



# Driver response to information provided by variable message signs in Beijing



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## ABSTRACT

This paper presents an investigation of driver response attitudes to traffic information provided by variable message signs (VMS). In order to obtain the potential contributing factors affecting drivers' response under the information provided by VMS, stated preference (SP) method was used to collect data through the on-site survey. The survey includes four parts, which are personal socioeconomic characteristics, trip characteristics, driver's attitude and perception towards VMS message content, stated response to VMS displayed, covering 13 questions. A total of 9600 drivers were interviewed to examine the factors affecting drivers' compliance with VMS, and a total of 8477 drivers' questionnaires were valid. Drivers' response in this paper is a polytomous variable with three categories, namely not diverting, undecided and diverting, so the multinomial logit model is used to develop drivers' response model under the information provided by VMS. Correspondingly, twelve explanatory variables are considered in the developed drivers' response model, and three explanatory variables are continuous variables, and the others are categorical variables. The results show that most explanatory variables show significant association with the drivers' response under the information provided by VMS, except for age. Comparing with diverting behavior, some explanatory variables, including gender, driving vehicle, familiarity with alternative route, usefulness, understandability, accuracy and displaying mode of VMS, have positive correlation with not diverting behavior. In a similar way, comparing with diverting behavior, some explanatory variables, including gender, drivers' experience, driving vehicle, usefulness and understandability, have positive correlation with undecided diverting behavior. The findings show that the multinomial logit model developed in this paper provides a better understanding of potential factors related to drivers' diversion behavior.

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## 1. Introduction

In recent years, there is an increasing focus on the use of Advanced Traveler Information Systems (ATIS) to mitigate traffic congestion and delay. ATIS is an important part of Intelligent Transportation Systems (ITS) and is intended to provide drivers with real-time traffic information so as to enable drivers to make more informed decisions regarding route choice and congestion avoidance. Variable message sign (VMS), also known as changeable message sign (CMS) or dynamic message sign

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(DMS), is one of the most elements of ATIS used to disseminate traffic information and road condition to en-route drivers in order to assist them in making route choice decisions. Comparing with information sources such as radio and telephone, VMS does not require any equipment on the drivers' side, which does not distract the driver from driving safely. When VMS has been widely used for disseminating description information on the traffic congestion, incidents, work zone or speed limits, the extent of their capabilities for improving road network performance has not been exploited sufficiently. Numerous studies have shown that displaying route guidance information on the relevant VMS has the potential to improve system performance by influencing drivers' route diversion decisions (Mammar et al., 1996; Yim & Ygnace, 1996). The success of VMS-based control strategies depends largely on the response of the drivers to the conveyed information. Therefore, it is becoming essential to understand the decision-making process of drivers under real-time information provision.

At present, two well-known methods were used to study the relationship between the supplied traffic information and the driver's response, namely Revealed Preference (RP) and stated preference (SP). The RP method, pioneered by American economist Paul Samuelson, is an approach for comparing the influence of policies on consumer behavior. In the VMS arena, the RP approach analyses the driver response to traffic information provided by VMS under real situations and is usually based on the driver report, which records actual driving trips, and observations of actual driver behavior through field studies. The drawback of RP method, which has been conducted in the previous studies, is that the results are limited to the messages conveyed during the study period (Durand-Raucher, Yim, & Ygnace, 1993; Kawashima, 1991). The SP method was originally developed in marketing research in the early 1970s, and it has been widely used to analyze transportation mode choice and consumer choice behavior. In the VMS arena, the SP method analyze driver route choice behavior under the hypothetical scenario. It can be seen that SP method is obviously less time- and cost-consuming than the RP method. Therefore, the SP method was used in this paper to identify the factors that potentially influence driver's route diversion decision under the influence of VMS-based information.

In the last two decades, the contributing factors directly associated with drivers' diversion behavior have been studied by many researchers, and various models have been developed to model drivers' response to VMS. The existing researches show that the driver's socioeconomic characteristics play an important role in affecting drivers' route diversion under the information provided by VMS (Caplice & Mahmassani, 1992; Chen, 2008; Emmerink, Nijkamp, Rietveld, & Ommeren, 1996; Peeta & Ramos, 2006; Wardman, Bonsall, & Shires, 1997). However, these results may differ significantly from one place to another. Caplice and Mahmassani (1992) found that females were more likely to change their departure time than males. In contrast, some evidences show that females were less willing to divert to the alternative route (Emmerink et al., 1996; Peeta & Ramos, 2006). Shao, Dong, and Zheng (2009) found that drivers of private car were more inclined to change their travel route than those of public bus and taxi. Kattan, Nurul Habib, and Islam (2010) found that drivers in the age group of 20–30 and 30–45 were less likely to divert to suggested route, but drivers older than 45 years were inclined to divert to suggested route. Ben-Elia, Erev, and Shifan (2008) found that drivers with limited driving experience tended to trust information provided by VMS.

Trip characteristics have been found to be a major contributing factor to in affecting drivers' route diversion under the information provided by VMS. Dudek (1992) found that the driver's diversion behavior was influenced by traffic conditions on the alternate routes, familiarity with the alternate route and confidence in the information. Hato, Taniguchi, Sugie, Kuwahara, and Morita (1999) found that familiarity with road network was determined to be a major contributing factor to in affecting drivers' route diversion under the information provided by VMS.

The content of VMS displayed and driver's attitude toward VMS have been found to be major contributing factors in affecting drivers' route diversion under the information provided by VMS. Khattak, Schofer, and Koppelman (1993) suggested the driver's diversion behavior was influenced by the accuracy and detailed information. Madanat, Yang, and Yen (1995) found that not only drivers' attitude toward route diversion and their perception of reliability of information provided by CMS, but also the type of information provided by CMS were determined to be significant explanatory variables of the drivers' route diversion intentions. Pal (1998) found that those factors, namely trust in traffic information provided, expectation level of quality of information provided, were determined to be significant explanatory variables of the drivers' route diversion intentions. Dia (2002) found that the information type and the way provided were significant influenced drivers' diversion behavior. Chatterjee, Hounsell, Firmin, and Bonsall (2002) found that the location of the incident and the message content were important factors influencing the probability of diversion. Choolcharukul (2008) found that VMS comprehension and perceived usefulness of VMS were direct determinant for drivers' route diversion decision.

Different methods were used to develop the drivers' route diversion model, such as binary logit (Abedel-Aty, Kitamura, & Jovanis, 1997; Caplice & Mahmassani, 1992; Pal, 1998), multinomial logit (Bierlaire & Thémans, 2005; Kim & Chon, 2005; Qin, Han, & Wang, 2009; Tsirimpas, Polydoropoulou, & Antonio, 2007; Bonsall & Palmer, 1999), binary probit (Gan, Ye, & Gao, 2008) and ordered probit regression (Abdel-Aty, 2001; Mannering, Kim, Barfield, & Ng, 1994).

Based on the above review, it is clear that potential contributing factors in affecting drivers' route diversion under the information provided by VMS have been determined. However, drivers of different socioeconomic characteristics have different understanding of the information provided by VMS, and different understandings result in making different decisions in driving. In other words, the driver's route diversion decision is vague to some extent. Therefore, it is inappropriate that the driver's route diversion behavior is simply classified into two groups: diverting and not diverting. In this paper, a questionnaire survey of drivers' diversion behavior is conducted, and a discrete model is developed to analyze the relationship between drivers' diversion decision and a series of potential factors related to drivers' route diversion behavior. The drivers' response to VMS is classified into three groups, namely not diverting, undecided and diverting.

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