groups, namely logit and probit (McKelvey–Zavoina [13]; Greene [4]). The general structure of these models is:

$$Y_i = \beta X_i + \varepsilon_i. \tag{1}$$

In which:
Y_i is the i-th unobserved dependent variable
X_i is the vector of explanatory variables for the i-th observation
β is the vector of model parameters to be estimated
ε_i is the random segment of observation i

Assume that Z_i is an ordered measurable response corresponding to Y_i and having M response categories $R_1, R_2, \ldots, R_M$ resulting from Y_i and that there exist $M + 1$ real numbers $\mu_0, \mu_1, \ldots, \mu_M$ with the condition:

$$\mu_0 \leq \mu_1 \leq \ldots \leq \mu_M \tag{2}$$

$$Z_i \in R_j \Leftrightarrow \mu_{j-1} \leq Y_i \leq \mu_j, \quad 1 \leq j \leq M, \tag{3}$$

where μ_j is the upper threshold of the j-th response category which defines Z_i and its value. Since Z_i is ordered, it can be sufficiently defined by a set of dummy variables, that is:

$$Z_i = (1 \text{ if } Z_i \in R_j)(0 \text{ o.w.}) \quad 1 \le i \le n, \quad 1 \le j \le M \tag{4}$$

$$\begin{aligned} Z_{ij} = 1 &\Leftrightarrow \mu_{j-1} \le Y_i \le \mu_j \Leftrightarrow \mu_{j-1} \le \Sigma_k \beta_k X_{ki} + \varepsilon_i \le \mu_j \\ &\Leftrightarrow (\mu_{j-1} - \Sigma_k \beta_k X_{ki})/\sigma \le \varepsilon_i/\sigma \le (\mu_j - \Sigma_k \beta_k X_{ki})/\sigma, \end{aligned} \tag{5}$$

where $k = 1, 2, \ldots, K$ stands for the K attributes of the alternative and σ is the variance of ε_i. If ε_i assumes a logistic distribution, an ordered logit model, and if it assumes a normal distribution, an ordered probit model is produced.

Ordered logit has the following distribution:

$$\Pr(Z_{ij} = 1) = \Pr(Z_i \in R_j) = F((\mu_j - \Sigma_k \beta_k X_{ki})/\sigma) - F((\mu_{j-1} - \Sigma_k \beta_k X_{ki})/\sigma) \tag{6}$$

in which, $F(t)$ is the logistic cumulative distribution function $(1 + e^{-t})^{-1}$.

Assuming $\sigma = 1$, ordered probit has the following distribution:

$$\Pr(Z_{ij} = 1) = \Pr(Z_i \in R_j) = \Phi(\mu_j - \Sigma_k \beta_k X_{ki}) - \Phi(\mu_{j-1} - \Sigma_k \beta_k X_{ki}) \tag{7}$$

in which $\Phi(t)$ is the standard normal cumulative distribution function.

It is also generally assumed without any loss of generality that:

$$\mu_0 = -\infty, \ \mu_1 = 0 \ \text{ and } \mu_M = +\infty.$$

3.2. Results of the Model

The results of the ordered logit model for drivers in Tehran using traffic information is presented in *Table 2*. The dependent variable in this model is the propensity to listen to radio traffic information (Payam Radio) while commuting to and from work in an ordered scale.

Regarding *Table 2* it can be concluded that older commuters have a higher propensity to listen to traffic information. Generally, older people tend to be more cautious and thus, they highly value planning, what has a positive effect on listening to radio traffic reports more often. Age variable was used as 3 different types in the model; as a continuous (interval) variable (AGE), ranging from 19 to 81; as an ordered 5-valued variable, ranging from 1 to 5 for different age groups; and as 4 dummy variables, each representing one age group. The interval type was the most suitable one in the model. This conclusion is in accordance with that of CAPLICE–MAHMASSANI [3], even though the variable types used for age are different in the two studies. The same conclusion was also obtained by KIRKEMO et al. [7] using the same kind of variable type for age.

Model results show that commuters who tend to adjust their departure time according to traffic conditions (DTC) have a higher propensity to use traffic information. Departure time change due to congestion is a dummy variable showing a personal characteristic or trait of the commuters. This trait of commuters can be

Table 2. Results of *traffic information use* modelling using ordered logit

Variable	Coefficient	t statistic
Constant	−1.5078	−2.981
AGE	0.0388	4.237
DTChw	0.3859	1.980
PAT	−0.1324	−2.016
Ln(PAT+1)	0.8246	2.721
TTT	0.0089	3.871
μ_1	1.1923	10.141
μ_2	2.7407	17.009

Number of observations, $n = 381$
Value of the log-likelihood function at zero, $L(0) = -519.7841$.
Value of the log-likelihood function at convergence, $L(\beta^*) = -499.0274$.

considered as an indicator of sensitivity to congestion, what justifies more and better use of information to reduce the probability of facing congestion. Commuters, who are more sensitive to congestion and tend to change their departure time accordingly, tend to listen to radio traffic reports more often.

