博士論文（要約）

論文題目：**Analyses on Travel Demand Variation Considering Users' Choice Behaviors on Urban Expressway Using ETC Data**

（首都高速道路ＥＴＣデータを用いた利用者選択行動と交通需要変動特性分析）

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Traffic congestion presents a major challenge for our society. Not only the congestion does affect the car users but it also creates various problems to public, particularly, in the form of CO2 emission or air pollution. The concentration of travel demand during peak period and the reduction of roadway capacity during incidents are the major causes of traffic congestion on road network. The concepts of travel demand and traffic management have been introduced in particular to reduce the spatial and temporal concentration of travel demand. Several strategies of travel demand and traffic management rely on the technology to deliver information to assist drivers making a trip. In association with the Intelligent Transportation Systems (ITS), the approaches become more achievable. If service providers were able to understand the nature of travel demand thoroughly, it would enhance the potential of roadway operation.

The conventional framework of travel demand modeling assumes that individual behavior is stable over time. In reality, however, travel demand and drivers' behavior may change over time. Researchers realize to the benefits of considering travel demand uncertainty in their methodologies. The knowledge about variability characteristics of travel demand in real world is rare, since it requires monitoring travel behavior of each individual repeatedly. The assumption of stability in travel behavior allows the conventional approaches to analyze travel behavior using cross-sectional data. To facilitate the more realistic analysis and modeling, it is necessary to observe multi-day or multi-period travel behavior. This observation provides longitudinal or panel data. Collecting individual travel information over multi-period is usually difficult and expensive. The availability of advanced technologies nowadays, especially from traffic surveillance and ITS technologies, provides opportunity to derive revealed preference panel data with lower cost.

On Metropolitan Expressway (MEX) in Tokyo, the Electronic Toll Collection (ETC) system is widely implemented throughout the network. The ETC users can represent the population of expressway users because of their high market penetration rate. Moreover, traffic condition information can be derived from the detector information located everywhere on this expressway network. The major objective of this research is to obtain the knowledge of travel demand variation by using the individuals' travel

information and traffic condition information derived from ETC and detector data.

To achieve this goal, this research presents the possible methods to derive such information from those available data sources. Using the repeated observations of drivers' behavior collected from several selected study areas on MEX, the knowledge of variability in individual travel behavior is examined empirically. The empirical results detect the characteristics of variability in drivers' behavior over time. The significant proportion of intrapersonal variability is confirmed.

A better understanding of travel demand variation should include both spatial and temporal dimensions of drivers' behavior. Drivers' behavior on road network mainly includes route choice and departure time choice. The spatial dimension of drivers' behavior is represented by route choice behavior. Model structures have been developed in particular to account for heterogeneity in drivers' behavior and the variability in behavior over time. Furthermore, the route switching behavior model is introduced to investigate the drivers' route diversion behavior.

On the other hand, a departure time choice model is developed to capture the temporal dimension of travel demand variation on expressway. In general, drivers are aware of their arrival at the destination because of the arrival constraints such as work start time. The ETC data does not provide the information of the start time of an activity at the destination. To take the effects of scheduling consideration into account, the time point reference, namely, Reference Start Time (RST) representing the start time of an activity at the destination is defined. This time point is determined based on the buffer time concept. The scheduling delay consideration is measured from this reference time point. The use of buffer time reflects individual's perception in travel time variation.

The analyses from both route choice and departure time choice on several study areas on MEX provide various knowledge of drivers' choice behavior. The impact of traffic condition information to drivers' behavior is investigated. It is also found that drivers' behavior varies across driver groups (e.g. frequent and infrequent users). The empirical analyses allow us to investigate the day-of-week effect to commuters' departure time

choice behavior as well. Moreover, the results, significant to panel effect, indicate the possibility of using panel-ETC data in modeling drivers' behavior.