Movement and outlook of dynamic traffic management by IT

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(Keywords) ITS, Expressway, Traffic management, Fare policy, Smart IC, Information service

1. Introduction

Expressways have been playing an important role of logistics and mass transportation between regions as foundation of social and economic activities. The proportion of expressway length represents a mere 0.6% against the total road length, but it increases to 9% on car/kilo basis and further to 44% in terms of transport volume of logistics. In addition, expressways fulfilled a function as an emergency transport route and risk management infrastructure at the time of the Great East Japan Earthquake.

However, by comparison with foreign expressways, our road length per head almost equals to -√population[1)] and our expressway density is relatively low now.

The fatal and injury accident rate of expressways against general roads is 1/12 of total roads and also expressways demonstrate considerable decrease of CO2 emission, but utilization rate of expressways is low in comparison with foreign countries. Although utilization rate of expressways in Europe and the United States is about 30%, our number is only 14% showing insufficient utilization. There are several reasons noted such as many missing links, high expressway toll and long distance between interchanges (IC) which is 10 km and about twice as long as the distance in foreign countries.

On the other hand, in order to solve traffic issues such as ease of traffic congestion, traffic safety and environment protection by seeking well-balanced utilization of expressways and general roads in each region, polices like reduced rate and installation of smart IC are being implemented.

2. Present situation of traffic management of expressways

Expressway management utilizing IT falls into the four general classifications, namely, information service, traffic control, fare policy and enhancement of network access. Movement at home and abroad concerning each policy shall be explained below.

(1) Traffic information service (VICS, route guidance)

VICS that distinguishes and delivers congestion degree from traffic counters and speed sensors, and displays traffic information on car navigation systems and mobile terminals is becoming widespread. In addition, a large scale and detailed dynamic route guidance using ITS spots set up on expressways has started. Furthermore, traffic information service by automakers and private information companies is becoming a big trend together with spread of personal terminals like smart phones, etc. Users make a shrewd choice of time and routes, etc. owing to such information service.

(2) Speed control (speed control and management)

Speed control is a policy that traffic controllers recommend or force to control speed in order to keep smooth traffic in case of congestion or an emergency (accident, abnormal climate, etc.). Active Traffic Management : ATM) which is introduced in the U.K. and the United States is a representative sample. ATM controls speed in real time on the basis of traffic volume and speed data. Especially, in case of an accident, ordinary automobiles are allowed to run on breakdown lane in order to keep a lane for accident handling vehicles, thereby accident handling time has been actually reduced significantly. Lane guidance in a sag zone enabled by research and development of ITS and a cruising technology by ACC will be effective linkage with speed control.

(3) Fare policy (road pricing, reduced rate)

In our country, a reduced rate pilot program has been executed throughout the nation with the aim of problem-solving such as improvement of environment in area along a road and ease of traffic congestion through traffic conversion from general roads to expressways. Councils involved in the pilot program around the country have contributed to improve receptivity of residents through program planning and execution, and also publicity and explanation of the outcome.

A nationwide analysis from both sides of effect of congestion ease and feasibility (degree of elasticity) showed the results that (i) reduced rate was effective in the morning and evening and late at night, especially late-night reduced rate made a remarkable switch of heavy vehicles from general roads to expressways, (ii) if an access to IC is good, degree of elasticity is high, etc. On the basis of the results of the pilot program, various and elastic reduced rates such as commuting reduced rate in the morning and evening using ETC and late-night reduced rate, etc. have been executed in earnest.

In Europe and the United States, policies to ease traffic congestion in cities and regions by application of road pricing to toll-free roads. For example, in major metropolitan regions in the United States, HOT lane which charges a part of lanes using IT is prepared as a traffic congestion mitigation program. Depending on a region, pricing and collecting method is different, a dynamic road pricing that fluctuates rates based on the

measured value in order to keep the speed above a certain level on a pay lane is recognized as the most effective method. Further, in Europe, congestion tax charged by ANPR in London and Stockholm and running distance rates for heavy vehicles charged by GPS and DSRC in EU countries such as Germany are becoming full-fledged. In Stockholm, the congestion tax was controversial at the time of introduction, however, as a result of its introduction following a pilot program and a referendum, inter-city traffic has been reduced by 24% three years after full-scale operation and favorable rating for congestion tax has risen to 74%. In this manner, these countries conducted pilot programs and flexibly introduced a fare policy utilizing IT, and finally gained support of residents through actual achievement to solve traffic issues.

(4) Enhancement of network access (Smart IC)

In our country, 63 smart ICs are installed and being operated across the country (as of April, 2013). As smart IC deals with ETC mounted vehicles only, it has merits such as simple tollgate installation, no collecting personnel and finally about a half of installation cost in comparison with traditional IC. In view of the present fact that ratio of ETC utilization has reached 88% at the end of 2012, further increase of utilization volume will be assured. It has been observed that the utilization volume of smart is affected by time crunch population and ETC penetration, etc. and also linked to various fare policies. For example, an exponential increase of utilization volume has been recognized in a trial free charge as well as adjacent IC. Utilization of smart IC has increased significantly because of functional advancement of IC such as full and 24hour operation, and handling of heavy vehicles. Furthermore, features of IC such as use for sightseeing and enhancement of access to emergency medical facilities are fully used.

3. Proposal of dynamic traffic management

Along with preparation of expressway network, selection of plural routes has become possible and it is becoming important to execute policy to guide traffic by information service and fare policy. As mentioned in above 2, IT technology is good at assisting users to take actions wisely within a regional and limited time by providing in real time detailed information meticulously.

In case of expressway management, it is possible to provide meticulous services such as (i) providing in real time information on congestion and fare, (ii) setting a proper level of fare, (iii) locating IC optimally, (iv) maintaining running environment for above a certain speed. Moreover, it is important to link policies of (i) through (iv) with each other. The author would like to propose traffic management which incorporates dynamic road pricing by IT composed of an integrated combination of information service, fare policy and access control, and also route guidance. Specifically, the proposed method provides in real time information on wide area congestion situation and a fare corresponding to this situation, then guide the nearest IC and show recommended route based on such information. It is necessary to verify cost and effect, but I believe that it is highly probable from technical point of view.

4. Various fare policies by IT and running distance rates [2)]

In Europe and the United States, pilot programs and review to introduce running distance rates by IT instead of fuel tax are carried out rapidly in view of securing revenues for social infrastructure corresponding to the rapid spread of EV and fuel-efficient car. It is a tough challenge to have this charge accepted by society considering a sense of burden of the charge, privacy and fairness, etc. but it is sure that discussion in those countries will become more lively because it is technically feasible. In consideration of running distance rates for heavy vehicles on main highways and actual introduction of congestion charges during peak hours and study progress of GPS usage on general roads for experimental running distance rates, it is highly possible for the time being that running distance charges will be introduced for limited type of cars within an area including expressways and main highway network. Although the time of introduction is unclear, I firmly believe that EV and micro-mini mobility are generalized and personal terminals play a great role.

[References]

1) Hitoshi IEDA: Vision – The Role of the Roads Responding to the Falling Population Environment: 'Square root of Population×Area(national land coefficient) hypothesis' and 'Interaction opportunity hypothesis,'*Dôro* (Roads) Magazine March issue 2005, pp4-5
2) See below for the recent developments of the running distance rates issues:
http://www.gao.gov/products/GAO-13-77