Another meaningful variable in the model is PAT. This variable has dual effect: its absolute value has a negative effect and its logarithm (since PAT can take the value of zero, the logarithm has a +1 in its argument) has a positive effect. It should be noted that the overall net effect is positive: the coefficient of logarithm of PAT is more than six times larger than the absolute value of the coefficient of PAT itself (the model with only PAT variable exhibited its positive effect, however, the model had a lower fit). That is, commuters with longer PAT are more apt to listen to traffic news. Since PAT can also be considered a measure of risk aversion (MAHMASSANI et al. [10]), it has a net positive effect. Similar result has also been reported by CAPLICE–MAHMASSANI [3] who first used PAT as an explanatory variable in traffic information use models.

The other meaningful variable is the total travel time (TTT). Longer total travel times (TTT) cause an increase in level of traffic information use. The result is expected and logical as the probability of incidents increases with travel time. Thus, assuming that commuters consider a margin of uncertainty with their trip, it is increasing with TTT, resulting in a higher level of traffic information use. It is interesting to note that similar effects were reported elsewhere (KIRKEMO et al. [7]; CAPLICE–MAHMASSANI [3]). As in the latter study, the two statistically most significant variables are age and total travel time.

Surprisingly, the findings of this study indicate that driver behavioural patterns regarding use of traffic information for a sample of drivers in Tehran are more or less the same as those in Seattle and Austin.The results confirm the idea of uniform rational behaviour of consumers.

In particular, as shown above, the variable PAT is actually a significant factor in the decision of the level of traffic information use. As an extension to the study, since PAT was identified as a meaningful factor, this concept was more delved into in order to further examine any behavioural pattern similarities for the above samples regarding this concept as well. Therefore, the same model structure is used to prepare grounds for meaning and even comparison. To test the significance and importance of the variable PAT, for the population of drivers in Tehran, this item was also included in the questionnaire.

4. Preferred Arrival Time

Preferred arrival time (PAT), the time period one prefers to be present at work before work actually starts, has been used in the commute behaviour models as an important characteristic of the commuter. Recently some researchers have found that PAT has a more important role in commute decisions and dynamics than the actual work start time (Mahmassani–Chang [11]; Mahmassani–Herman [12]). This quantity can also be used to show some personal characteristics of the commuter like risk aversion, which is quite important in commute decision-making. It has been shown that this variable can be sufficiently modelled using Poisson regression (Caplice–Mahmassani [3]). To test this hypothesis for the population of drivers in Tehran and compare the results (behaviour patterns) with those of similar studies in other locations, this concept was also modelled. Since the respondents generally stated their PAT as a multiple of five minutes, in the corresponding model the number of five minutes will be used as the dependent variable. The large number of zeros for this variable supports further the application of Poisson regression model.

4.1. Poisson Regression Model

The probability of commuter i having a PAT of x according to Poisson distribution is given by:

$$\Pr(y_i = x) = (exp(-\lambda_i)\lambda_i^x)/x!, \tag{8}$$

where λ_i is the Poisson parameter for commuter i. One of the interesting properties of this distribution is that λ_i is both the mean and the variance of the distribution. λ_i has been defined in a number of different ways (Lerman–Gonzalez [8]), of which the most important one is:

$$\lambda_i = \exp(\beta Z_i) \tag{9}$$

in which β is the vector of parameters to be estimated and Z_i the vector of explanatory variables for commuter i. Maximum likelihood estimation is used to estimate β coefficients (Greene [4]; Maddala [9]). The likelihood function for this model is given by:

$$\Pi[[\exp(-\exp(\beta Z_i))(\exp(\beta Z_i))^x]/x!] \tag{10}$$

which yields the following log-likelihood function:

$$L(\beta) = \sum [-\exp(\beta Z_i) + x(\beta Z_i) - \ln(x!)]. \quad (11)$$

A measure of goodness of fit when maximum likelihood estimation is applied is defined on the basis of the difference between the log-likelihood function at zero ($\beta = 0$) and at convergence ($\beta = \beta^*$). The value of log-likelihood function at zero is calculated using the equation:

$$L(0) = \sum [-1 - \ln(y!)] \quad (12)$$

the value of this function at convergence, $L(\beta^*)$, is reported in the output of the statistical packages.

4.2. *Results of the Model*

With the available data for the sample of drivers in Tehran, different models were calibrated using the standard packages like Gauss and Limdep. The results of the selected model for PAT are presented in *Table 3*. The positive sign of MwoPD verifies that male employees without permitted delay have a longer PAT. This can be due to the fact that these commuters must be at work with no delay and thus prefer to be there some time earlier to make sure they are not late. This variable indicates the combined effect of an individual characteristic (sex) and job characteristics (level of delay permitted at work).

Table 3. Results of modeling *PAT* using Poisson regression

Variable	Coefficient	t statistic
Constant	1.0382	16.066
MwoPD	0.3714	5.099
Single	−0.4671	−2.975
EW	−0.2062	−2.571
Age1	0.5576	2.860
Age2	−0.1819	−2.100

Number of observations, $n = 268$ (those respondents for whom permitted delay applies)
The dependent variable is the integer part of the number of 5 minutes.
Value of the log-likelihood function at zero, $L(0) = -599.6641$.
Value of the log-likelihood function at convergence, $L(\beta^*) = -569.9871$.

The variable representing marital status has appeared in the model with negative sign. Single commuters (Single) prefer a shorter PAT. For this group, it seems that employment and income are not really vital and are of less importance compared with married ones. Or may be due to fewer tasks, problems and uncertainties, they have a more reliable schedule and need not follow a larger margin of caution/certainty for presence at work; for example they need not take the children to school on their way to work.

Early work start time defined as a dummy variable, is an important factor for determining PAT. Employees with early work (EW) start times (6:30 to 7:30) have a shorter PAT. This can be ascribed to the fact that at that time of the day, there is not really much traffic and commuters can count on a more or less fixed travel time and need not plan to start off too early. Furthermore, these commuters face a narrower span of time for the maneuver of their departure time; there is an absolute limit to departure time (Caplice–Mahmassani [3]).

Nonlinear effects of commuter age in this model (unlike the previous one) is significantly captured by age-group dummy variables. The age group of 19 to 24 years (Age1) has a longer PAT, while the 25 to 34-year (Age2) group shows a shorter PAT than others. It can be reasoned that since younger people (aged 19 to 24) do not have much experience, need to act more cautiously and so they prefer early presence at work to any kind of delay. Whereas, by the time they are older (25 to 34 years) and more experienced, they have gained enough experience and self-confidence that not only they see no reason to be at work sooner than needed but also, they prefer a shorter PAT than the rest of age groups (greater than 35 years old).

Regarding PAT, it can be concluded that unlike the Austin sample, the Tehran sample is less influenced by permitted delay. For the Austin sample all significant variables (except the constant term) in the model are defined using the concept of permitted delay but, for the Tehran sample only one variable out of the 5 significant variables (besides the constant term) is defined using this concept. That is, most of the explanatory power of the model for Austin sample is due to permitted delay whereas for Tehran this is comparatively limited. That is, not much explanatory power can be observed from this variable in the model for Tehran. This important finding can be an indicator of the strictness of work start time in Austin as compared to Tehran where late arrival at work is not usually a very important issue and does not affect the decision of PAT.

5. Conclusions

This study has focused on identification of factors influencing commuter behaviour of drivers in Tehran. The main focus has been on using traffic information in the form of listening to radio reports. Use of traffic information in the form of radio traffic reports by a random sample of drivers is modelled using ordered response models namely ordered logit model.

The results of the study and its comparison with similar studies in the US have shown that some aspects of commuter behaviour in Tehran are similar to those in the US. In other words, commuter behaviour pattern in the sense of use of traffic information is more or less the same for drivers in Tehran and those in Seattle, Washington and Austin, Texas even though the models are different. In particular, it has been shown that older commuters, commuters who adjust their departure time according to traffic conditions, commuters with longer preferred arrival time, and those with longer total travel time, have a higher propensity to listen to radio traffic reports.

As a statistically significant determinant and factor in the traffic information use, PAT was also delved into. Poisson regression model was employed as a tool for describing preferred arrival time (PAT). It has been shown that male commuters without permitted delay, married commuters, and those in the age ranging from 19 years to 24 have a longer PAT as compared to others. Commuters with early work start time, and those in the age ranging from 25 years to 35 prefer a shorter PAT. Unlike the Austin sample, Tehran sample is less influenced by the permitted delay variable, which reveals a difference regarding the importance of this concept in the decision of PAT in different societies.

This study has focused only on two of the issues pertaining to traffic information. Other issues like the propensity to change departure time and route on the basis of traffic information are among issues which need further research.

Acknowledgements

This research was mainly funded by the Research Deputy of Sharif University of Technology to whom we feel sincerely indebted.

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